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Seasonal variations of zooplankton community in freshwater reservoir Gulbarga District, Karnataka, South India

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Abstract- In the present work, we provide quantitative information on the seasonal variations of zooplankton and selected physico-chemical variables a large man-made reservoir in the Gulbarga district. In the study period we have recorded 24 species of which, 10 species belongs to rotifera, 6 species belongs to cladocera, 5 species belongs to copepoda and 3 species of ostracoda. Among zooplankton, particularly rotifera was the dominant group throughout the study period and highest count was recorded in the summer season while low incidence was observed in southwest monsoon season. Zooplankton community is also correlated with physicochemical parameters. The results indicate that the distribution and density of zooplankton species influenced by physical and chemical factors of the environment.
Keywords- Rotifera, Cladocera, physico-chemical parameters, seasonal flucuations.

Introduction

Dry lands are located in arid, semi-arid or dry subhumid climatic zones, comprising 41% of all continental areas of the Earth's surface and are home to more than 2 billion people, or approximately one-third of the world population. It is estimated that around 20% of the dry lands of the planet are already completely desertified and that the desertified areas will increase considerably in the coming decades [24]. In semi-arid regions, the droughts and the highly irregular rainfall, together with high evaporation rates, cause the loss of a great part of the surface waters. As a result, almost the entire hydrologic network is alter, which leads to a severe problem for the storage and uses of this essential resource. Therefore, many reservoirs are constructed in these regions with the main purpose of storing water for various purposes. The frequent alterations in trophic state, other physico-chemical factors in these reservoirs represent an important selective factor for the success of potentially colonizing species. Furthermore, these reservoirs are relatively shallow environments, highly vulnerable to wind action and to oscillations in climatic conditions, which represent other important selective factors for the biota. Hence, the composition and the relative abundance of species in the aquatic communities must be influenced by the variations in the trophic state, seasonal changes of physico-chemical variables of the waterbody. Zooplankton has been recommended as regional bioindicators of lake eutrophication [3, 28, 29, 6, 38, 39] acidification [27], disturbances by agriculture [10 26]. Although zooplankton are usually considered to be good indicators of environmental changes and have a fundamental role in energy flow and nutrient cycling in aquatic ecosystems, these organisms have been little studied in aquatic ecosystems of Hyderabad Karnataka region. Therefore, their potential value as indicators of alterations in the water quality of reservoirs in these regions needs to be assessed. Also, there is an increasing demand by environmental monitoring programs for bioindicators of water quality. This study attempted to investigate the structure and composition of the zooplankton community in Khaji Kotnoor reservoir

Study area

The Khaji Kotnoor reservoir a major perennial reservoir of the district and located at near Gulbarga city, which is 22 km away from the Gulbarga University campus which falls under 17°22′30″ N latitude and 76°59′0″ E longitude (Fig. 1). The total cathment area of Khaji Kotnoor is 265.70 Sq.Km and live storage capacity is 5.1784 mm^3 and grass storage of the reservoir is 6.2180 mm^3. This reservoir is used for drinking water and irrigation purpose. The maximum depth of reservoir is 9 meters.

Materials and methods

Monthly zooplankton samples were obtained from each of these sites for the period October 2005 to September 2006. Concurrently, water samples were taken for measuring selected physico-chemical variables. For zooplankton samples, we filtered 40 l of water using plankton net of 50 μm mesh size. Samples were collected from the surface (0.5 m) during the morning hours. Although we collected the samples for some months at fortnightly intervals, for presentation we pooled the data and expressed it on a monthly basis. Zooplankton samples were preserved in 10%formalin at the site itself. At the time of sampling, we measured the surface water temperature and pH, conductivity and secchi depth. Analysis of other variables (dissolved oxygen, free ammonia, dissolved ammonia, nitrite, nitrate and phosphate) were conducted in the laboratory using standard procedures [2].

Identification of zooplankton species was done using standard literature [19, 11, 18]. For quantitative analysis, we counted the number of individuals for each species present in aliquot of 1ml from the concentrate (to 100 ml) of field-collected zooplankton. The data were later converted to the actual quantity of water filtered from the lake. We used 3–4 aliquots for each sample. Density of zooplankton was expressed as number of individuals per liter.

Results

The range of atmospheric temperature throughout the study period varied from 29 ^{O}C (December) to 36(May) ^{O}C and the water temperature was ranged between 22 ^{O}C (December) to 27 ^{O}C (May). During the study period, the range of dissolved oxygen values varied from 5.1 to 9.5 mg/l, the lowest being during the winter and highest during summer. Similarly pH of the reservoir indicated an alkaline condition. High values pH (8.7) was observed in summer while the values were near-neutral in winter (pH=6.8). Conductivity measurements suggest an annual average of 148 μS cm^{-1}. The highest values of over 231 μS cm–1 were recorded in the month of June. The concentration of nitrate content was ranged between 0.28 mg/l to 1.05 mg/l. Phosphate values were ranged between 0.19mg/l to 0.74 mg/l). The annual mean value of the N:P (nitrate nitrogen: phosphate ratio) ranged from 0.78 to 8.88. Secchi disc transparency values recorded between 0.89 to 2.12 m depending on the period of sampling. In general, higher transparency values were recorded during the northeast monsoon season. Monthly and seasonal abundance of zooplankton for one year of investigation presented in Table No1, 2 Fig 1,2. Principle component analysis Fig 3. The zooplankton of Khaji Kotnoor reservoir consists of Rotifers, Cladocera, Copepoda and Ostracoda; the total 24 species were recorded from the reservoir during the present study, in which 10 taxa of rotifera, 6 taxa of cladocera, 5 taxa of copepoda and 3 taxa of ostracoda contributed to zooplankton diversity in the reservoir. There was a distinct seasonal fluctuations and composition of the zooplankton in the Khaji Kotnoor reservoir with productive (October to May), retardation (June to August) and recovery (September onwards) periods. The total zooplankton population was dominated by rotifera (41%), cladocera (28%), copepoda (23%) and ostracoda (8%) respectively. Among zooplankton, rotifera was the dominant group. The rotifera group was represented by 10 genera. The most dominant being *Brachionus species,* represented by 4 species viz., *Brachionus angularis, B. candatus, B. calyciflorus and B. rubens.* The others were*, Tricocera cylinderica, T. smiles, Lapadella ovalis, Lecane luna, Keratella tropica,* and *K. cochlearis.* The most common species occurring throughout the year were *Keratella tropica, Keratella cochlearis, Brachinus angularis, Trichocerca similis.* Maximum density of rotifera between 81 ind/l to 329 ind/l were recorded during October 2005 to September 2006. The highest numerical abundance of rotifera population was observed in the month of May (329 ind/l), while low density was observed in the month of September 2006. The maximum density of rotifera noticed in summer season, while low incidence was recorded in northeast-monsoons season. Among the rotifers *Brachionus angularis, Tricocera cylinderica, Keratella tropica, and K. cochlearis* were dominant species. Statistically rotifers showed positive correlation with copepods ($P< 0.05$; $r = 0.72$), Dissolved oxygen ($P< 0.05$; $r = 0.71$), phosphate ($P< 0.01$; $r =0.58$) and primary productivity ($P < 0.01$; $r =0.58$) respectively. The ShannanWeiner diversity indices of the rotifers is 2.373 and Simpson index values is 0.897, dominance value is 0.102 and evenness values is 0.89 respectively. In the present investigation cladocera group represented by 6 species *Viz., Monia brachiata, Monia macrocopa, Daphnia carinata, Daphnia pluxes, Euryalona orientalis, Alona pulchella .* This group was second dominant group during the study period. The maximum density was observed in southwest monsoon season and northeast monsoon season, while low density was observed in summer season. Among the cladocera *Daphnia Pluex* and *Monia brachiata* were dominant species throughout the study period. Statistically cladocera showed positive correlation with total alkalinity ($P< 0.01$; $r = 0.68$), nitrate ($P<0.05$; $r = 0.81$) rotifera ($P<0.01$; $r = 0.52$) and ostracoda ($P<0.01$; $r = 0.71$). The ShannanWeiner diversity indices value of the caldocera is 2.29 and Simpson index values is 0.81, dominance value is 0.110 and evenness values is 0.83 respectively. The copepoda group is represented by 4 species *Viz., Mesocyclops lukarti, M.hyalinus, Paracyclops fimbriatus, and Neodiaptomus strigilipes .* High incidence of copepoda was encountered in southwest monsoon season and northeast monsoon season. The maximum density of cladocera was recorded in the month of October 2005 (223 ind/l), while low density was noticed in summer season in the month of April (39 ind/l). Statistically copepoda showed positive correlation with dissolved oxygen ($P<0.01$; $r = 0.68$), total alkalinity ($P<0.01$; $r = 0.64$), primary productivity ($p< 0.05$; $r = 0.71$) respectively. The ShannanWeiner diversity indices of the copepoda is 0.23 and Simpson index values is 0.83, dominance value is 0.109 and evenness values is 0.86 respectively. Ostracoda occupied fourth position of zooplankton and represented very low population diversity compared to other groups. This group represented by three species *Viz.,*

Hemicypris fossulate, Spirocypris and Hyocypris. This group was also found abundantly in winter season followed by monsoon season during study period. The high number of individuals recorded in the month of December 2005 (58 ind/l) and low number was observed in the month of July 2006 (10 ind/l). The ostracoda was absent in the April and May months. Satistically ostracoda showed positive correlation with total alakalinity ($P<0.01$; $r = 0.70$), rotifera ($P<0.01$; $r = 0.66$) and ostracoda ($p <0.05$; $r = 0.081$). The ShannanWeiner diversity indices value of the rotifers is 2.1 and Simpson index values is 0.81, dominance value is 0.128 and evenness values is 0.86 respectively.

Discussion

Based on the nutrient data, this reservoir can be regarded mesotrophic. However, we found a high density of phytoplankton, indicated by a low Secchi transparency particularly during the summer months. There are numerous studies indicating the importance of phosphates and nitrates in controlling the abundance of phytoplankton and thereby, zooplankton [33,5]. A better indicator of nutrient status of reservoir or lakes appears to be the ratio of nitrate nitrogen to orthophosphates (N:P). It has been shown that a ratio less than 10 results in nitrogen limitation which favors cyanobacterial blooms [12, 37, 25]. In the present study, these ratios ranged from 0.98 to 5.68. However, the complete reliance on N:P ratios may not always be sufficient to explain autotroph succession in water bodies [45, 21, 8]. In aquatic ecosystems zooplankton plays a critical role not only in converting plant food to animal food but also they themselves serve as source of food for higher organisms. zooplankters provide the main food for fishes and can be used as indicators of the trophic status of water bodies [42]. In the temperate lakes and reservoirs the plankton production often takes the form of a bimodal curve with productionand autumn peaks [44]. These studies range from high altitude ponds to typical tropical systems [32, 41]. Data on the temperature, nutrient concentrations, pH range, dissolved oxygen values, and Secchi transparency were in general agreement with limnological characteristics of waterbodies. but there is no quantitative data on the seasonal abundance of zooplankton. Studies on this reservoir are also interesting to compare whether patterns conform to tropical or temperatewater bodies. [16, 7] has reported that the increase alkalinity of water increases the zooplankton population. In the present study some of the zooplankton groups increase with rise in alkalinity of water. Rotifers are prominent group among the zooplankton of a water body irrespective of its trophic status. This may be due to the less specialized feeding, parthenogenetic reproduction and high fecundity [31]. Among the zooplankton rotifers respond more quickly to the environmental changes and used as a change in water quality [13]. During the study period the high incidence of rotifers in summer season indicating the influence of temperature on positive correlation between temperature and rotifers population. Similar trend was noticed by [36, 35, 17] while working with other reservoirs. Cladocerns are play key role in limnotic and benthic food chain. Seasonal variations of cladocerans population in Indian reservoirs and lakes have been reported [23,30,22].The presence of *Daphnia* species indicates that reservoir water is clear and indication of absence of organic pollution. On other hand chemical variables are also with in the permissible limit. Competition and predation are two factors strongly affecting the structure of zooplankton communities in freshwater ecosystems [14]. Reviewed the negative relationship between the density of rotifers and cladocerans. In the present study, we found inverse relationship between rotifer density and the abundance of cladocerans. Similar observation were reported by [4,17]. In the present study maximum abundance was noticed in southwest monsoon season and northeast monsoon season, while low density was encountered in summer months. This may be due to availability of food and competition between other species. Copepods are high in stable environmental conditions and they disappear as pollution level increased [9]. The seasonal variations of copepods were studied in Indian waterbodies by several workers [23,43]. During the study period copepods showed direct correlation with ostracods and rotifer population, indicate that their differential food preference in habitat. [34] reported that the maximum abundance of copepods in winter season, while low density was in monsoon season. Our findings are agreeable with earlier reports. Ostracoda occupied fourth position of zooplankton and represented very low population diversity compared to other groups [15] reported that high abundance and diversity ostracods occurred in hard water. The maximum abundance of ostracods in northeast monsoon season and southwest monsoon season indicate that they prefer low temperature. In conclusion, our study showed that although nutrient levels were moderate, relatively high densities of zooplankton were found in Khaji Kotnoor reservoir. The densities of various zooplankton thus, in the order rotifera > cladocera > copepoda > ostracoda. The results indicates that the maximum number of genera occurred during winter season than summer and monsoon season which also reported by [1,20] the less number of genera might be attributed to the less nutrients in the reservoir which consequently result in less productivity. The reduction in the number of species may be due to predation,

variation in the other physico-chemical factors. In winter, it is biotic interaction operating through feeding pressure rather than water quality it seems to affect the zooplankton diversity and density particularly the stocked fish species play an important role in harvesting species of copepoda and cladocera, thereby reducing their predatory pressure on other groups. The rotifers and particle feeder cladocera were higher in winter can be linked to favorable temperature and availability of abundant food in the form of bacteria, nanoplankton and suspended detritus.

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Table1- Monthly variations in zooplankton groups (No ind/l) in Khaji Kotnoor reservoir

Months	Zooplankton				
	Rotifera	Cladocera	Copepdoa	Ostracoda	Total
Oct 2005	121	198	223	35	577
Nov	136	162	194	49	541
Dec	142	120	141	58	461
Jan 2006	171	69	89	56	385
Feb	286	93	51	24	454
Mar	275	71	50	18	414
Apr	306	32	39	00	377
May	329	11	52	00	392
Jun	102	182	123	12	419
July	122	231	114	10	488
Aug	99	198	94	22	413
Sep	81	246	73	31	431
Total	2170	1504	1251	427	5,351

Table 2- Seasonal variations in zooplankton groups (No/l) in Khaji Kotnoor reservoir

Seasons	Zooplankton			
	Rotifera	Cladocera	Copepdoa	Ostracoda
NEM	142 ± 20.95	137± 50.55	161±59.20	49±10.40
Summer	299 ± 23.76	51.75 ± 30.07	48±6.05	21± 4.24
SWM	101±16.79	214.25 ± 29.39	101± 22.25	18.75 ± 9.70

NEM=Northeast monsoon season, SWM=Southwest monsoon season.

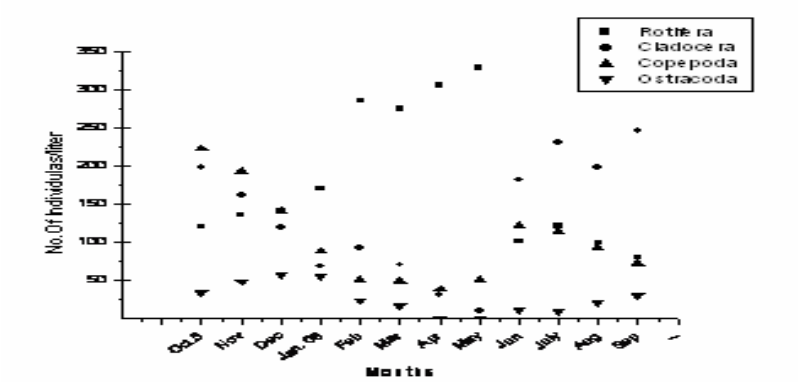

Fig. 1- Monthly occurrence of zooplankton groups (No of Ind/l) in Khaji kotnoor reservoir