International Journal of Entomology Research
www.entomologyjournals.com
ISSN: 2455-4758
Received: 08-07-2024, Accepted: 06-08-2024, Published: 21-08-2024
Volume 9, Issue 8, 2024, Page No. 136-142

Assessment of zooplankton composition in mallapura lake of Chitradurga district, Karnataka, India

Manjunath V S[1*], M Venkateshwarlu[2]
[1] Research Scholar, Department of Zoology, Kuvempu University, Shankaraghatta, Karnataka, India
[2] Vice Chancellor, Professor, Department of Zoology, Kuvempu University, Shankaraghatta, Karnataka, India

Abstract
Quite possibly of the most essential biological boundary in surveying water quality is zooplankton variety. They are believed to be expected signs of water quality since they are extremely sensitive to changes in the climate. This research aims to examine the zooplankton species composition in Chitradurga district's Mallapura lake over the course of a single year, from January 2023 to December 2023. These zooplankton were calculated using diversity indices like the Simpson Index and the Shannon-Weiner Index. In this study, 31 species of zooplankton, including 05 groups, were identified: Protozoa, Ostracoda, Copepoda, Rotifera, and Cladocera. There are 10 species of Cladocera, 12 species of Rotifera, 4 species of Protozoa, 2 species of Copepoda, and 3 species of Ostracoda. However, Cladocera, Protozoa, Ostracoda, and Copepoda follow Rotifera. The most zooplankton species were found in the genera Rotifera and Cladocera. The Shannon-Weiner Index was between 2.22 and 2.60, while, the Simpson Index was between 0.78 and 0.95. The lake Shannon-Weiner and Simpson records demonstrated moderate water contamination and moderate zooplankton variety. This increases the lake's productivity and helps in the planning of successful fisheries management. Consequently, after proper treatment, the water from Mallapura village is safe for drinking and household use. The ongoing investigation showed that the Mallapura lake is has a place with mesotrophic class and it is likewise shielded from the wellspring of contamination.

Keywords: Mallapuralake, Chitradurga district, Mesotrophic, Zooplankton, Sewage

Introduction
Since Webber et al (2005) [32] and Vandysh (2004) [29] zooplankton has been used as an indicator of eutrophication. The mid year has a more noteworthy wealth of zooplanktonic fauna, while, the stormy season has lower overflow. Changes in the climate are principally to fault for the zooplankton's variance (Sunkad and Patil, 2004 [26]; 2005, Sheeba and Ramanujan; Nayaka,2018) [14].
Zooplankton are response of serious modification in encompassing circumstances inside an aquatic biological system. Abiotic and biotic factors can also regulate their abundance (Ramesha and Sophia, 2013 [18]; Ajay Kumar and Priyanka Malhotra, 2014) [16]. Copepoda is the gathering of zooplankton that occupy in different living spaces for example freshwater or marine water bodies. Algae, other invertebrates, and fish larvae affect their density. Copepod densities keeps up with the biomass and the efficiency of the freshwater conditions (Harish Kumar and Kiran,2020) [5, 7].
In the water bodies' energy production and food web circulation, zooplankton are a major contributor. The variety, thickness and conveyance of zooplankton are affected by ecological variables in which they live (Sonic Patritia and Martin, 2017) [25]. Freshwater bodies are home to a diverse population of zooplankton. Their organization and overflow are of eco significance, as they are bioindicator delicate living beings (Shashank and Raghunandan, 2020) [20].
Water is an essential resource for sustaining life and the environment. The use of water for drinking, irrigation, fisheries and many other industrial purposes has advantages in recent decades. The federal Clean Water Act's goal of protecting and preserving the chemical, physical, and biological integrity of the nation's waters emphasizes the importance of assessing each water quality and the habitat necessary for the preservation of various aquatic organisms. Water, in the nature to, goes to be contaminated day by day with developing urbanization (Kiran Kumar et al. ,2022) [11].
Wetlands are distinct ecosystems with numerous environmental, socio-economic, and communal characteristics and significant natural functions. Wetlands are known to be the most profitable and contrasting natural frameworks on earth since they give quick and underhanded benefits to people as wellsprings of food, re-energize of springs, controlling water quality, normal cleaning of waste water, diminishing sediment load, water stimulate, reusing of biogenic salts as a wellspring of cultivating water, animal development, aquaculture and moreover as a decline for unprecedented and jeopardized sorts of plants and animals (Hosetti, 2002 [9]; Harish and co., 2011) [11].
The ionic composition of inland water is significantly altered by domestic sewage from urban catchment areas. Investigation of ionic creation of weed-attacked water bodies is a significant part of limnological examinations (Lund 1965 [13]; Rao,1969 [20]; Sharma et.al., 1978 [22]; Das et al., 2003) [4]. According to Krishna and Piska (2006) [12] and Thirumala and Kiran (2020) [28] Indian wetlands support a wide range of aquatic organisms, including fish species. As a result, they help fisheries increase their capacity for production. The present study aims to know the variations in zooplankton occurrence in Mallapura lake, Chitradurga district since recently no studies are carried out on this aspect prevailing in this area.

Materials and Methods
Study area
Chitradurga is the district head quarter (Fig 1) which can be found in the middle of the Indian state of Karnataka, in the valley of the Vedhavathi river. Chitradurga is about 200

kilometers to the North-West of Bengaluru. Mallapura lake is a natural, perennial fresh water body 2 km from Chitradurga city that lies between longitudes 76° 24' and 76° 28' 5" E and latitude 14° 11' to 14° 17' N.

Gonuru is the Gram panchayath of this lake. Complete water spread region is 91.84 hectares and the profundity of the water body is around 2.5 meters. 130 hectares make up the command area. The water storage limit is around 189 million cubic feet. Rainfall, sewage and agricultural runoff all contribute to the supply of water to this lake. Water is a bluish-green color. Crops like arecanut, coconut, jowar, ragi, and maize, as well as green leaves and vegetables, are grown in this lake's water. Water is also used for washing clothes, bathing cattle, and other domestic purposes.

Sewage water reaches Mallapura lake, especially from the city's urban areas. Pesticides, hospital wastes, heavy metals, and other poisonous substances are all present in the sewage water, which is directly discharged into the water body (Fig 2).

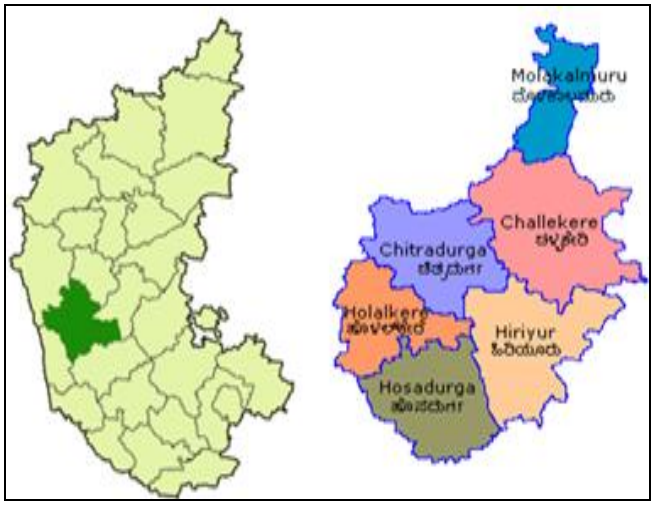


Fig 1: Study area map of Chitradurga

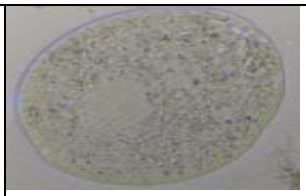
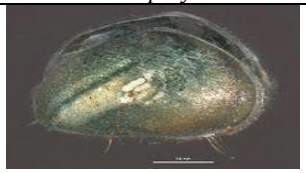
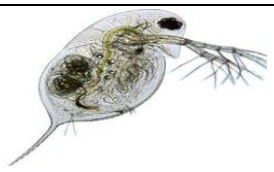
Fig 2: Different views of Mallapura lake showing *Eichhornia* infestation

Zooplankton Analysis

The study was carried out from January 2023 to December 2023 at 05 sampling sites. A modified plankton net with a square metal frame was used to collect zooplankton for qualitative analysis. The filtering cone was constructed of nylon bolting silk plankton net with a mesh size of 50µ for zooplankton collection. 10 meters of the net had to be towed. Labeled vial bottles containing 5% formalin were used to contain the collected samples. Standard methods were used for identification (Needham and Needham, 1962 [15]; Battish, 1992) [2]. The main zooplankton groups' relative abundance will be the only use of the data.

Statistical Analysis

One-wayANOVA and Post Hoc Tukey HSD test for zooplankton samples are designed to compare the means of three or more independent samples simultaneously by using socscistatistics.com software.

 *Diffugia*	 *Holophrya*	 *Trichocerca*	 Copepod
 *Litonotus*	 Cypris	 Nauplius larvae	 Cladocera

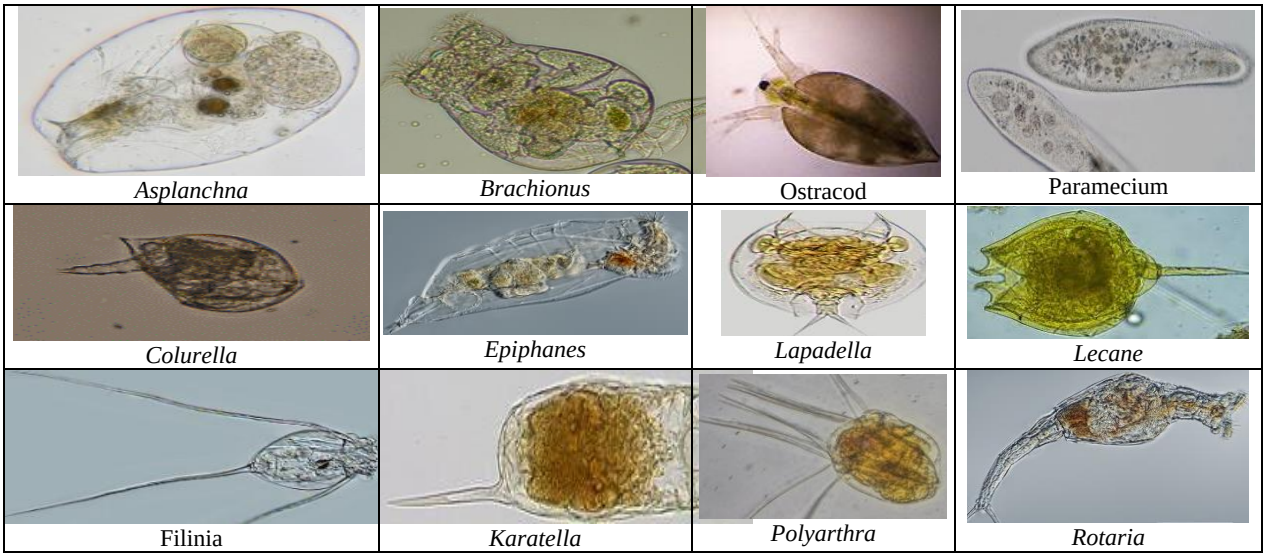


Fig 3: Zooplankton observed in Mallapura lake of Chitradurgadistric

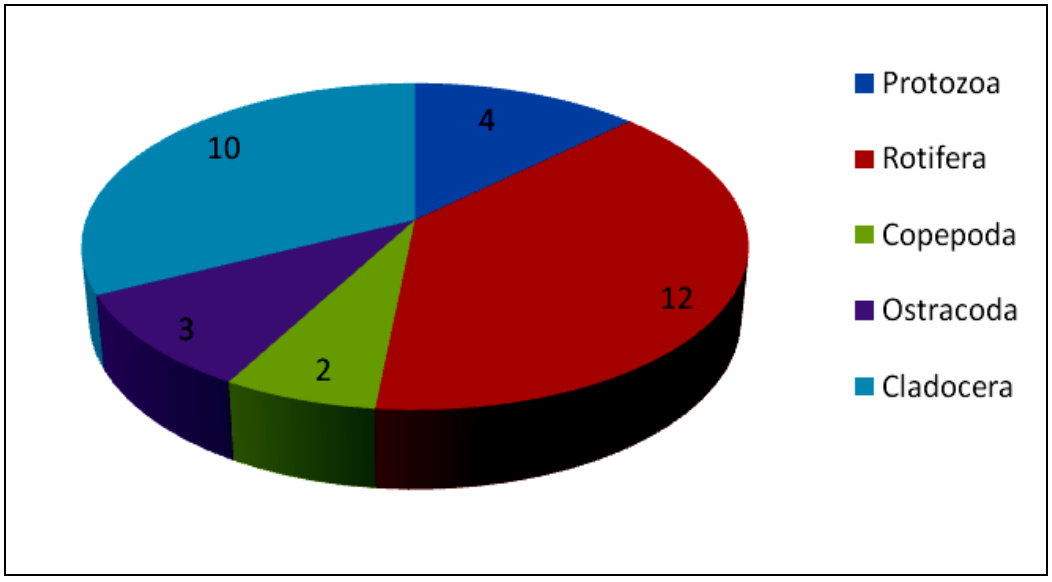


Fig 4: Number of zooplankton species in different groups of Mallapura lake, Chitradurga district

Results and Discussion

The results are depicted in Table 1-5 and Figure 3-4. Tables 4 show the Shannon-Weiner and Simpson Indices for zooplankton in Mallapura lake. The following five groups of zooplankton were examined in this study: Protozoa, Ostracoda, Copepoda, Rotifera, and Cladocera. Rotifera is the most dominant of these groups in all of the sites. 12 genera of Rotifera, 10 of Cladocera, 04 of Protozoa, 02 of Copepoda, and 3 of Ostracoda were discovered in the Mallapura lake. Rajagopal et al. (2010) [17] have also reported similar results. The genera such as *Brachionus, Keratella, Ceriodaphnia, Daphnia, Moina, Cypris, Hemicypris* and *Cyclops* were recorded throughout the study period.

Genus like Ceriodaphnia, Moina, Cyclops and Daphnia indicate naturalorganic pollution and considered Moina as the foremost tolerant species.

If yearly average occurrence of Zooplankton is considered the density of Protozoa varied from 400 o/l (Site 3 and5) to 2400 o/l at site 2. But, Rotifera deviated from 1200 o/l at site 5 to 5400 o/l at site 4. Copepoda density fluctuated from 200 o/l (sites 3 and 4) to 1800 o/l at site 2. However, Ostracoda population varied between 250 o/l (Site 5) and 600 o/l (site 3). Nonetheless, Cladocera density was between 450 o/l Site 2) and 1400 o/l (Site 4) respectively (Table 2).

Vipul Sharma and coworkers (2012) [31] detailed that supplements, weeds and profundity of the water bodies leaned toward rich wealth of cladocerans. Cladocerans are food hotspot for the majority food fishes. According to Sharma (2001) [21], cladocerans are indicators of eutrophic water bodies. From a sewage-fed tank in the Bhadravathi taluk, Karnataka, Harish Kumar and Kiran (2020) [5, 7] identified 07 species of copepods and 06 families of cladocerans. According to their findings, the water body's surface quality is productive and nutrient-rich.

Bharati et al., (2014) [3] reported that eutrophicated, nutrient-rich water bodies contain an abundance of Rotifera. Universally, rotifers have 500 types of which 330 species having a place with 63 genera and 25 families have been verified and were depicted from Indian water bodies (Arora and Mehra, 2003 [1]; Kiran et al.,2007; Tanmay Datta,2011) [27] The rotifers in the Jannapura tank, which was near the town of Bhadravathi in the Shivamogga district, were

evaluated by Harish Kumar and Kiran (2015) [6]. They recorded a total of 05 genera and 8 Rotifera species belonging to 4 families.

Bosmina, *Daphnia*, and *Alona* species were found in polluted waters, according to Verma and Dalela (1975) [30]. While, Rao (1987) [19] stated that cladocerans are found in eutrophic water bodies. As a result, the current findings concur with the previous researchers.

Table 1: Occurrence of Zooplankton (o/l) in 05 sites of Mallapura lake, Chitradurga district

Class/ Species	Site 1	Site 2	Site 3	Site 4	Site 5
Protozoa					
Diffugia	+	+	+	-	+
Holophrya	-	-	-	-	-
Litonotus	+	+	+	+	+
Paramecium	+	+	-	+	-
Rotifera					
Asplanchna	+	+	+	+	+
Brachionus	+	+	+	-	+
Colurella	-	+	-	+	-
Diurella	+	+	+	-	+
Epiphanes	+	-	-	-	+
Filinia	-	+	+	+	-
Keratellatropica	+	-	-	-	+
Lapadella	+	+	+	+	+
Lecane	-	-	-	+	-
Polyarthra	+	+	-	-	+
Rotaria	+	-	+	+	+
Trichocerca	+	-	+	-	+
Cladocera					
Bosmina longirostris	+	+	-	+	-
Daphnia magna	+	+	+	+	+
Macrotrixgoeldi	-	+	-	-	-
Moina daphnia.	+	+	+	+	+
Cerodaphniamacrura	+	+	+	+	+
Cerodaphnia sp.	-	-	-	-	-
Diphanosoma sp.	+	+	+	+	+
Moina brachiata	+	+	+	+	-
Moina sp.	-	-	+	+	-
Cerodaphniamacrura	+	+	+	+	+
Copepoda					
Cyclops	+	-	+	+	+
Nauplius larvae	-	+	-	+	+
Ostracoda					
Cypris sp.	+	+	+	+	+
Stenocypris sp.	-	+	+	-	+
Hemicyprisfossulate	-	+	-	-	+

Table 2: Yearly occurrence of Zooplankton (o/l) in 05 sites of Mallapura lake, Chitradurga district

Class	Site 1	Site 2	Site 3	Site 4	Site 5
Protozoa	1000	2400	400	1000	400
Rotifera	3200	4600	3100	5400	1200
Copepoda	1400	1800	200	200	1400
Ostracoda	300	400	600	300	250
Cladocera	1200	450	800	1400	900

Table 3: Monthly occurrence of Zooplankton (o/l) in 5 sites of Mallapura lake

Site1												
Class	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Protozoa	40	210	100	150	180	30	40	20	30	50	60	90
Rotifera	320	350	280	310	460	320	160	140	140	160	280	200
Copepoda	110	200	130	175	350	40	55	50	45	65	75	105
Ostracoda	30	40	20	50	40	20	05	10	30	15	25	15
Cladocera	160	220	120	160	300	40	50	30	40	60	80	100
Site 2												
Protozoa	200	300	200	300	400	200	100	50	200	100	150	200
Rotifera	300	600	400	700	800	300	250	200	300	200	250	300
Copepoda	140	200	145	270	405	100	75	110	80	110	85	100
Ostracoda	40	50	30	60	50	30	10	20	40	25	30	15
Cladocera	45	45	50	70	60	40	15	15	45	20	25	20

Site3												
Protozoa	50	60	40	70	60	30	-	10	20	30	20	10
Rotifera	310	340	270	380	170	310	150	130	130	150	210	270
Copepoda	25	30	20	35	30	15	-	5	10	15	10	5
Ostracoda	75	90	60	100	90	40	10	15	30	45	30	15
Cladocera	100	120	80	130	120	60	20	20	40	50	40	20
Site 4												
Protozoa	50	200	90	160	170	40	30	30	40	50	70	80
Rotifera	500	600	600	900	1000	400	200	150	450	350	250	300
Copepoda	20	25	15	30	25	15	5	10	20	20	15	20
Ostracoda	35	35	25	50	30	30	5	10	30	15	20	15
Cladocera	105	205	130	180	340	50	60	45	40	70	80	95
Site 5												
Protozoa	30	40	50	60	50	-	30	20	25	40	15	30
Rotifera	110	210	110	150	290	50	60	20	40	50	90	100
Copepoda	100	200	140	180	345	45	50	45	50	80	60	105
Ostracoda	25	35	15	45	35	20	5	5	25	10	20	10
Cladocera	110	130	90	140	130	70	30	30	50	60	35	25

Table 4: Zooplankton Species diversity indices ofMallapura lake

	Site 1	**Site 2**	**Site 3**	**Site 4**	**Site 5**
Shannon-weiner Index					
Rotifera	2.39	2.47	2.50	2.60	2.32
Cladocera	2.52	2.53	2.58	2.51	2.47
Copepoda	2.44	2.40	2.42	2.44	2.39
Ostracoda	2.36	2.34	2.22	2.26	2.40
Protozoa	2.40	2.42	2.28	2.48	2.45
Simpson Index					
Rotifera	0.90	0.88	0.92	0.94	0.86
Cladocera	0.88	0.92	0.88	0.88	0.78
Copepoda	0.95	0.94	0.98	0.89	0.80
Ostracoda	0.79	0.85	0.86	0.88	0.92
Protozoa	0.86	0.78	0.88	0.95	0.80

Table 5: One way ANOVA and Post Hoc Tukey HSD data for zooplankton in Mallapura lake, Chitradurga district

	T1 Protozoa	**T2 Rotifera**	**T3 Copepoda**	**T4 Ostracoda**	**T5 Cladocera**	**Total**
$\sum X$	5200	17500	5000	1850	4750	34300
Mean	1040	3500	1000	370	950	1372
$\sum X^2$	8080000	71610000	7240000	762500	5052500	92745000
Std.Dev.	817.3127	1609.3477	748.3315	139.6424	367.4235	1379.695

Source	**SS**	**df**	**MS**	
Between-treatments	29795400	4	7448850	$F = 9.37552$
Within-treatments	15890000	20	794500	The f-ratio value is 9.37552. The p-value is.000195.
Total	45685400	24		The result is significant at p <.05.
Post Hoc Tukey HSD data				
Pair wise Comparisons		$HSD_{.05} = 1686.9311$ $HSD_{.01} = 2110.0292$		$Q_{.05} = 4.2319$ $Q_{.01} = 5.2933$
T_1:T_2	$M_1 = 1040.00$ $M_2 = 3500.00$	2460.00		Q = 6.17 (*p* =.00248)
T_1:T_3	$M_1 = 1040.00$ $M_3 = 1000.00$	40.00		Q = 0.10 (*p* =.99999)
T_1:T_4	$M_1 = 1040.00$ $M_4 = 370.00$	670.00		Q = 1.68 (*p* =.75770)
T_1:T_5	$M_1 = 1040.00$ $M_5 = 950.00$	90.00		Q = 0.23 (*p* =.99984)
T_2:T_3	$M_2 = 3500.00$ $M_3 = 1000.00$	2500.00		Q = 6.27 (*p* =.00211)
T_2:T_4	$M_2 = 3500.00$ $M_4 = 370.00$	3130.00		Q = 7.85 (*p* =.00017)
T_2:T_5	$M_2 = 3500.00$ $M_5 = 950.00$	2550.00		Q = 6.40 (*p* =.00173)
T_3:T_4	$M_3 = 1000.00$ $M_4 = 370.00$	630.00		Q = 1.58 (*p* =.79553)

T_3:T_5	M_3 = 1000.00 M_5 = 950.00	50.00	Q = 0.13 (*p* =.99998)
T_4:T_5	M_4 = 370.00 M_5 = 950.00	580.00	Q = 1.46 (*p* =.83911)

One way ANOVA and Post Hoc Tukey HSD data

The F-ratio value is 9.37552 and p-value is.000195. The result is significant at p <.05. The F statistic tells whether there is an overall difference between sample means. Tukey's HSD test depicts, a blue value for Q (below) indicates a significant result (Table 5).

Conclusion

The current examination shows that the lake is different and contains a more prominent number of species, bringing about a moderate degree of contamination Mallapura lake's Shannon-Weiner Index and Simpson Index values indicate a healthy diversity. Cladocera added to auxiliary creation. *Ceriodaphnia, Moina, Cyclops, Diaptomus* and *Daphnia*, all species of zooplankton, are indicators of organic pollution. Moina is regarded as the most tolerant species.,. The Mallapura lake is under moderately eutrophic condition which is a record of sewage and human anthropogenic exercises. The concerned authorities frequently conserve and manage the lake. Since the raw sewage that ends up in the lake frequently poses a serious threat to public health, it is imperative that a proper disposal procedure be developed. Because they will significantly remove BOD, suspended solids, and nutrients (phosphate and nitrate), constructed wetlands can lessen the impact on the environment. The level of pollution is indicated by the diversity of zooplanktons, which are bioindicators. This helps plan successful fisheries management and makes the lake more productive.

Acknowledgements

The authorswishes to express sincere thanks to Kuvempu University for providing necessary laboratory facilities.

References

1. Arora J, Mehra NK. Seasonal diversity of planktonic and epiphytic rotifers in the backwaters of the Delhi segment of the Yamuna River, with remarks on new records from India. Zoological Studies,2003:42:239-249.
2. Battish SK. Freshwater zooplankton of India. New Delhi: Oxford and IBH Publishing Co. Pvt. Ltd, 1992, 130.
3. Bharati G, Kolhe Shinde SM, Rane MS. Composition and biodiversity of rotifer population in Godavari River. Indian Journal of Applied Research,2014:4(6):554-556.
4. Das SK, Parvin Kumar, Singh RA, Roy JN. Ionic composition of Mehdiganj lake of Bihar. Intt. Journal of Mendel,2003:20(1-2):9-10.
5. Harish Kumar K, Kiran BR. Documentation on distribution and abundance of micro-crustaceans (Cladocera and Copepoda) in sewage-fed tank of Bhadravathi Taluk, Karnataka. CIBTech Journal of Zoology,2020:9:107-114.
6. Harish Kumar K, Kiran BR. Population dynamics of rotifers in Jannapura tank, Karnataka. International Journal of Fisheries and Aquatic Studies,2015:3(1):165-168.
7. Harish Kumar K, Kiran BR. Documentation on distribution and abundance of micro-crustaceans (Cladocera and Copepoda) in sewage-fed tank of Bhadravathi Taluk, Karnataka. CIBTech Journal of Zoology,2020:9:107-114.
8. Harisha MN, Hosetti BB, Ahmad S. Wetland avifauna of Kundavada Lake, Davanagere district, Karnataka. Current Biotica,2011:5(3):351-358.
9. Hosetti BB. Wetlands Conservation and Management. Jaipur: Pointer Publishers, 2002.
10. Kiran BR, Puttaiah ET, Kamath D. Diversity and seasonal fluctuation of zooplankton in fish pond of Bhadra fish farm, Karnataka. Zoos' Print Journal,2007:22:2935-2936.
11. Kiran Kumar MS, Madhura R, Manu Prasad CB, Praveen DR, Md Sameer Khan A. Analysis of surface and groundwater quality in Anaji Village, Davangere, Karnataka. International Journal of Engineering Research & Technology, 2022, 10(11).
12. Krishna M, Piska RS. Ichthyofaunal diversity in secret lake Durgamcheruvu, Ranga Reddy District, Andhra Pradesh, India. J. Aqua. Biol,2006:21(1):77-79.
13. Lund JWG. The ecology of freshwater plankton. Bio. Rev,1965:40(2):231-293.
14. Nayaka BM. Zooplankton diversity and distribution in Yelahanka Lake, Bangalore, Karnataka, India. National Journal of Multidisciplinary Research and Development,2018:3(1):1328-1330.
15. Needham JG, Needham PR. A guide to the study of fresh water biology. San Francisco: Holden Day, Inc, 1962, 108.
16. Malhotra P, Kumar A. Comparative studies on zooplanktonic diversity of River Yamuna and Western Yamuna Canal in relation to industrial pollution in Yamunanagar (Haryana), India. International Journal of Science and Research,2014:3(9):1438-1441.
17. Rajagopal T, Thangamani A, Sevarkodiyone SP, Sekar M, Archunan G. Zooplanktons diversity and physico-chemical conditions in three perennial ponds of Virudhunagar district, Tamil Nadu. Journal of Environmental Biology,2010:31:265-272.
18. Ramesha MM, Sophia S. Species composition and diversity of plankton in the river Seeta at Seetanadi, the Western Ghats, India. Advanced Biotech,2013:12(8):20-27.
19. Rao NG. Synecology of the lake Rangsagar in relation to limnology and eutrophication. [PhD thesis]. Udaipur (Rajasthan): M.L. Sukhadia University, 1987.
20. Rao VP. Plant Protection Bulletin,1969:21(4):1-8.
21. Sharma BK. Biological monitoring of freshwaters with reference to role of freshwater Rotifera as biomonitors. In: Sharma BK, editor. Water Quality Assessment Biomonitoring and Zooplanktonic Diversity. New Delhi: Ministry of Environment and Forests, Government of India, 2001, 83-97.
22. Sharma KP, Goel PK, Gopal B. International Journal of Ecology and Environmental Science,1978:4:89-105.
23. Shashank KR, Raghunandan KS. A checklist of zooplanktons recorded at Melukote ponds, Pandavapura

taluk, Karnataka. International Journal of Fisheries and Aquatic Studies,2020:8(3):268-272.
24. Sheeba S, Ramanujan N. Qualitative and quantitative study of zooplanktons in Ithikkara River, Kerala. Pollut Res,2005:24:119-122.
25. Sonic Patritia A, Martin P. A survey on seasonal variation of freshwater zooplankton diversity in Kolavai Lake, Chengalpattu, Tamilnadu, India. World Journal of Pharmaceutical Research,2017:6(10):1732-1744.
26. Sunkad BN, Patil HS. Water quality assessment of Fort Lake of Belgaum (Karnataka) with special reference to zooplanktons. Journal of Environmental Biology,2004:25(1):99-102.
27. Datta T. Zooplankton diversity and physicochemical conditions of two wetlands of Jalpaiguri district, India. International Journal of Applied Biology and Pharmaceutical Technology,2011:2(3):576-583.
28. Thirumala S, Kiran BR. A review on fish diversity in the rivers of Shivamogga District, Karnataka. Adalya Journal,2020:9(3):722-732.
29. Vandysh OI. Zooplanktons as an indicator of state of lake ecosystems polluted with mining wastewater in the Kolapeninsula. Russian Journal of Ecology,2004:32(2):110-116.
30. Verma SR, Dalela RC. Studies on the pollution of the Kali Nadi by industrial waste near Mansurpur. Part II: Biological index of pollution and biological characteristics of the river. Acta Hydrochim Hydrobiologia,1975:3(3):259-274.
31. Sharma V, Verma BK, Sharma RS, Sharma MS, Gaur KS. A report on the freshwater cladocera (Crustacea: Branchiopoda) of south Rajasthan (India). International Journal of Environmental Sciences,2012:3(1):275-296.
32. Webber MM, Edward E, Cambell C, Webber D. Phytoplanktons and zooplanktons as indicators of water quality in Discovery Bay, Jamaica. Hydrobiologia,2005:545:177-193.