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Research Article

STUDY OF ZOOPLANKTON BIODIVERSITY AND THEIR ECOLOGY IN GUNDOLAV LAKE, KISHANGARH (AJMER), RAJASTHAN

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ABSTRACT
Gundolav Lake is situated in Kishangarh (Rajasthan) lies at $26^0$28' N and $74^0$52' E, at 500 m above MSL. This lake is now on the verge of extinction due to pollution hazards caused by drainage and sullage water of Kishangarh town in it. Change in water quality exerts selective pressure on the diversity and abundance of zooplanktons. The study reveals that the diversity of zooplanktons have been fairly good evidenced by the presence of a total of 70 species belonging to 60 genera belonging to Protozoa (40 sp.), Rotifer (12 sp.), Cladocera (06 sp.), Ostracoda (04 sp.) and copepod (08 sp.). Eight species were found perennial at all stations while additional 05 species were also found perennial at one or more stations. Maximum zooplanktons were observed in summers followed by winter and monsoon. The zooplankton population showed a positive correlation with TDS, BOD, and chloride concentration.

Keywords: *Zooplanktons, Physico-chemical factors, Gundolav, Biodiversity, Co-relation*

INTRODUCTION
The physico-chemical conditions present in various combinations and intensities create the fundamental environment and structure upon which the occurrence, distribution, and success of aquatic organisms depend (Forbes, 1887). Aquatic ecosystems are the most delicate ecosystem and are easily disrupted by various human activities. Zooplanktons are highly sensitive to environmental variations and as a result, change in their abundance, species diversity, or community composition can provide an important indication of environmental change or disturbance (Irwin, 1968).
Conditions within an environment are mutually dependent largely and the growth and distribution of the plankton population are not determined by a single factor but by the combined effects of many physico-chemical factors (Laprise and Dodson, 1994).
A study on zooplankton biodiversity and their ecology greatly contribute to an understanding of the basic nature of the aquatic ecosystem since zooplankton forms the main link in the entire food chain. Zooplanktons play an important role in the trophic dynamics of the aquatic ecosystem (Tundisi and Tundisi, 1976).

Figure 1: Gundolav Lake of Kishangarh (Rajasthan)

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Study Area

Kishangarh is an important industrial city of Ajmer district, located on National Highway No. 8 between Ajmer and Jaipur. The city lies at 26^0 28' North latitude and 74^0 52' East longitude in the central Aravali region. Topographically, this region is an ecotone region characterized by more or less a plain surface interrupted by low hills. The area in and around Kishangarh city is characterized by many shallow perennial fresh-water bodies and temporary ponds.

Gundolav Lake, as the reservoir is popularly known, is a man-made lake located in the North of Kishangarh town just close to the Phool Mahal. Surrounded by hills on two sides, this reservoir resembles a natural lake with regard to morphometry, dynamics of nutrients, and types of inhabiting biota. The surface area of water is more and the lake is shallow. Monsoon prevails in this region from June end to mid-September.

The study was aimed to observe variations in species composition and density of zooplankton population biodiversity of the lake and to analyze the correlation between BOD and zooplankton biodiversity of the lake.

MATERIALS AND METHODS

Methodology

Water samples along with plankton were collected from the five stations (Station I – *Bheru Ghat*, Station II – *Shiv Ghat*, Station III – *Temple Corner*, Station IV – *Nala Site*, Station V – *Awannaki Pal*), on a fixed date of each month, covering a complete annual cycle, encompassing all the three seasons - monsoon (July to October), winter (November to February), and summer (March to June). The samples were collected by filtering 120 liters of lake water through a plankton net (Mesh No. 25) and stored in 70% ethanol having a 5 ml Glacial acetic acid solution. Zooplanktonswere identified with the help of standard references mentioned in the fresh-water animals of India by Tonapi (Tonapi, 1980). Sedgwick-Rafter cell method (Moore, 1952) was used for the quantitative estimation of zooplanktons. The procedure was repeated by taking another replica and continuing until about 10 replicates were counted.

$$No.\ of\ planktons/liter = \frac{No.\ of\ organisms\ counted}{No.\ of\ replicates\ taken}$$

RESULTS AND DISCUSSION

In the present investigation, zooplankton's population comprised five groups namely; Protozoa, Rotifera, Cladocera, Ostracoda, and Copepoda. Among the zooplankton, 70 species belonging to 60 genera, out of these 40 were protozoans, 12 rotifers, 6 cladocerans, 4 ostracods, and 8 copepods.

In Gundolav Water, Protozoan's showed superiority over other groups both in terms of the number of species (57.14 % of all zooplanktons) and population density (67.27 org./lit). Percentage contribution to the zooplankton population in terms of species composition and density was in the following order:

Species Composition (in %)

Protozoa (46.05) > Rotifera(22.37) > Cladocera(10.90) > Copepoda(10.64) > Ostracoda(7.21)

Population Density (organisms/liter)

Protozoa(67.27) > Rotifera(35.38) > Copepoda(16.09) > Cladocera(14.78) > Ostracoda(12.80)

In the present investigation, total zooplankton showed more or less a bimodal type of annual variation. The prominent one was during April (summer) and the other in January (winter). Yadav *et al.* (1987) found a bimodal pattern of zooplankton population with summer and winter maxima in Dighalibeel (Assam), similar patterns were also observed by Sanjer and Sharma (1995) in Kawar Lake wetland, Begusaria, Bihar and by Jindal (2002) in Bicherli Pond, Beawar.

Table 1: List of Zooplanktons reported from Gundolav Lake, Kishangarh

S. NO.	NAME OF SPECIES	S. NO.	NAME OF SPECIES
Protozoa			
1.	*Euglena spirogyra*	*21.*	*Glaucoma pyriformes*
2.	*Phacuspleuronectes*	*22.*	*Vaginicolacrystallina*
3.	*Ceratiumhirudinella*	*23.*	*Neobursaridiumgigas*
4.	*Amoeba proteus*	*24.*	*Metopussp.*
5.	*Pelomyxapalustris*	*25.*	*Metopusovalis*
6.	*Arcelladiscoides*	*26.*	*Spirostomumambiguum*
7.	*Lesquereusiamodesta*	*27.*	*Blepharisma intermedium*
8.	*Difflugiapyriformes*	*28.*	*Paramoeciumcaudatum*
9.	*Prorodonteres*	*29.*	*Unicentrum turbo*
10.	*Holophrya simplex*	*30.*	*Frontoniacomplanata*
11.	*Urotrichabhatiai*	*31.*	*Cyclidium glaucoma*
12.	*Loxodesstriatus*	*32.*	*Cothurniacurva*
13.	*Coelepsdevadaniensis*	*33.*	*Platycoladecumbens*
14.	*Dileptusanser*	*34.*	*Pyxicolaaffinis*
15.	*Didiniumnasutum*	*35.*	*Vorticella campanula*
16.	*Chilodonellauncinata*	*36.*	*Condylostoma patens*
17.	*Chilodonellacucullulus*	*37.*	*Eulotes patella*
18.	*Colpodaaspera*	*38.*	*Oxytrichaovalis*
19.	*Colpodainflata*	*39.*	*Oxytrichaoblongatus*
20.	*Plagiopylanasuta*	*40.*	*Saprodiniummimeticum*
Rotifera			
41.	*Hexarthramirum*	47.	*Epiphanes clavulata*
42.	*Brachionusforficula*	48.	*Lecane sp.*
43.	*Brachionuscalcyflorus*	49.	*Monostyla bulla*
44.	*Keratellatropica*	50.	*Hexarthrasp*
45.	*Keratellaprocurva*	51.	*Filiniaterminalis*
46.	*Macrochaetusserica*	52.	*Filinialongiseta*
Cladocera			
53.	*Daphnia carinata*	56.	*Ceriodaphnia sp.*
54.	*Daphnia lumholtzi*	57.	*Macrothrix sp.*
55.	*Moina sp.*	58.	*Diaphanosoma sp.*
Ostracoda			
59.	*Ostracod sp.*	*61.*	*Cypris sp.*
60.	*Stenocyprismalcomsoni*	*62.*	*Heterocypris sp.*
Copepoda			
63.	*Heliodiaptomusviduus*	*67.*	*Spicodiaptomuschilospinus*
64.	*Phyllodiaptomusannae*	*68.*	*Cletocamptusalbuquerquensis*
65.	*Neodiaptomusschmackeri*	*69.*	*Mesocyclopsleuckart*
66.	*Neodiaptomushandeli*	*70.*	*Mesocyclopshyalinus*

Table 2: Total number of species and density of zooplankton (org./ lit)

Station	Monsoon		Winter		Summer	
	Total no. of Species	**Total Density**	**Total no. of Species**	**Total Density**	**Total no. of Species**	**Total Density**
I - *Bheru Ghat*	39	323	63	565	65	727
II - *Shiv Ghat*	34	325	56	618	63	891
III - *Temple Corner*	29	222	57	464	63	622
IV - *Nala Site*	32	509	59	761	64	1096
V - *Awannaki Pal*	33	274	60	500	62	642

Temperature fluctuations influenced the seasonal occurrence of the zooplankton with the highest densities occurring in warmer months. Manzer *et al.* (2005) and Pandey *et al.* (2004) also reported the maximum total population of zooplankton during summer and suggested that this seasonal variation may be due to environmental changes. In contrast to the present study, Maruthanayagam *et al.* (2003) reported a higher density of zooplankton during the rainy season and their stabilization during the post rainy season and further decline.

In the present study, protozoans dominated the zooplankton population; the reason for the low rotifer population as compared to protozoan may be due to their predation by copepods as also observed by Sharma *et al.* (1990). Maximum populations of Protozoa were recorded in winter (13.8^0C to 19.6^0C) and minimum during monsoon (22.3^0C to 29.5^0C). Low pH, low alkalinity and hardness, running water conditions, and lack of vegetation failed to provide a suitable environment for the growth of Protozoa during monsoon (Kaur *et al.* 1997). In the presently studied Gundolav Lake, the presence of *Euglena* and *paramoecium sp.* is indicative of the lake being polysaprobic.

In the present investigation, a bimodal pattern of abundance of rotifers population has been noticed. Rotifers attained the first peak in July (29.5^0C) and others in May (29.4^0C). The abundance of rotifers during monsoon, particularly at station IV may be attributed to its dependence on phytoplankton and detrital matter as food. Rao (1987) and Bhatnagar (2005) observed similar findings.

Among zooplanktons, rotifers are perhaps the most sensitive indicator of water pollution. The Rotifera communities were reported to have a positive correlation with dissolved solids and any variation in the suspended solids, dissolved solids, organic matter, etc. in the water would immediately affect their distribution (Holland *et al.*, 1983). So the presence of certain species may be used as a reference for physical and chemical characteristics of water (Pejler, 1981). In Gundolav waters, *Brachionus calcyflorus, Brachionus forficula, Keratella tropica,* and *Keratella procurva* can be regarded as indicators of the eutrophicated condition of the lake. The present study also confirms a positive correlation of rotifers with TDS (r = 0.45).

The cladoceran population was relatively scanty during the present investigation with 10.90% in species composition and having a population density of 14.78 organisms per liter. The main cladocerans peak was observed during the summer. In the present investigation, a low number of cladocerans in the presence of sufficient food may be due to active competition between cladocerans and other groups. In the present study, a high peak of the cladoceran population was recorded during summer. It can be said that the summer peak of this population prefers a higher temperature, pH, and conductivity. In contrast to the present study, Sunkad (2004) reported maximum cladocerans were found in the rainy season followed by winter.

The ostracods were found to be the least prominent group (only 7.21% in species composition) during the present study. They have not found a comfortable place in the total zooplankton population. In Gundolav waters, the presence of ostracods was seen during the rainy season and *Cypris sp.* was perennial in occurrence.

In the present investigation, station III showed a minimum zooplankton population (population density 222 org/liter in monsoon) throughout the study period. Due to more anthropogenic activities like sewage discharge, *Trapa* cultivation, and due to much macrophytic-growth, station IV located in the standing water exhibited maximum population (64 species identified in winter) and species diversity (1096 org/liter in winter).

Water temperature (23.1 ± 0.48^0C) showed a positive correlation with Rotifera, Cladocera, and Ostracoda, whereas protozoans of Gundolav showed a negative correlation (Table: 3). Jindal (2002) also reported a positive correlation of water temperature with Protozoa, Rotifera, Cladocera, Copepoda, Ostracoda, and total zooplankton in Bicherli Pond of Beawar, Rajasthan.

Table 3 : inter-correlation matrix ('r') in zooplankton and Physico-chemical properties

	Temperature	pH	Transparency	Alkalinity	Total Hardness	Calcium	Mg	TDS	DO	BOD	Chlorine	Nitrate	Phosphate
Total Zooplanktons	-0.13	0.36	-0.62	0.40	0.33	0.21	0.27	0.61	0.24	0.53	0.57	-0.34	0.30
Protozoans	-0.45	0.22	-0.64	0.48	0.09	-0.06	0.13	0.51	0.14	0.28	0.70	-0.62	0.09
Rotifers	0.76	0.43	0.03	0.09	0.61	0.78	0.29	0.45	0.08	0.68	-0.23	0.73	0.63
Cladocerans	0.67	0.66	-0.18	0.45	0.46	0.56	0.24	0.55	0.27	0.69	0.13	0.56	0.57
Ostracods	0.71	0.45	-0.01	0.14	0.43	0.67	0.15	0.30	0.20	0.57	-0.15	0.75	0.46
Copepods	-0.08	0.47	-0.58	0.24	0.43	0.23	0.40	0.60	0.26	0.61	0.51	-0.30	0.27

Besides temperature, other factors like pH, alkalinity, dissolved oxygen, nutrients, etc. work singly or collectively on the zooplankton population (Davis, 1955) and their life processes are affected by the inflow of sewage as well as decomposition of waste material in the catchment area. Ansari and Raja (2007) also observed a positive correlation of the zooplankton population with water temperature and pH while studying the fresh-water bodies of the Aligarh region.

In Gundolav, depth of visibility negatively influenced the zooplankton population. Bhatnagar (2005) also reported an inverse relationship of total zooplanktons with transparency. In the present study, the total zooplankton showed a positive correlation with TDS, BOD, and chloride concentration (Table: 3).

DO was found to have a slight positive correlation with zooplankton (r = 0.24) whereas Bhatnagar (2005) reported a strong positive relationship between the two, suggesting wider availability of the food (nannoplankton) was responsible for the positive relation. On the other hand, Jindal (2002) observed a negative correlation between DO and total zooplankton in a highly eutrophic lake in Beawar (Ajmer). In the present investigation, in general, a positive correlation was observed between BOD and total zooplankton (r = 0.53).

The study revealed a positive correlation of Cladocera with pH (r =0.66). Johri (1989) have also reported similar observations in Lower Lake of Bhopal. However, Pandey *et al.* (2004) reported a negative correlation between pH and phosphate. The data of zooplankton indicate that in Gundolav, rotifers,

cladocerans, and ostracods were the zooplankton found positively correlated with calcium, nitrate ad phosphate (Table: 3). Protozoans and copepods, on the other hand, were positively correlated with chloride (Table: 3). Pandey *et al.* (2004) also reported a negative correlation of Rotifera with pH, DO, and transparency. But in the present study, rotifers showed no relationship with Transparency (r = 0.03) and DO (r = 0.08) and strong positive correlation with pH (r = 0.43).

CONCLUSION

Therefore, due to the multifold pressure of urbanization and industrialization, urban sewage water discharge, cultivation of Singhara (*Trapa bispinosa*), lake water is subjected to various biotic and abiotic influences which in turn have affected its quality. This anthropogenic meddling exerted selective pressure on the diversity and abundance of zooplanktonic forms inhabiting the Lake. The study revealed that the biodiversity of zooplankton's has been fairly good, evidenced by the identification of a total of 70 species belonging to 60 genera. The zooplankton population showed a positive correlation with TDS, BOD, and chloride concentration. Rotifers, cladocerans, and ostracods were the zooplanktons that were found positively correlated with temperature, calcium, nitrate, and phosphate. Protozoans and copepods, on the other hand, were positively correlated with chloride. In general, transparency was found to be negatively correlated with the planktonic population. If BOD is considered, then a positive correlation was found with the zooplankton except for the protozoans.

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