AN ASSESSMENT OF ZOOPLANKTON COMMUNITY AND PHYSICO-CHEMICAL PARAMETERS OF SAFARI ZOO LAKE, LAHORE.

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خلاصہ

زوپلاکٹن دنیا بھر میں حیاتیات ہیں جو پانی کے ہر ذخائر میں موجود ہیں۔ وہ آپس میں جڑے ہوئے ہیں اور آبی ذخائر میں پوری جماعت کو تشکیل دیتے ہیں۔ زوپلاکٹن کی ہزاروں اقسام دنیا میں پائی جاتی ہیں۔ موجودہ مطالعہ 2019 میں کیا گیا ہے، یہ لاہور کے سفاری چڑیا گھر میں اس برادری کی ایک قابل تصویر تصویر پیش کرتا ہے۔ یہ ایک میٹھا پانی ہے لیکن تفریحی اقدار کے لئے استعمال کیا ہوا جھیل ہے۔ نمونے لینے کا معیاری طریقہ اپنایا گیا تھا۔ زوپلکٹن میش کی مدد سے، زوپلکٹن کو جھیل کے پانی سے جمع کیا گیا۔ جسمانی کیمیکل پیرامیٹرز کا مطالعہ کرنے کے لئے پانی کے نمونے الگ الگ جمع کیے گئے تھے۔ زوپلانکٹن کے چار بڑے گروہوں سے کل 45 پر جاتیوں کی نشاندہی کی گئی تھی جن میں روٹیفیرا، کوپپوڈا، کلاڈوسیرا اور ٹنٹنڈس شامل ہیں۔ ان پر جاتیوں میں سے کچھ کی ابتدائی تحقیقوں میں شاذونادر ہی اطلاع ملی تھی۔ ہماری تحقیق نے نہ صرف ہر نوع کو پر جاتیوں کی سطح تک شناخت کیا بلکہ تنوع اور کثرت کی بھی کھوج کی۔ جسمانی کیمیکل پیرامیٹرز نے جھیل میں زوپلیپٹن کی آبادی کو متاثر کیا جیسے گندگی، ہیپیچ اور تحلیل آکسیجن کے ساتھ ساتھ کچھ حیاتیاتی عوامل بھی۔ جھیل کی حالت خود مختار تھی۔ تمام گروہوں میں سب سے زیادہ پائے جانے والی انواع یوٹروفک بریکیئنس کیلسیفلورس (پلاس، 1766) تھی، جو ایک روٹیفر تھا، جو بائیوانڈیکیٹر کے نام سے مشہور ہے۔ اس کی موجودگی کے ساتھ ساتھ کچھ دوسری پر جاتیوں نے بھی جھیل کی حالت کی تصدیق کر دی ہے۔

Abstract

Zooplanktons are worldwide organisms which are present in every water reservoir. They are interlinked and shape up the whole community in the water bodies. Thousands of species of zooplanktons are found in the world. The present study carried out in 2019, presents a vivid picture of this community in Safari Zoo Lake, Lahore. It is a fresh water but manmade lake used for recreational values. Standard method of sampling was adopted. With the help of zooplankton mesh, zooplanktons were collected from lake water. Water samples were collected separately to study physico-chemical parameters. Total 45 species were identified from four major groups of zooplanktons including Rotifera, Copepoda, Cladocera and Tintinnids. Some of the species identified were rarely reported in the earlier researches. Our research not only identified each species up to species level but also explored the diversity and abundance. The physico-chemical parameters influenced the zooplankton population in the lake like turbidity, pH and dissolved oxygen as well as some biotic factors. The lake condition was eutrophic. The most abundant species among all groups was *Brachionus calyciflorus* (Pallas, 1766), a rotifer, which is well known as a bio-indicator. Its presence along with some other species confirmed the eutrophic state of lake.

Keywords: Zooplanktons, Rotifera, Copepoda, Cladocera, Tintinnid, physico-chemical parameters, *Brachionus calyciflorus* (Pallas, 1766).

Introduction

Zooplanktons play a key role in freshwater bodies within food chains acting as primary and secondary linkages. The zooplankton community and population dynamics helps to determine the flowing processes going on in fresh water (Uma *et al*., 2018). Zooplanktons play an important role in maintenance of stable and healthy ecosystem (Krylov, 2015). Zooplanktons can be studied in against a fixed place to find out the changes in their species composition and their patterns of assemblage. The pattern of zooplanktons species composition can bring out changes in the interlinked micro-invertebrate and fish composition of any water body, so both the compositions shape up dynamic nature of whole community (Das *et al*., 2020). In a fixed place, many factors can contribute in the rhythmic movement of zooplanktons for example availability of food, pressure exerted by predators and light cycle including hypo-limnetic anoxia which leads lake water stratification (Arcifa *et al*.,

2013). Presence of fish and fish fry in lakes causes reduction in zooplankton communities. This has special effect on Cladocera (Jack and Thorp, 2002).

Hu *et al*., (2019) has reported presence of three major groups of zooplanktons including Rotifera, Copepoda and Cladocera. According to their observations, Rotifers came out to be diverse, abundant and rich group of zooplankton in comparison with the rest of types. Among zooplanktons, Rotifers are worldwide in distribution and are more common in fresh water bodies (Leasi and Smet, 2020). Copepoda is the second important and imperative group of zooplanktons originated in oceans, present in all forms of water bodies. They constitute major component of water communities and are also the bio-indicator of water quality (Maqbool *et al*., 2014). Cladocera are the crustaceans, worldwide in distribution, sensitive to pH changes and are indicative of eutrophic state of a lake (Dumont *et al*., 2020). Tintinnids are small organisms forming an integral part between nano and micro planktons in the food webs specially marine environment (Santiago and Langman, 2018). The present study carried out a preliminary research to explore zooplankton community of the Safari Zoo Lake, Lahore and find out the diversity and density of all obtained types of zooplanktons in relation to physico-chemical parameters. Our aim was to identify zooplanktons up to species level and to find out their density and diversity.

Materials and Method

Study Area and Sampling Period:

The Woodland Wildlife park later named as Safari Zoo Lahore was established in 1981 and opened for public in 1996. It contained a large artificial lake with five manmade islands four large and one small. The average temperature of the park was 9-14 ˚C minimum and 34-38 ˚C maximum. Whereas the average rainfall was about 663.9 mm. The Safari Zoo lake was the study area. This lake is the biggest in the whole city. It was about 7 feet 2 inches (2.19 m) deep and covered about 5 acres area. Sampling was done from January to December (2019), once in each month. Sampling was done between 10 am to 12 pm morning time. In order to cover the maximum diversity of zooplanktons, whole lake was divided in four parts Easter Site (ES), Western Site (WS), Northern Site (NS) and Southern Site (SS) (Figure 1).

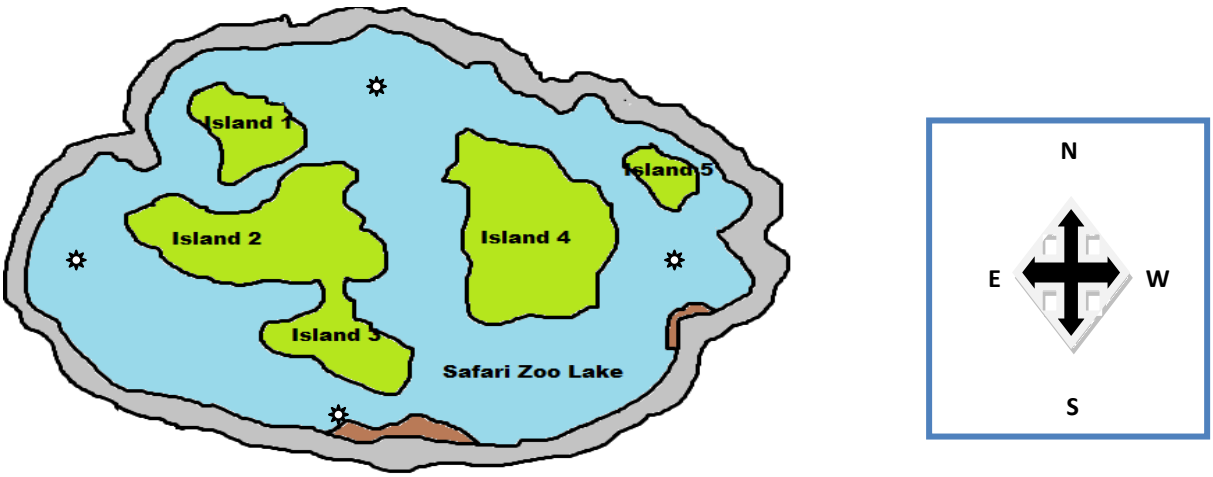

Fig.1. Map of Safari Zoo Lake, Lahore with Locations of Sampling ( ).

Zooplankton Sampling, Counting and Identification: Zooplankton samples were collected rowing a water boat in the lake applying tow method. A zooplankton net of mesh size 37 µm fitted in a circular frame of 30 cm diameter and fixed with 90 cm long rope was dipped and towed in the water to allow about 50 liters of water to pass through it horizontally for five minutes. The contents were preserved in Tarson 100 ml plankton tubes with 4 % formalin solution (Koste, 1978; Sulehria and Malik, 2012). For quantitative analysis, the zooplanktons were counted with Sedgewick-Rafter Chamber. The zooplanktons were identified with the help of various keys including Ward and Whipple, 1959; Pennak, 1978; Michael and Sharma, 1988; Yoo and Kim, 1990 and Segers, 2007.

Water Sampling and Physico-Chemical Parameter Analysis: For estimation of physico-chemical parameters, water samples were collected separately. Bottles were washed with lake water to acclimatize before collection. The sample was collected carefully to avoid air bubble formation. Physico-chemical parameters studied include Temperature (Air and Water), Turbidity, Salinity, Electrical conductivity, Oxygen Saturation, Dissolved Oxygen and Transparency. These parameters were determined with the help of their respective meters (APHA, 2005) (Table 1).

Table 1. Physico-Chemical Parameters and the respective meters.

Physico-Chemical Parameters	Meters
Temperature (Air and Water)	Thermometer (HANNA HI-8053)
Dissolved Oxygen and Oxygen Saturation	D.O. Meter (YSI-Eco Sense DO 200)
Electrical Conductivity and Salinity	Electrical Conductivity Meter (YSI-Eco Sense 300)
pH	Ph Meter (YSI-Eco Sense pH 100)
Transparency	Secchi Disc and Measuring tape
Turbidity	(HANNA HI-93703)

Data Analysis: Analysis of variance (ANOVA) was applied to study the significance of biotic factors with abiotic factors. It was applied with the help of Minitab 13. Species abundance curve were plotted for each group of zooplankton to study maximum abundance and diversity. It was plotted with the help of Past Software. Graphs were plotted Microsoft Excel 2010.

Results and Discussion

In total four different types of zooplanktons were obtained including Rotifera, Copepoda, Cladocera and Tintinnids. Total 45 species of zooplanktons were identified. There were 23 species of Rotifers belonging to 8 genera. Copepods included 13 species belonging to 6 genera and Cladocera obtained were 6 species belonging to 5 genera. Three species of Tintinnids belonging to one genus *Tintinnopsis* were obtained (Table 2). So among all zooplanktons, Rotifers were the most abundant (Figure 2). The physico-chemical parameters showed variations in the study period except salinity which remained unchanged with mean value of 0.17. Lowest values of air and water temperature were observed during January (18.2˚C) and (11˚C) respectively. Dissolved oxygen (mg/dl) was highest in September (14.5 mg/dl) and lowest in March (5.5 mg/dl). Electrical conductivity (µs/cm) was lowest in September (510.9 µs/cm) and highest in May (570.9 µs/cm). Oxygen saturation (mg/l) was highest in October and lowest in April (1.55 mg/l) and (5.61 mg/l) respectively. pH ranged (6.8-8.18). Transparency was lowest in November (1.77 inches) and highest in January (3.65 inches). Turbidity was highest (447 FTU) in October and lowest (152 FTU). ANOVA (Analysis of Variance) showed that oxygen saturation, dissolved saturation and pH were statistically non-significant. Whereas rest of the physico-chemical factors were statistically significant (Table 3) (Figure 3).

Table 2. Diversity of Zooplankton Species obtained from Safari Zoo Lake.

Rotifer Species	Rotifer Species	Copepod Species	Cladocera Species	Tintinnids Species
Brachionus calyciflorus	*Keratella valga*	*Dicyclops thomsai*	*Daphnia longispina*	*Tintinnopsis wangi*
Brachionus sericus	*Keratella cochlearis*	*Dicyclops bicuspidatus*	*Daphnia lumholtzi*	*Tintinnopsis sinensis*
Brachionus urceus	*Lecane luna*	*Dicyclops nanus*	*Alona guttata*	*Tintinnopsis subpistillum*
Brachionus bidentatus	*Polyarthra dolicoptera*	*Eucyclops micrurus*	*Moina micrura*	
Brachionus forficula	*Polyarthra minor*	*Mesocyclops vericans*	*Bosima longirostris*	
Brachionus diversicornis	*Polyarthra remarta*	*Eucyclops pheleratus*	*Chydorus reticulatus*	
Brachionus angularis	*Polyartha trigla*	*Macrocyclops fuscus*		
Brachionus quadridentatus	*Pleurotrocha petromyzon*	*Acanthocyclops virdis*		
Cephalodella gibba	*Synchaeta oblonga*	*Eucyclops elegans*		
Cephalodella exigua	*Synchaeta stylata*	*Mesocyclops leuckarti*		
Filina longiseta	*Synchaeta pectinata*	*Eucyclops agilis*		
Filina terminalis		*Macrocyclops albidus*		

Various biotic factors i.e. animals other than zooplanktons were also found during sampling including nauplius larvae, tadpole larvae, fish fry and small fish at all sites. Water fowls were present to lesser extent (Table 4). Species abundance curves were plotted for each group of zooplankton. The most abundant species of Rotifer group was *Brachionus calyciflorus* and least abundant was *Lecane luna*. In Copepod group most abundant species *Dicyclops thomsai* and least abundant *Eucyclops agilis.* In Cladocera group most abundant species is *Alona guttata* and least abundant is *Moina micrura*. Most abundant species of Tintinnids is *Tintinnopsis sinensis* and least abundant is *Tintinnopsis subpistillum* (Figure 4).

Table 3. Physico-Chemical Parameters of Lake Water.

Parameters	R	M±SDV	ANOVA
Air Temperature (˚C)	18.2-38	29.4±6.54	F= 46.28, P=0.000
Water Temperature (˚C)	11-35.1	25.53±8.03	F= 29.44, P=0.000
Dissolved Oxygen (mg/dl)	5.5-14.5	12.35±2.51	F= 4.41, P=0.050
Electrical Conductivity (µs/cm)	510.9-570.9	535.8±18.7	F= 8977.43, P=0.000
Oxygen Saturation (mg/l)	1.55-5.61	4.13±1.10	F= 1.19, P=0.490
pH	6.8-8.18	7.55±0.48	F= 0.50.28, P=0.000
Salinity	0.12-0.2	0.17±0.03	F= 17.14, P=0.001
Transparency (Inches)	1.77-3.65	2.38±0.56	F= 9.71.28, P=0.006
Turbidity (FTU)	152-447	290.9±107	F= 43.31, P=0.001

Key: R= Range of parameters; M= Mean; SDV= Standard Deviation; ANOVA= Analysis of variance.

Table 4. Presence of non-zooplankton biotic factors of lake.

Biotic Factors	ES	WS	NS	SS
Phytoplanktons	+++	++	+++	++
Macrophytes	++	+	+	+
Mosquito Larvae	+	++	++	++
Tadpole Larvae	+	+	+	+
Fish Fry	+	+	+	+
Fish	+	+	++	+
Water Fowl	+++	+	++	+

Key: ES (Eastern Site); WS (Western Site); NS (Northern Site); SS (Southern Site); Abundant= (+++); Numerous= (++); Lesser= (+).

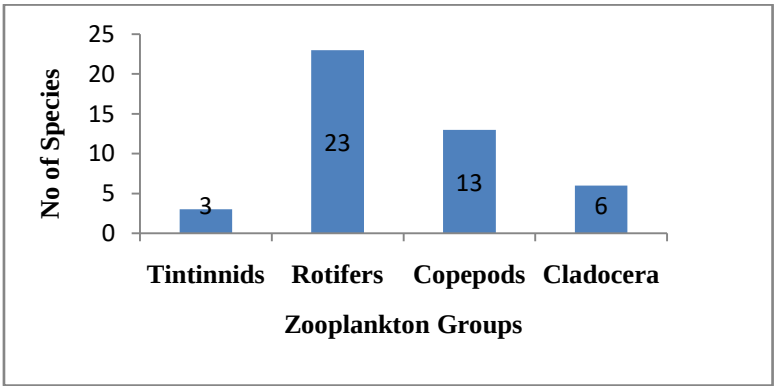

Fig.2. Number of species obtained of zooplanktons from safari Zoo Lake, Lahore.

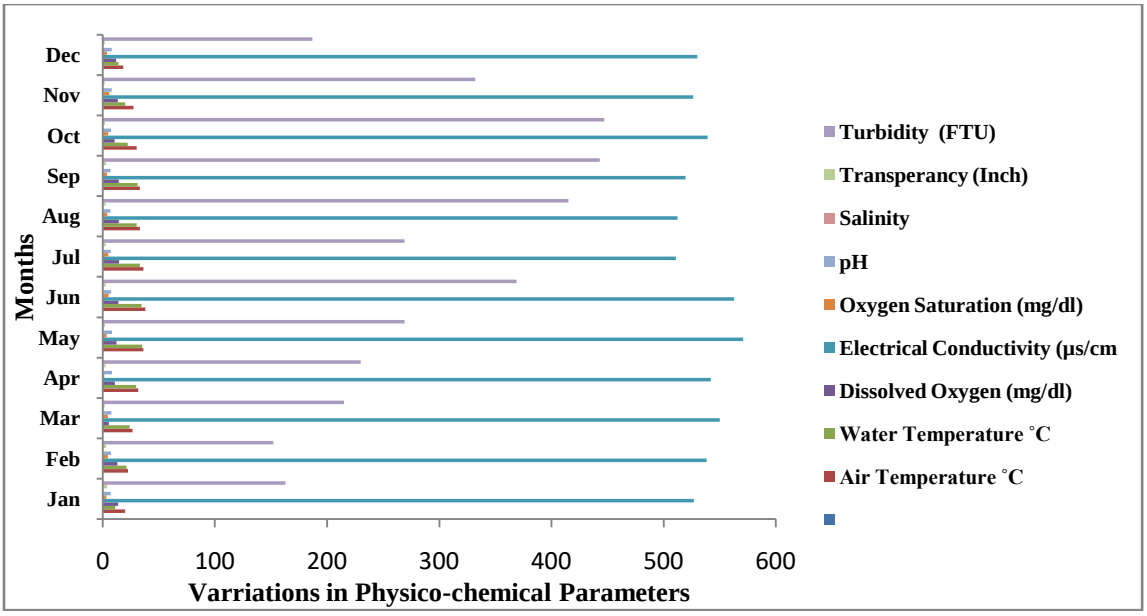

Fig.3. Monthly Variation of Physico-Chemical Parameters.

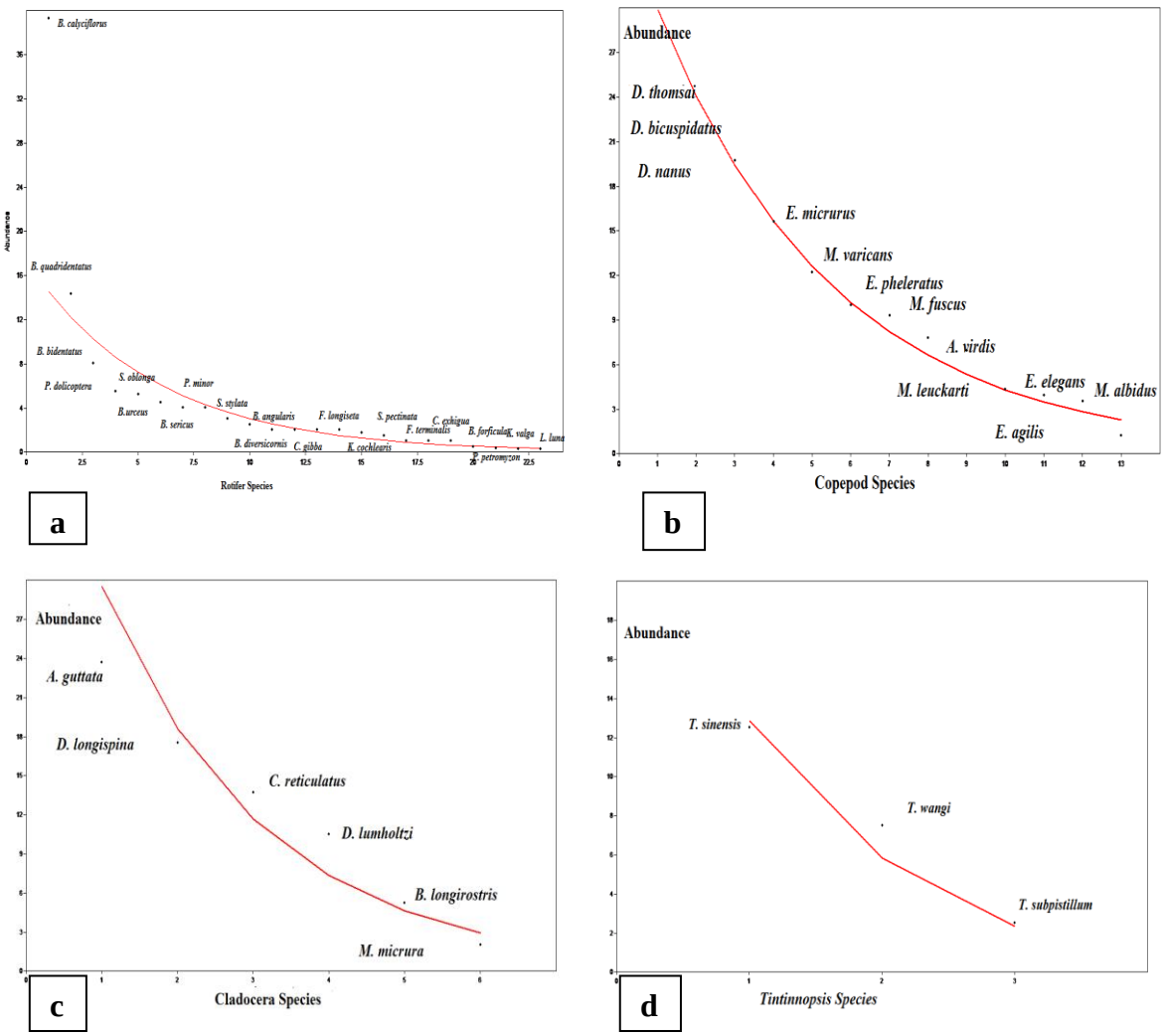

Fig.4. Species Abundance Curve; (a) Rotifer; (b) Copepoda; (c) Cladocera; (d)Tintinnids.

In the present study, four types zooplanktons were collected from the four different sites of Safari Zoo Lake. Maximum number of species (23) belonged to Rotifera. A similar study conducted by Abbai and Sukand (2013) reported Rotifers constituting 41 % of total zooplankton population over Copepoda and Cladocera. *Brachionus calyciflorus* was the most dominant species and *Lecan luna* was least abundant in this group. The abundance of *Brachionus calyciflorus* has been supported by many of the studies as it is the bio-indicator of eutrophic state of any water reservoir. The same diversity of rotifers were also reported from a study conducted on pond (Pattnaik, 2014). Moderate diversity of copepods was explored in the present study although food source available was available. This is due to temperature fluctuations, high turbidity and predation in the form of Cladocera and fish fry etc. Most species belonged to genera including *Dicyclops*, *Eucyclops* and *Mesocyclops*. These species are usually reported earlier in water bodies with above mentioned conditions. A similar observation has been made by Maqbool *et al*., (2014). A moderate diversity of copepods have been observed, this is in accordance with the reports presented by Sharma and Sharma (2021). The presence of Cladocera genera including *Alona* and *Bosmina* shows light on the eutrophic state of this lake, because these species are bio-indicators. A similar result was reported by Zawisza *et al*., (2016). These are species adapted to live in such conditions. The present study has reported the occasional presence of Tintinnids for the first time in Pakistan which is a small ciliated planktonic group. Titinnids were the least abundant and least diverse group. Only three species were obtained belonging from the same genus *Tintinnopsis*. Among Tintinnids, the most abundant species was *Tintinnopsis sinensis*. Tintinnids showed seasonal presence preferring to occur in the period of low temperature including December, January and February only. The physico-chemical parameters like pH, dissolved oxygen and transparency were regulating the population. This observation gets support from a similar study by Dash *et al*., (2017).

Since the lake water was replaced with one tube-well, replacement process was very slow and was not good enough for such a large lake. These zooplanktons were linked in small food chains, were used as food source for other biotic factors i.e. predators in the form fish fingerlings and adult fish. The whole linkage of the biotic factors formed a food web with larger water animals like water fowls, amphibians and reptiles coming from islands. Many reptiles coming from islands along with water fowls like ducks contributed excreta in the water leading the conditions towards eutrophication. Moreover solid wastes were also observed in lake water contributed by people coming for boating to the lake. So overall low diversity was observed and condition of lake was eutrophic. Predation, eutrophication and some of the physico-chemical parameters were shaping up the community structure of zooplanktons.

Conclusion

Due to eutrophic condition of lake, overall low diversity of the zooplankton community in Safari Zoo Lake was observed. The results of this study could be helpful in future to study the factors contributing eutrophication of a water reservoir, interlinked relationship of zooplanktons and role of higher biotic factors on the density and diversity of major zooplanktons. This work is in support of investigation of biodiversity of zooplanktons as an ideal model to discover the short term and long term effects of anthropogenic and human activities on the water reservoirs. Moreover it is necessary to explore zooplanktons for their diversity and abundance so that these organisms can be categorized to be cultured in labs for the possible commercial use as cheap food source for fish larvae and adult fish to flourish fisheries.

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