Biospectra : ISSN: 0973-7057, Vol. 17(1), March, 2022, pp. 23-30
An International Biannual Refereed Journal of Life Sciences

5(AS).
Animal Science

ISSN : 0973-7057

Int. Database Index: 616 www.mjl.clarivate.com

Composition and abundance of zooplankton in freshwater perennial ponds of Madhepura district, North Bihar

Avinash Kumar[a], Jai Nandan Prasad Yadav[a] & Arun Kumar[b]*

[a]Department of Zoology, K. P. College Murliganj, B.N.M. University, Madhepura, Bihar, India

[b]University Department of Zoology, B.N.M. University, Madhepura, Bihar, India

Received : 15th October, 2021 ; Revised : 16th December, 2021

Abstract- The study was conducted to explore the zooplankton composition and abundance in freshwater perennial ponds, locally named as Puraini Pokhar (Pond 1) and Baghmara Talab (Pond 2) located at Madhepura district, North Bihar. Water and zooplankton samples were collected monthly from March, 2019 to February, 2020. The investigation on physico-chemical characteristics at both the ponds revealed its alkaline nature, suitable for aquaculture practices. Four groups of zooplankton viz. Rotifera, Cladocera, Copepoda and Ostracoda comprising of total 26 species were identified.Of these 23 species consisting 13 species of Rotifera followed by Cladocera 5 species, Copepoda 4 species and Ostracoda 1species were recorded from Pond 1, though, 17 species comprising 11 species of Rotifera followed by Cladocera and Copepoda 3 species each were identified from Pond 2. Zooplankton abundance ranged from 82 ind./l to 318 ind./l in Pond-1 and from 54 ind./l and 376ind./l in Pond-2. Zooplankton density was minimum during monsoon and maximum in summer. Percentage compositions showed dominance of Rotifera contributing 55.56% followed by Copepoda 22.53%, Cladocera 20.73% and Ostracoda1.18% in total zooplankton abundance in Pond 1, while, Rotifera contributing 57.75%, followed by Copepoda 23.04% and Cladocera 19.86% in Pond 2. Most dominant rotifers were *Brachionus angularis*, *Brachionus caudatus*, *Brachionus falcatus*, *Filinia longiseta* and *Keratella tropica* in the studied ponds. No important differences were observed in abundance of Cladocera and Copepoda. Among cladoceran group, *Daphnia* sp. were found most dominant followed by *Moina dubia*. Copepoda was dominated by *Nauplii.* Sørensen's similarity index was applied to assess similarity in the species composition among the ponds. Index values showed highest similarity in copepods species 85.71% followed by rotifers 75% and cladoceran 50%. The distribution and density of zooplankton was influenced by physical and chemical factors of the pond environment were discussed.

Key words: Zooplankton, abundance, composition, perennial ponds, physico-chemical factors

INTRODUCTION

Zooplanktons are most common heterogeneous assemblage of free floating minute animal forms found in all aquatic ecosystems. Zooplankton comprises of various taxonomic groups belonging to 4 major groups, Rotifera, Cladocera, Copepoda and Ostracoda often dominate entire consumer communities. Zooplanktons are most important biotic components influencing all the functional aspects of aquatic ecosystem, such as food chain, food web, energy flow and cycling of materials.[1] They are highly sensitive to physical and chemical changes in water. Zooplankton occupies the secondary level in the food chain and mediate transformation of the food energy synthesized by the phytoplankton to the higher trophic level.[2] They are

*Corresponding author :
Phone : 9006991000
E-mail : prf.arunkumar@gmail.com

important food for fish and many invertebrate predatorsand graze heavily on algae.Carp fish fry feed mostly on zooplankton.[3] They play an important role in indicating the trophic condition of aquatic system.[4] Zooplankton composition and abundance of zooplankton is affected by several environmental and biological factors and also limited by the various physico-chemical parameters.[5,6] There is, however, no information on zooplankton communities found in the water bodies of this region, particularly in Madhepura district. Thus, the present investigation was made to determine physico-chemical condition and zooplankton composition and abundance as well as community similarities in two perennial ponds of Madhepura district, North Bihar.

MATERIALS & METHODS

Study area

The present study was carried out on freshwater perennial ponds namely Puraini pokhar (Pond-1) and Baghmara talab (Pond-2) of Madhepura district, North Bihar (Fig 1). Pond-1 is a rectangular shape water body spread over an area of 2.79 acre located at latitude 25°35'53" N and longitude 86°59'31"E. Fishery of pond is being managed by local fishermen. Pond-2 is an irregular shape surrounded by farming lands spread over an area of 2.2 acre situated at latitude 25° 34' 26" N and longitude 87° 0' 34" E. No organized fishing activity is being carried out in this pond.

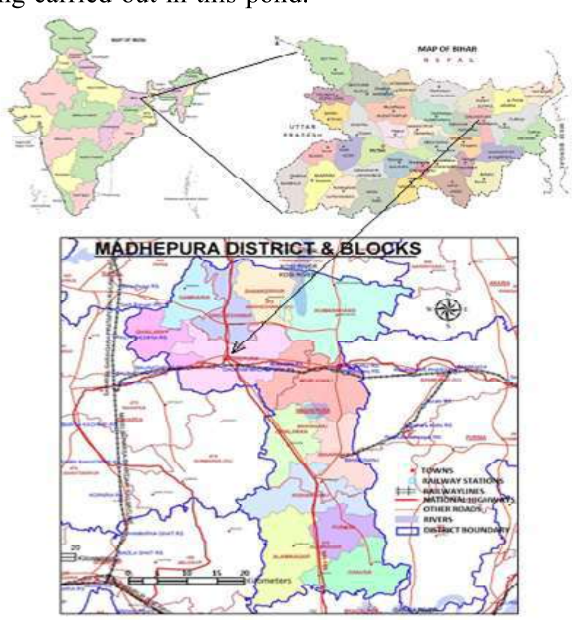

Fig. 1: Geographical location of Madhepura district, North Bihar

Water quality monitoring

The physico-chemical parameters of water were analyzed monthly from March 2019 to February 2020. Water samples were collected in 2-liter polyethylene containers between 08 am to 10am. Temperature was recorded using mercury thermometer graduated up to 50°C. Transparency was measured by Secchi disc (20cm diameter). The parameters, such as temperature, Secchi depth, pH, dissolved oxygen, free carbon dioxide, carbonate and bicarbonate alkalinity were recorded at sampling site and parameters like conductivity, calcium, magnesium, chloride, nitrate-nitrogen, phosphate-phosphorus and BOD were analyzed in the laboratory. Physico-chemical parameters were analyzed following standard methods.[7]

Zooplankton sampling

Zooplankton samples were collected using plankton net made up of bolting cloth, No. 25 (Mesh size approx. 56m). For zooplankton collection 50 liter of sub-surface pond waters were filtered through the net from the ponds. Samples were then transferred to specimen bottles and preserved by adding 5% formalin on site. Identification and analysis of the zooplankton was conducted in laboratory under a binocular compound microscope with different magnifications. Quantitative analysis of zooplankton was done using Sedgewick-Rafter plankton counting chamber. Analysis involved transfer of 1 ml sub-sample from each of the samples to the Sedgewick-Rafter chamber using pipette. The zooplanktons were identified up to genus and species level with the help of standard taxonomic references,[1,8-10] and counts were expressed numerically per liter of water of the pond. Community similarities were analyzed using Sørensen's similarity index.[11]

RESULTS & DISCUSSION

Physico-chemical characteristics

The range and mean with standard error (SE) of physico-chemical variables of water are shown in Table 1. Seasonal variations in water temperature might be related to the weather conditions. No important differences were observed between the water temperature ranged between 17.1°C and 30.9°C in Pond-1 and between 18.5° C and 31.2° C in Pond-2. Maximum water temperature was recorded in summer might be due to longest sunshine hours, higher atmospheric temperature

Table 1: Physico-chemical parameters of Pond 1 and Pond 2 showing the ranges, mean averages and Standard Error (±SE)

Parameters	Pond-1		Pond-2	
	Min. - Max.	Min. - Max.	Min. - Max.	Min. - Max.
Water temperature °C	17.1 - 30.9	26.43 ± 0.82	18.5 - 31.2	26.65 ± 0.76
Secchi disc depth cm	19.3 - 55.3	36.42 ± 2.24	11.2 - 36.7	23.83 ± 1.41
EC µmohs/cm	91.2 - 221.7	164.11 ± 7.47	183.6 - 412.3	286.33 ± 13.53
pH	6.9 - 8.3	7.6 ± 0.07	6.8 - 8.1	7.5 ± 0.06
Dissolved oxygen $mg.l^{-1}$	5.2 - 8.2	6.69 ± 0.19	5.1 - 8.0	6.33 ± 0.17
Free carbon dioxide $mg.l^{-1}$	2.1 - 7.6	5.6 ± 0.71	5.4 - 10.1	7.9 ± 1.07
Carbonate alkalinity $mg.l^{-1}$	6.8 - 13.7	9.8 ± 0.44	11.4 - 26.8	18.98±0.88
Bicarbonate alkalinity $mg.l^{-1}$	98.6 - 253.2	161.31 ± 7.73	174.2 - 311.3	214.4 ± 7.78
Calcium $mg.l^{-1}$	17.3 - 33.6	25.13 ± 0.87	23.2 - 45.3	33.13 ± 1.19
Magnesium $mg.l^{-1}$	6.2 - 15.4	9.52 ± 0.45	4.8 - 21.5	14.7 ± 0.94
Chloride $mg.l^{-1}$	9.7 - 36.9	32.08 ± 1.65	14.9 - 54.5	34.35±2.0
Nitrate-nitrogen $mg.l^{-1}$	0.298 - 0.736	0.782 ± 0.03	0.289 - 0.845	0.538 ± 0.04
Phosphate-phosphorus $mg.l^{-1}$	0.049 - 0.352	0.160 ± 0.02	0.131 - 0.681	0.334 ± 0.03
BOD $mg.l^{-1}$	2.1 - 5.9	3.80 ± 0.21	3.5 - 8.7	6.08 ± 0.28

and decreased water level, while minimum during winter could be due to shorter sunshine hours and low temperature. Similar trends were reported by several workers.[12,13] Secchi disc depths recorded showed significant difference, higher in Pond-1(36.42 ± 2.24 cm) than in pond-2 (23.83± 1.41cm). Data reflects that light penetrated much deep in water column in Pond-1, however, light penetration in water was blocked by suspended particles thus reducing water clarity in Pond-2. Conductivity is an important parameter to evaluate water quality.[14] The value of conductivity was higher in pond-2 (286.33±13.53 µmohs/cm) than in Pond-1 (164.1±7.47 µmohs/cm). pH ranged between slight acidic and alkaline, varied between 6.9 and 8.3 in Pond-1 and between 6.8 and 8.1 in Pond-2. The pH value was lower during monsoon probably due to addition of the rainwater. The amount of dissolved oxygen was slight higher in pond-1 (7.6±0.07) than in Pond-2 (7.5±0.06). Dissolved oxygen was observed maximum during winter probably due to high rate of photosynthetic activities due to greater phytoplankton density and low temperature holds more oxygen, while minimum in monsoon could be due to high decompositions rate and high rate of respiration by the aquatic biotaconsume more oxygen. Free carbon dioxide was recorded only in monsoon could be due to higher decompositions rate released more carbon dioxide in water. Carbonates was recorded when the free carbon dioxide was absent. Carbonate and bicarbonate along with free carbon dioxide form an equilibrium system in water and acts as buffer system not allowing pH to fluctuate more. Higher value of calcium and magnesium was observed in Pond-2 might be due to discharge of domestic sewage and lower in Pond-1 could be due to its utilization by aquatic organisms. Chloride is good indicators of organic pollution.[15] The higher amount of chloride was recoded in Pond-2 (34.35±2.0 mg/l) than in Pond-1(32.08±1.65 mg/l). Maximum chloride was noticed in summer probably due to decreased water level concentrate content, while minimum during monsoon could be due to increased water level dilutes content.[16,17] The higher amount of nitrate-nitrogen was recorded in Pond-1 (0.782±0.03 mg/l) than in Pond-2 (0.538±0.04 mg/l). Nitrate value was maximum during summer might be due to decreased water level concentrate content and minimum during winter could be due to its utilization by plant and algae. The amount of phosphate-phosphorus was higher in Pond-2 (0.334±0.03 mg/l) than in Pond-1 (0.160±0.02 mg/l) could be due to discharge of domestic sewage and wastes from nearby cultivated lands increasing content. Phosphate-phosphorus was maximum in summer could be due to higher temperature increasing biological degradations of organic materials released more phosphate in water. BOD value was higherin Pond-2 (6.08±0.28 mg/l) indicated the higher loads of organic matters than in Pond-1 (3.80±0.21 mg/l). BOD value was maximum in summer might be due to increased microbial activities consume more oxygen and minimum during winter could be due to reduced decomposition rates and decreased temperature. Physico-chemical parameters of pond water measured were found within suitable range for zooplankton production.

Analysis of zooplankton

The study recorded 26 species of zooplankton belonging to four important groups, viz., Rotifera, Claocera, Copepoda and Ostracoda. Systematic list of recorded zooplankton has been presented in Table 2, and abundance and percentage distribution shown in Figure 2 to 4. Out of 26 species identified, 23 species were reported from Pond-1, of these, 13 species were Rotifera followed by 5 Cladocera, 4 Copepoda and 1 Ostracoda, while 17 species recorded from Pond-2, of these 11 species were Rotifera followed by 3 Cladocera and 3 Copepoda. Zooplankton abundance ranged between 82 individual/l and 318 individual/l in Pond-1, whereas between 54 individual/l and 376 individual/l in Pond-2. Zooplankton abundance followed a bimodal annual variation, with major peak during summer, after following decline in monsoon attained minor peak during winter (Fig 2). Zooplankton density was highest during summer might be due to availability ofrich food in form of algae, bacteria and detritus.[18,19] Zooplankton density appears to decline in monsoon probably linked with dilution factors as addition of rainwater dilutes population density.[20]

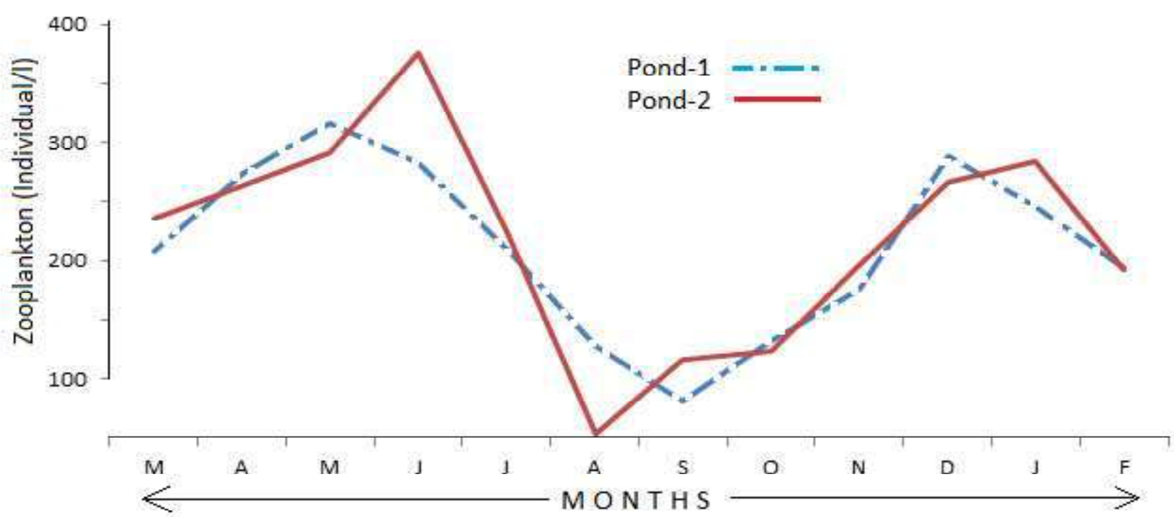

Fig. 2: Monthly variation of total zooplankton population in the studied ponds.

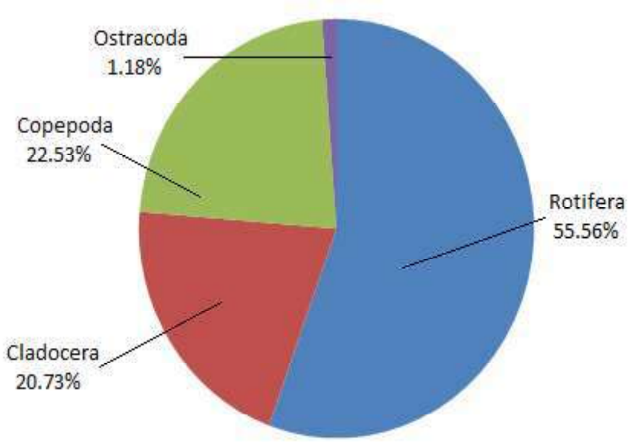

Fig. 3: Percentage distribution of zooplankton in Pond-1.

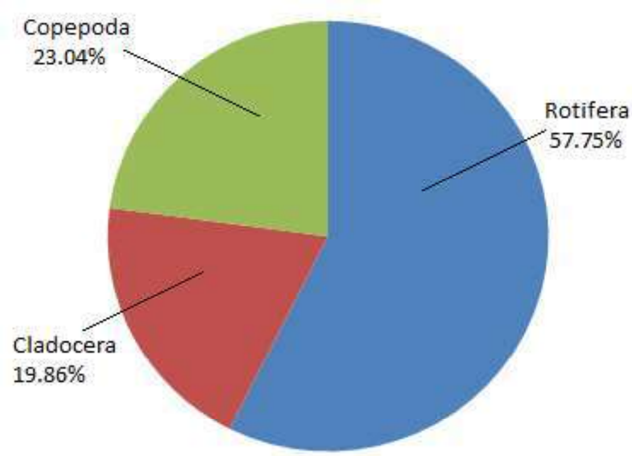

Fig. 4: Percentage distribution of zooplankton in Pond-2.

Table 2: Systematics and occurrence of zooplankton species in ponds.

Zooplankton	Pond-1	Pond-2
Phylum: Rotifera		
Subclass: Eurotatoria		
Superorder: Monogononta		
Order: Ploima		
Family: Brachionidae		
Brachionus angularis (Gosse, 1851)	+	+
Brachionus calyciflorus (Wierzejski, 1891)	+	+
Brachionus caudatus (Borrois & Daday, 1894)	+	+
Brachionus falcatus (Zacharias, 1898)	+	+
Brachionus forficula (Wierzejski, 1891)	+	+
Keratella tropica (Apstein, 1907)	+	+
Keratella cochlearis (Gosse, 1851)	+	
Keratella lenzi (Hauer, 1938)	-	+
Family: Lecanidae		
Lecane sp.	+	-
Monostyla sp.	+	+
Family: Filinidae		
Filinia longiseta (Ehrenbergh, 1834)	+	+
Filinia terminalis (Plate, 1886)	+	-
Family: Asplanchnidae		
Asplanchna sp.	+	+
Family: Synchaetidae		
Polyarthra sp.	+	-
Family: Testudinellidae		
Testudinella sp.	-	+
Super class: Crustacea		
Class: Branchiopoda		
Super order: Cladocera		
Family: Bosminidae		
Bosmina longirostris (O.F. Muller, 1776)	+	-
Family: Daphania		
Ceriodaphnia sp.	+	-
Daphnia carinata (King, 1853)	+	+
Daphnia lumholtzi (Sars, 1885)	+	+
Family: Moinidae		
Moina dubia (Guerne & Richard, 1892)	+	-
Moina brachiate (Jurine, 1820)	-	+
Class: Copepoda		
Family: Cyclopoidae		
Cyclops sp.	+	+
Diaptomus sp.	+	+
Mesocyclops	+	-
Nauplii larvae	+	+
Subclass: Ostracoda		
Cypris sp.	+	-
Total	**23**	**17**

Rotifera was the most abundant group of zooplankton contributing 55.56% in total zooplankton abundance in Pond-1 followed by Copepoda 22.53%, Cladocera 20.73% and Ostracoda 1.18%, while in Pond-2, Rotifera contributing 57.75% followed by Copepoda 23.04% and Cladocera 19.86% (Fig. 3 and 4). Rotifera abundance was dominated by *Brachionus angularis*, *Brachionus caudatus*, *Brachionus falcatus*, *Filinia longiseta* and *Keratella tropica*. Dominance of Rotifera over Cladocera and Copepoda in terms of species number was reported by various studies.[21,22] *Brachionus* species dominated rotifers reflect that ponds investigated were approaching towards eutrophication.[23,24]

Copepoda was second most abundant group consists of *Cyclops* sp., *Diaptomus* sp., *Mesocyclops* sp. and *nauplii* larvae. Population density of Copepoda was minimum in monsoon and maximum during summer. Similar trend was recorded by various workers.[25,26] The occurrence of *Nauplii* throughout the study period showed an active continuous reproductive phase of the cyclopoids.

Cladocera was the next dominant group of zooplankton comprised of *Ceriodaphnia* sp., *Bosmina longirostris*, *Daphnia carinata* and *Daphnia lumholtzi*. After attaining highest density in summer cladocerans reached least abundance in monsoon and then increased during winter probably due to high pH and rich phytoplankton. Cladoceran density was highest during summer could be due to availability of abundant food. *Cerio daphnia* sp. and *Moina dubia* were only found in Pond-1 and *Moina brachiate* in Pond-2 (Table 2).

The group Ostracoda was found comparatively least in number represented by a single species, *Cypris* sp. contributing insignificantly to total abundance of zooplankton.

Community similarities

Sørensen's index[11] used to know compositional similarity between zooplankton communities of two ponds. The similarity index value of zooplankton and their different groups is presented in Table 3. Zooplankton communities of Pond-1 and 2 registered 70% similarity (*vide* Sørensen's similarity index) indicating more homogeneity in the species composition. Results of Sørensen's index showed 85.71% similarity, in the species composition of Copepoda followed by Rotifera 75% and Cladocera 50% (Table 3). The index value was relatively much higher indicating more similarity between two communities of zooplankton could be attributed to greater homogeneity in environmental condition, as studied ponds are located in same climate and similar geographic location. However, it is rather difficult to account that environmental factor alone responsible for high similarity in zooplankton communities, because the other factors, like high pH, conductivity and nutrients were also accountable for greater similarity in species compositions. The results of similarity index analysis indicate minor differences between two zooplankton communities.

Table 3: Sørensen's similarity index values between zooplankton communities

Zooplankton	Co-efficient of similarity (%)	Dissimilarity (%)
Rotifera	75.00	25.00
Cladocera	50.00	50.00
Copepoda	85.71	14.29
Total zooplankton	70.00	30.00

CONCLUSION

The results of present study showed that zooplankton composition and abundance are not same in perennial ponds. No single factor is responsible for this variability. Zooplankton communities were comprised of mainly Rotifera, Cladocera, Copepoda and Ostracoda and their occurrence and abundance indicates water bodies studied were productive. Zooplankton contributes significantly to the secondary production as they forms important food constituent of fishes and many other aquatic animals thus play major role in flow of energy in aquatic ecosystem. Results showed that most of the physico-chemical parameters were within the optimum level thus water is in the ideal state and is conducive for growth and reproduction of zooplankton, ultimately fish production. The present information on zooplankton abundance and composition would provide a valuable tool for further study and monitoring of aquatic ecosystem.

ACKNOWLEDGEMENTS

Authors are thankful to the Head of the Department of Zoology, B.N.M. University, Madhepura, Bihar for providing necessary laboratory facilities during the period of study.

REFERENCES

1. **Battish SK. 1992.** Freshwater Zooplankton of India. Oxford & IBH publishing Co. Pvt. Ltd., NewDelhi, pp. 233 .
2. **Waters TF. 1977.** Secondary production in inland waters. *Advances in Ecological Research*. **10:**11-164.
3. **Jhingran VG. Fish and Fisheries of India. 1991.** Hindustan Publishing Corporation, Delhi, 954 pp.
4. **Neves IF, Rocha O and Pinto AA. 2003.** Zooplankton community structure of two marginal lakes of the river Cuiaba (MatoGrosso, Brazil) with analysis of Rotifera and Cladocera diversity. *Brazilian Journal of Biology*. **63:**1-20.
5. **Sharma BK. 1998.** Faunal Diversity in India: Rotifera. Eds. J.R.B. Alferd, A.K. Das and A.K. Sanyal, *Zoological Survey of India, Envis Centre*. 57-70.
6. **Hutchinson GE. 1967.** A Treatise on Limnology: An Introduction to Lake Biology and the Limnoplankton. Vol. **2**. John Wiley & Sons Inc., New York.115 pp.
7. **APHA. 1992.** Standard Methods for Examination of Water and Wastewater. American Public Health Association, AWWA, WPCF, Washington, D.C. (USA), 1193 pp.
8. **Edmondson WT. Ward and Whipple. 1959.** Freshwater Biology. 2nd ed., John Wiley & Sons Inc., New York. 1248 pp.
9. **Needham JG, Needham PR. 1962.** A Guide to the Study of the Freshwater Biology. Holden-Dey Inc., San Francisco. 108 pp.
10. **Adoni AD. 1985.** Work book on limnology. Pratibha Publishers, Sagar. 126 pp.
11. **Sørensen, T. 1948.** A method of establishing groups of equal amplitude in plant sociology based on similarity of species and its application to analyses of the vegetation on Danish commons. *Kongelige Danske Videnskabernes Selskab*. **5(4):**1-34.
12. **Saha GN, Sehgal KL and Nandy AC. 1971.** Studies on the seasonal and diurnal variationns in physicochemical and biological condotions of a perennial fresh water pond at Cuttack, Orissa. *J. Inland Fish Soc. India*. **3:**80-102.
13. **Mishra RR, Rath B and Thatoi H. 2008.** Water quality assessment of aquaculture ponds located in Bhitarkanika Mangrove Ecosystem, Odissa, India. *Turkish Journal of Fish and Aqua. Sci.* **8:** 71-77.
14. **Acharya GD, Hathi MV, Patel AD and Parmar KC. 2008.** Chemical properties of ground water in Bhiloda Taluka Region, North Gujarat. India. *E-Journal of Chemistry*. **5(4):**792-796.

15. **Jana BB. 1975.** Seasonal periodicity of plankton in freshwater ponds, West Bengal, India. *Journal of International Rev. Ges. Hydrobiology*. **58(1):**127-143.

16. **Khare SL, Paul SR and Dubey A. 2007.** A study of water quality of Khomph–Niwau Lake at Chhatarpur, M.P., *Nature Environment and Pollution Technology*. **6(3):** 539-540.

17. **Arya S, Kumar V, Raikwar M and Dhaka A. 2011.** Physico-chemical analysis of selected surface water samples of Laxmi Tal (Pond) in Jhansi City, UP, Bundelkhand Region, Central India. *Journal of Experimental Sciences*. **2(8):**01-06.

18. **Mishra R, Kanungo VK, Shrivastava S and Agrawal RK. 2014.** Seasonal abundance of zooplanktons in five ponds of Raipur city in Chhattisgarh. *International Journal of Fauna and Biological Studies.* **1(6):**78-82.

19. **Ramesh PL and Shashikanth M. 2016.** Zooplankton diversity in some ponds of Chikkballpur district Karnataka, India. *Journal of Applied Science and Research*. **4(1):**30-37.

20. **Kumar KS. 2001.** Studies on fresh water Copepods and Cladocera of Dharmapuri Distt, Tamil Nadu, *J. Aqua. Biol.*. **16(1&2):** 5-10.

21. **Nasar SAK and Datta Munshi JS. 1975.** Studies on the primary production of a freshwater pond. *Jap. J. Ecol.*. **25:**21-23.

22. **Ahmad SH and Singh AK. 1988.** Zooplanktons in lentic and lotic water bodies in and around Patna (Bihar) and their similarity index. *Indian J. Anim. Sci.,* **58(3):** 406-409.

23. **Ahmad U, Parveen S, MolaHR, Kabir HA and Ganai AH. 2012.** Zooplankton population in relation to physicochemical parameters of Lal Diggi pond in Aligarh, India. *Journal of Environmental Biology.* **33:**1015-1019.

24. **Sharma KK, Devi A, Sharma A and Antal N. 2013.** Zooplankton diversity and physico-chemical conditions of a temple pond in Birpur (J&K, India). *International Research Jour. of Environment Sciences*. **2(5):**25-30.

25. **Bhuiyan AS, Islam MT and Sharmeen R. 2008.** Occurrence and abundance of some copepods in a fish pond in Rajshahi, Bangladesh in relation to the physico-chemical conditions. *Jour. of Biosciences*. **16:**115-119.

26. **Akther S, Ashaduzzaman and Hossain MJ. 2015.** Abundance of zooplankton in Ramsagar-dighi, Dinajpur, Bangladesh. *Bangladesh Journal of Zool*ogy. **43(2):** 303-312.

***