China Petroleum Processing and Petrochemical Technology

Catalyst Research Volume 23, Issue 2, November 2023 Pp. 3715-3733

"ZOOPLANKTON DIVERSITY IN THE KOLAR DAM OF BHOPAL"

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Abstract
An aquatic ecosystem's trophic structure depends heavily on zooplankton, which is also essential for the transfer of energy. The variety of zooplankton in the Kolar reservoir of Bhopal is the subject of the current study. Beginning in September 2020 and ending in September 2022, water samples were taken seasonally for a two-year period. Thirty-two species in all, including seven species of rotifera, belong to five groupings. Eight species of Cladocera, five species of Copepoda, nine species of Protozoa, and three species of Ostracoda. There was a good correlation found in the study between the physico-chemical characteristics of the Nagaral dam and the zooplankton. For the duration of the investigation, the protozoa group of zooplankton dominated all other categories.
Key words:- zooplankton, Kolar reservoir, Physio chemical parameters, etc.

Introduction

Zooplankton are microscopic animals which float freely in the aquatic ecosystems and whose distribution is primarily determined by water currents. The majority of them are unicellular or multicellular with a size ranging from a few micrometers (Protozoa) tomore than a millimeter (macro-zooplankton) (Goswami, 2004). In aquatic ecosystems, zooplankton form an important link in the food chain from primary to tertiary levels leading to the production of fishery, also as intermediaries for nutrients/energy transfer between primary and tertiary trophic level (Gajbhiye, 2002). Furthermore, a specific group of zooplanktons which was Cladocera, Copepoda, and Rotifera are important in freshwater ecosystem in food webs (Imoobe and Akoma, 2009).Zooplankton are characterized by their faunal diversity and arrays of animal organism, varying in size from microns (μ) to several millimeters (mm). No single system of classification has been adopted universally as mentioned by Gajbhiye (2002). They are classified into several groups by size (Cushing, 1989).

i. Ultraplankton :<5 μm

ii. Nanoplankton : 5-60 μm

iii. Microplankton : 1-500μm

iv. Mesoplankton : 0.5-1.0 mm

v. Macroplankton : 1-10 mm

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vi. Megaplankton : 10-20 mm

Rotifers play a pivotal role in many freshwater ecosystems. They are ubiquitous, occurring in almost all types of freshwater habitat. Most well-known and diverse are the predominantly freshwater Bdelloidea and Monogononta as reported by Segers (2008). Rotifers vary widely in their morphology, but most species have distinguishable head, trunk, and foot regions as well as an elongated body (Wetzel, 1983). Feeding occurs bymoving organic matter to the mouth cavity by using cilia (Wetzel, 1983). This ciliated region around the mouth, called a corona, is also used for locomotion. All rotifers have a muscular pharynx, the mastax, which contains a set of jaws called trophi (Wallace and Snell, 2010). Rotifers mostly have asexual reproduction via cyclical parthenogenesis, but sexual reproduction can occur when there is a switch from an amictic phase, where malesare absent, to a mictic phase, where males are produced (Wallace and Snell, 2010)Zooplankton of freshwater systems has been recognized as an important energy resource for fish of small body size that, in turn, provide energy to piscivorous fish consumers higher up the food web (Kingsford et al., 1999). Within this context, zooplankton have been recognized as an important trophic link between primary production and consumers (jones et al .,1999)

Zooplankton may form an important component of the biological communities for their ability to cycle nutrients in the aquatic environment (Kobayashi et al., 1998). The water quality was also improved by zooplankton grazing on phytoplankton and bacteria (Pinto-Coeluo et al., 2005). According to Paterson (2001), zooplankton communities are highly sensitive to environmental variations, such as water temperature, light, pH, DO, phosphate, food availability (algae and bacteria) and predation by invertebrates and fishes. Therefore, thechanges in zooplankton abundance, species diversity, or community composition can provide potential indications of environmental changes or disturbances .Most of zooplankton species have short generation times usually took a day or weeks (Jaiswal et al., 2014) which makes them suitable indicators to assess the ecosystem healthdue to their ability to respond quickly to environmental stress (Gannon and Stemberger, 1978).Understanding their structure communities and the affecting factors to diversity and abundance, as well as their linkages with the other ecosystem components is essential tooptimize the resources use and to improve the sustainable management of the river ecosystems. Erondu C.J. and Solomon R.J (2017) Identification of Planktons (Zooplanktons) behind girls hostel university of Abuja , Nigeria that topic conclude the presence of Zooplankton in the reservoir are different and are less in which zooplankton have the total of 12 species and 4 taxa in a decreasing order as copepod Clacedoran> Rotifer >Ciliophora, resulting in copepod having highest number of species Copepod . In conclusion, there were plankton in the reservoir water, while , phytoplankton dominated the water body more than zooplankton.

Material and Method

Sampling for Analysis of Physico-Chemical Parameters

For a period of two years (September 2020 to July 2022), various stations of the Kolar Reservoir were visited seasonally to study various physicochemical parameters, including water temperature, turbidity, electrical conductivity (EC), pH, dissolved oxygen (DO), total alkalinity, chloride, total hardness, calcium, magnesium, biological oxygen demand (BOD), total nitrate, and total phosphate. Seasonally, samples of surface water (0.05m) were taken from each of the 5 sampling locations. The samples were transported to the lab in an ice box and stored in a freezer for further examination in well-labeled, tightly-capped, 1-liter polyethylene bottles. On-site measurements were made of variables like pH, total alkalinity, and water temperature.

Zooplankton Sampling and Analysis

For a period of two years, samples were taken from the reservoir's surface area on a seasonal basis in order to investigate zooplankton. For quantitative study, 20 liters of water from each station were run through a plankton net made of No. 25 bolting silk with a mesh size of 55 m. For qualitative analysis, the plankton net was submerged in water for 5 to 10 minutes. Samples of filtered water were collected in 50 ml plastic bottles with clear labels and kept fresh with a few drops of glycerin. The bottles were brought to the lab and set aside for better sedimentation the following day. Using the Sedgwick-Rafter Cell technique, the supernatant plankton-free water was collected, and concentrated samples of 10 ml were counted (Trivedi and Goel, 1984). Under a microscope, zooplankton identification was carried out up to the species level using the keys of Ward and Whipple (1959), Tonapi (1980), Battish (1992), and Dhanapathi (2000). Number of organisms/liter of reservoir water was calculated using an average of 10 counts for each sample.

Result

Zooplankton group/ species and composition in the reservoir

Protozoa, Rotifera, Copepoda, Cladocera, and Ostracoda were only a few of the five groups that made up the zooplankton community in Kolar reservoir for this study. Zooplankton species from 32 different genera, including 20 different species, were identified. Of them, 9 species (9 genera) belong to Protozoa, 7 species (4 genera) to Rotifera, 8 species (5 genera) to Cladocera, 3 species (1 genera) to Ostracoda, and 5 species (2 genera) to Copepoda.

Zooplankton composition during three seasons

The zooplankton composition and seasonal fluctuations in Kolar reservoir were clearly visible in the research, which lasted an average of two years. ANOVA revealed significant differences in the total zooplankton collected over the course of various seasons ($P < 0.05$), but no differences between stations ($P > 0.05$) were found to be significant. (Appendix III, Table I). Throughout the study period, zooplankton were more common (197.88/l) during the Premonsoon season, while their population decreased (99.50/l) during the monsoon, and their density was moderate (169.35/l) during the postmonsoon season. (Table 5.2). Five different zooplankton groups, including Rotifera, Protozoa, Copepoda, Cladocera, and Ostracoda, were found in the reservoir during the premonsoon season. Rotifera (61.63/l), which made up 31.14% of all the zooplankton in the reservoir during this season, was the most prevalent species. (Fig.5.3).

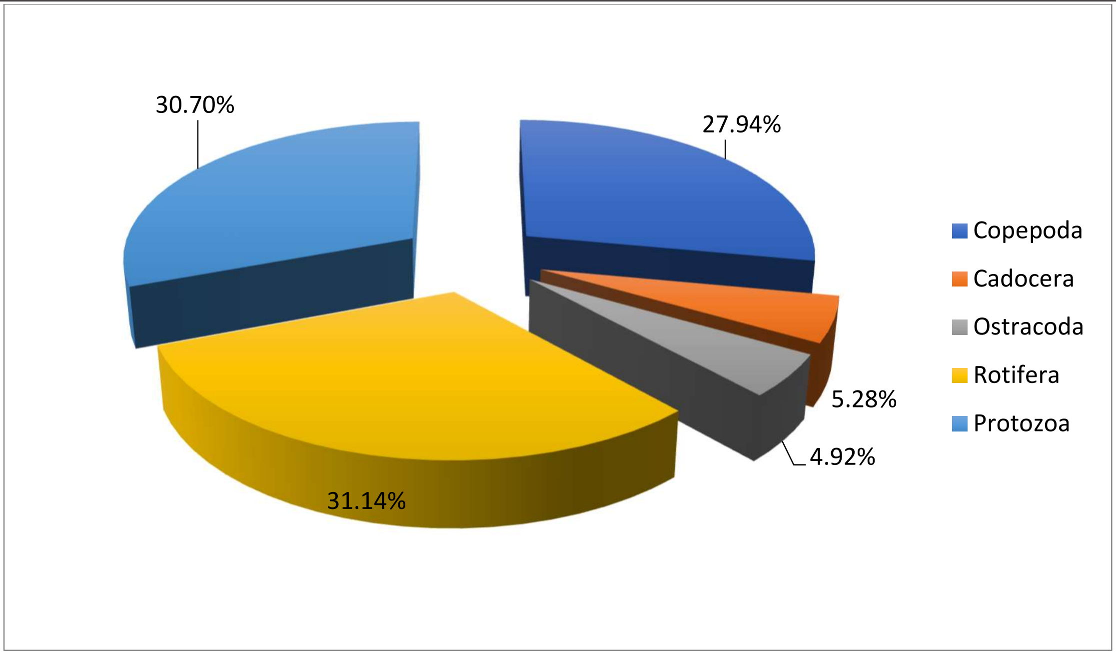

Fig. 5.3 Percentage distribution (mean) of zooplankton groups in Kolar reservoir during premonsoon season

Protozoa provided 30.70% and was the second most prevalent class (60.75/l). In this season, Copepoda (55.30/l) came third which provided 27.94% Cladocera and Ostracoda added very little population density, with only 10.45/l (5.28%) and 9.75/l (4.92%), respectively. The season saw a total of 29 species with Nauplius larvae (13.57%) of the group Copepoda being the most prevalent species. Brachionus angularis (12.00%) and Difflugia (19.91%) of the Rotifera and Protozoa category came in second and third, respectively. The species of Cladocera, Sida (0.26%) had the lowest dominance. (Table 5.3).

Only four zooplankton species (Rotifera, Copepoda, Protozoa and Cladocera) were identified in the reservoir during the monsoon season. (Table 5.2). This season, the Ostracoda cohort was not seen. With a count of 52.11/l, the zooplankton group Cladocera was the most abundant and provided about 52.37% of the total population during this season. Protozoa (17.16%) and Copepoda (15.28%) came next. (Fig.5.4). Protozoa and Copepoda had densities of 17.08/l and 15.21/l, respectively. (Table 5.2). During this season, 18 different zooplankton taxa and Nauplius larvae were seen. Nauplius (12.52%) was the prevalent species, followed by Daphnia carinata (9.24%) and Sida (7.87%).Vorticella, which made up only 1.45% of the season's total zooplankton, was the least common species found. (Table 5.3).

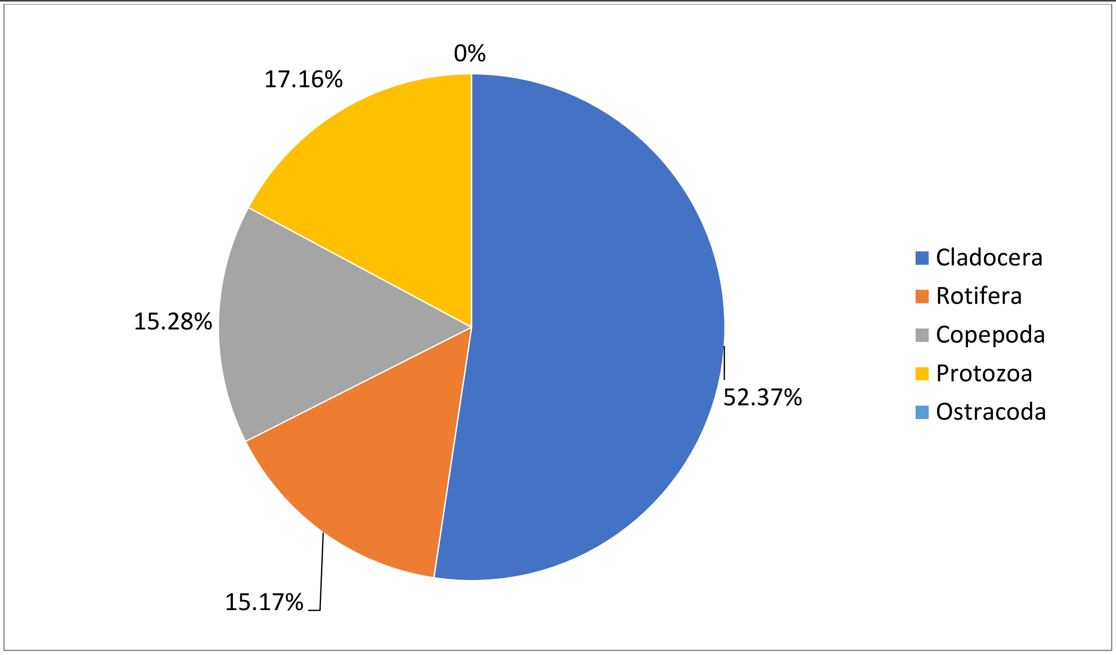

Fig. 5.4 Percentage distribution (mean) of zooplankton groups in Kolar reservoir during monsoon season

All 5 families were discovered in the reservoir during the post-monsoon season. Rotifera made up the majority of the zooplankton (50.17/l) and provided 29.62% of the total. (Table 5.2). Following this group were Copepoda (40.14/l), which made up 23.70% of the total zooplankton, Protozoa (37.40/l),which added 22.08%,Cladocera (30.24/l), which added 17.85%, and Ostracoda (11.40/l), which made up only 6.37%. (Fig. 5.5).

This season, the reservoir documented 29 species and Nauplius, and among the zooplankton, Nauplius larvae were discovered to be the dominant (9.48%) species. Keratella heimalis (8.53%) and Branchionus angularis (6.14%) were the next two most common species. In this season, Heliodiaptomus had the lowest species dominance (0.80%). (Table 5.3).

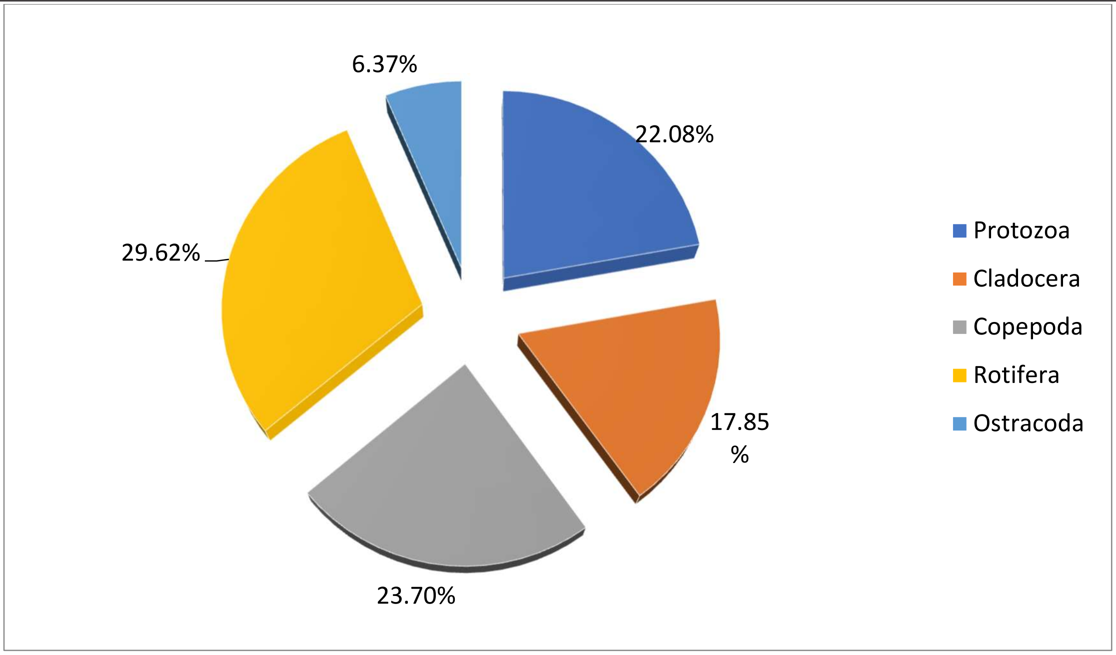

Fig. 5.5 Percentage distribution (mean) of zooplankton groups in Kolar reservoir during post monsoon season

Table 5.2 Groupwise seasonal percentage composition of zooplankton (No/l) in Kolar reservoir

	Premonsoon		**Monsoon**		**Postmonsoon**	
Group/ Species	**Average of all stations**	**%**	**Average of all stations**	**%**	**Average of all stations**	**%**
Rotifera						
1Branchionus angularis	23.76	38.55	7.65	50.66	10.41	20.74
2 Cephalodella	5.65	9.16	3.25	21.52	6.16	12.27
3 Filinia	7.58	12.29	0.00	0.00	3.44	6.85
4 Hexarthra	0.00	0.00	0.00	0.00	4.77	9.50
5Keratella heimalis	12.34	20.02	4.20	27.81	14.46	28.82
6 Keratella mira	8.20	13.30	0.00	0.00	5.60	11.16
7 Polyarthra	4.10	6.65	0.00	0.00	5.33	10.62
Total	**61.63**	**100**	**15.10**	**100**	**50.17**	**100**
Protozoa						
1 Arcella	8.12	13.36	3.20	18.73	5.30	14.17
2 Difflugia	16.15	26.58	5.13	30.03	8.43	22.54
3Euglypha	6.24	10.27	2.10	12.29	4.20	11.23
4 Didinium	5.18	8.52	0.00	0.00	3.51	9.38
5 Prorodon	2.19	3.60	0.00	0.00	3.70	9.89
6 Paramecium	7.12	11.72	3.12	18.26	3.30	8.82

7 Glaucoma	6.45	10.61	0.00	0.00	2.10	5.61
8 Opercularia	4.10	6.74	2.08	12.17	3.58	9.57
9 Vorticella	5.20	8.55	1.45	8.48	3.28	8.77
Total	**60.75**	**100**	**17.08**	**100**	**37.40**	**100**
Cladocera						
1 Daphnia	3.75	35.88	9.20	17.65	8.15	26.95
2 Moina	2.20	21.05	6.80	13.04	6.38	21.09
3 Ceriodaphnia	1.88	17.99	6.30	12.08	6.10	20.17
4 Sida	0.52	4.97	7.84	15.04	0.00	0.00
5 Macrothrix	0.00	0.00	5.84	11.20	4.24	14.02
6 Bosmina	0.90	8.61	6.87	13.18	3.80	12.56
7 Alona	1.10	10.52	7.46	14.31	0.00	0.00
8 Leydigia	0.00	0.00	1.80	3.45	1.57	5.19
Total	**10.45**	**100**	**52.11**	**100**	**30.24**	**100**
Ostracoda						
1 Cypris	4.25	43.58	0.00	0.00	5.15	45.17
2 Stenocypris	3.85	39.48	0.00	0.00	4.05	35.52
3 Cyprinotus	1.65	16.92	0.00	0.00	2.20	19.29
Total	**9.75**	**100**	**0.00**	**0.00**	**11.40**	**100**
Copepoda						
1 Cyclops	10.26	18.55	0.00	0.00	10.23	25.48
2 Mesocyclops	8.33	15.06	0.00	0.00	7.38	18.38
3 Nauplius	26.86	48.57	12.46	81.91	16.06	40.00
4 diaptomus	6.30	11.39	2.75	18.08	5.10	12.70
5 Heliodiaptomus	3.55	6.41	0.00	0.00	1.37	3.41
Total	**55.30**	**100**	**15.21**	**100**	**40.14**	**100**
Total Zooplankton	**197.88**		**99.50**		**169.35**	

Table 5.3 Seasonal variations (mean) and percentage composition of zooplankton (No/l) in Kolar reservoir

	Premonsoon		**Monsoon**		**Post monsoon**	
Group/Species	**Average of all stations**	**%**	**Average of all stations**	**%**	**Average of all stations**	**%**
Rotifera						
1Branchionus angularis	23.76	12.00	7.65	7.68	10.41	6.14
2 Cephalodella	5.65	2.85	3.25	3.26	6.16	3.63
3 Filinia	7.58	3.83	0	0.00	3.44	2.03

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4 Hexarthra	0	0.00	0	0.00	4.77	2.81
5Keratella heimalis	12.34	6.23	4.20	4.22	14.46	8.53
6 Keratella mira	8.20	4.14	0	0.00	5.60	3.30
7 Polyarthra	4.10	2.07	0	0.00	5.33	3.14
Protozoa						
1 Arcella	8.12	4.10	3.20	3.21	5.30	3.12
2 Difflugia	16.15	8.16	5.13	5.15	8.43	4.97
3Euglypha	6.24	3.15	2.10	2.11	4.20	2.48
4 Didinium	5.18	2.61	0	0.00	3.51	2.07
5 Prorodon	2.19	1.10	0	0.00	3.70	2.18
6 Paramecium	7.12	3.59	3.12	3.13	3.30	1.94
7 Glaucoma	6.45	3.25	0	0.00	2.10	1.24
8 Opercularia	4.10	2.07	2.08	2.09	3.58	2.11
9 Vorticella	5.20	2.62	1.45	1.45	3.28	1.93
Cladocera						
1 Daphnia	3.75	1.89	9.20	9.24	8.15	4.81
2 Moina	2.20	1.11	6.80	6.83	6.38	3.76
3 Ceriodaphnia	1.88	0.95	6.30	6.33	6.10	3.60
4 Sida	0.52	0.26	7.84	7.87	0	0.00
5 Macrothrix	0	0.00	5.84	5.86	4.24	2.50
6 Bosmina	0.90	0.45	6.87	6.90	3.80	2.24
7 Alona	1.10	0.55	7.46	7.49	0	0.00
8 Leydigia	0	0.00	1.80	1.80	1.57	0.92
Ostracoda						
1 Cypris	4.25	2.14	0	0.00	5.15	3.04
2 Stenocypris	3.85	1.94	0	0.00	4.05	2.39
3 Cyprinotus	1.65	0.83	0	0.00	2.20	1.29
Copepoda						
1 Cyclops	10.26	5.18	0	0.00	10.23	6.04
2 Mesocyclops	8.33	4.20	0	0.00	7.38	4.35
3 Nauplius	26.86	13.57	12.46	12.52	16.06	9.48
4 diaptomus	6.30	3.18	2.75	2.76	5.10	3.01
5 Heliodiaptomus	3.55	1.79	0	0.00	1.37	0.80
Total Zooplankton	**197.88**	**100**	**99.50**	**100**	**169.35**	**100**

Pielou's evenness value was discovered to be comparatively high in the reservoir during the monsoon (rainy) season, low during the premonsoon, and moderate during the postmonsoon. (Fig.5.9). In the monsoon, station 4 had a high evenness rating (0.988), while station 3 had a low one (0.954). At station 1, the premonsoon evenness number was high (0.985), while at station 5, it was low (0.947). At station 2, the post monsoon evenness value was high (0.987), while at station 1, the value was low (0.970).

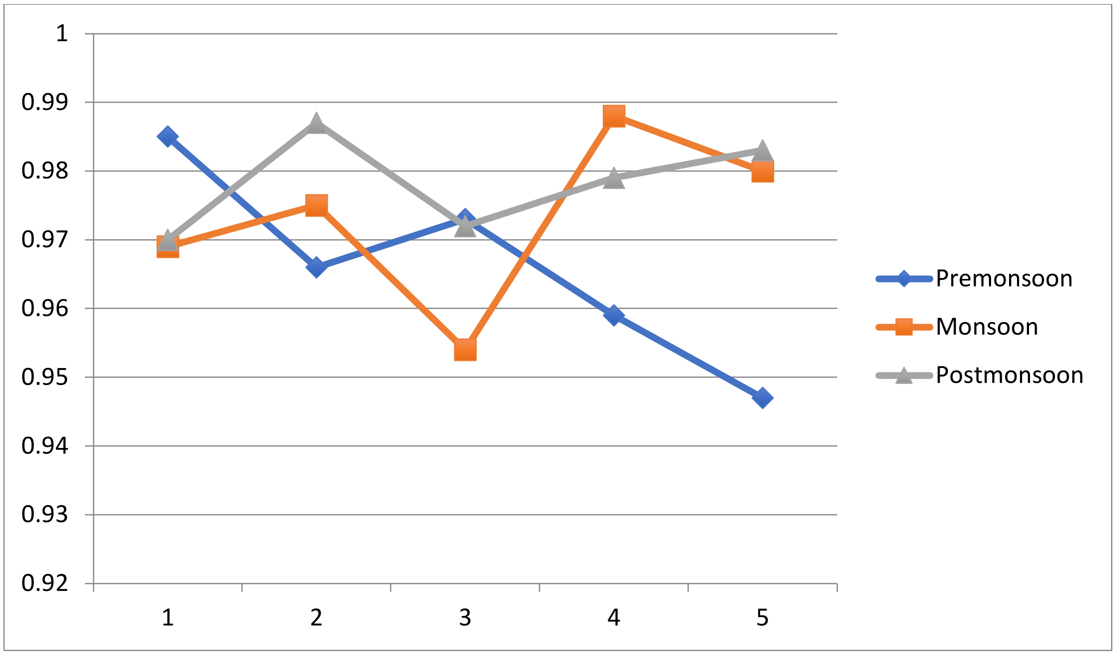

Fig.5.9 Seasonal variations in Pielou's evenness (mean) of zooplankton at various stations in Kolar reservoir.

5.3.4 Protozoa

During the investigation time, the Protozoa made up 24.68% of the total zooplankton population and contributed the most, with an average number of 115.32/l. (Table 5.1). Nine species from four different families made up the Protozoa group. They were Vorticella, Difflugia, Arcella, Euglypha, Prorodon, Didinium, Glaucoma, Opercularia, and Paramecium. Difflugia (31.61%) was the most prevalent protozoan, followed by Opercularia,(11.91%) and Vorticella (11.00%) (Table 5.1). The lowest percentage was reported by the Prorodon species, which made up only 2.83%. Difflugia and Arcella were the two species that appeared the most frequently throughout the research. (Table 5.2).

The overall Protozoa count varied significantly between seasons ($P < 0.05$) according to an ANOVA, but there was no significant variation between stations ($P > 0.05$). (Appendix III, Table 2). Premonsoon season saw the highest density of protozoa (60.75/l), while monsoon season saw the lowest frequency (17.08/l), and postmonsoon season saw the moderate density (37.40/l). (Table 5.2).

All species were seen in the reservoir during the premonsoon season. (Table 5.2). During this season, Difflugia were the most prevalent species found in the reservoir (16.15/l), making up about 26.58% of all protozoans. Arcella 8.12/l (13.36%), Paramecium 7.12/l (11.72%), and Glaucoma 6.45/l (10.61%) were the next in line. Prorodon (2.19/l), which made up only 3.60% of the total Protozoa species in the reservoir during the premonsoon season, was the least prevalent. (Table 5.2). The average of a two-year study of the stations revealed that, during premonsoon season,

station 3 had the greatest density of protozoa (68.50/l), while station 4 had the lowest density (45.25/l). (Fig. 5.10). Each of the five stations captured Difflugia and Arcella. They were the most widespread and numerous variety.
Except Prorodon, Didinium, and Glaucoma all species were noted from the reservoir during the monsoon season. (Table 5.2). In this season, Difflugia (5.13/l), which made up 30.03% of all Protozoa, was the most prevalent of them. While the proportion of Arcella in the overall Protozoa was 18.73% (3.20/l).. The station with the greatest average Protozoa density (20.99/l) was station 4, while the station with the lowest average density (8.12/l) was station 2.
Four different kinds of protozoa were discovered in the reservoir during the postmonsoon season. (Table 5.2). The Difflugia made up 22.54% of all protozoa and were the most numerous (8.43/l) during this season. Arcella (14.17%), Euglypha (11.23%), and Prorodon (9.89%) were its immediate competitors. Glaucoma, which made up only 5.61% of all species in the pool post-monsoon, was the least prevalent. The station with the greatest average Protozoa density (53.67/l) was station 5, while the station with the lowest density (18.49/l) was station 1. (Fig.5.10).

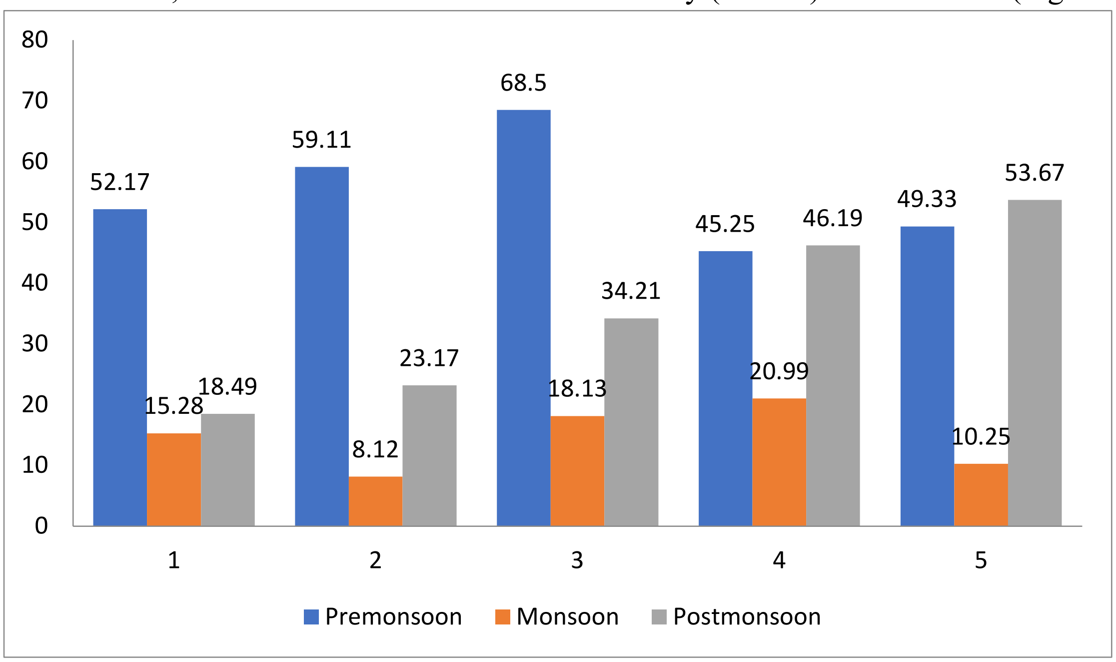

Fig.5.10 Seasonal distribution of Protozoa (mean) in all sampling stations of Kolar reservoir

5.3.5 Rotifera

With an average of 126.90/l (27.18%) of the reservoir's total zooplankton, the Rotifera were the first-most prevalent group. (Table 5.1). It was represented by 7 species from 5 genera, including Keratella heimalis, Keratella mira, Cephalodella, Hexarthra, Filinia longiseta, Polyarthra sp., and Brachionus angularis. Among the Rotifera, Brachionus angularis (32.95%) was the species with the highest population, followed by Cephalodella (11.86%) and Keratella mira (10.87%). The Hexarthra species, which made up just 3.75% of the total, had the lowest percentage. Brachionus angularis, Keratella heimalis, and Keratella mira were the most frequent species to be found all year. (Table 5.2).

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The total Rotifera count varied significantly between seasons, according to an ANOVA of Rotifera (Appendix III, Table 3), although there was no significant variation between stations (P > 0.05). The premonsoon season (61.63/l) saw the highest density of Rotifera, whereas the monsoon season (15.10/l) saw the lowest density. Despite the fact that their density was only moderate (50.17/l) in the post-monsoon season (Table 5.2).

Six species of Rotifera were spotted in the reservoir during the premonsoon season: Brachionus angularis, Keratella heimalis, Cephaodella, Keratella mira, Filinia longiseta, and Polyarthra sp. (Table 5.2). This season, the Hexarthra was not documented at any station. In this season, Brachionus angularis was the species with the highest abundance (23.76/l), making up 38.55% of all Rotifera. Keratella heimalis (20.02%), Keratella mira (13.30%), Filinia longiseta (12.29%), and Cephaodella (9.16%) were its immediate competitors. Polyarthra sp. was the least prevalent Rotifera species in the reservoir during the premonsoon season, making up only 6.65% of the total. The premonsoon season saw the maximum density of Rotifera (63.57/l) at station 1 and the lowest density (41.10/l) at station 3, according to an average 2-year analysis of the sites.(Fig.5.11). Only Keratella heimalis, one of the six species seen during the premonsoon season, was discovered at each of the five sampling locations. Brachionus angularis and Keratella mira were seen a total of 2 and 5 stations, respectively, while Cephaodella was observed at 4 stations. Three stations each of Filinia longiseta and Polyarthra sp. were recorded. (Table 5.4).

Only three Rotifera species were identified in the reservoir during the monsoon season. (Table 5.2). This season, Brachionus angularis, which made up 50.66% of the entire Rotifera, was the leading species. Keratella heimalis (27.81%) and Cephaodella (21.52%) came in second and third place, respectively.

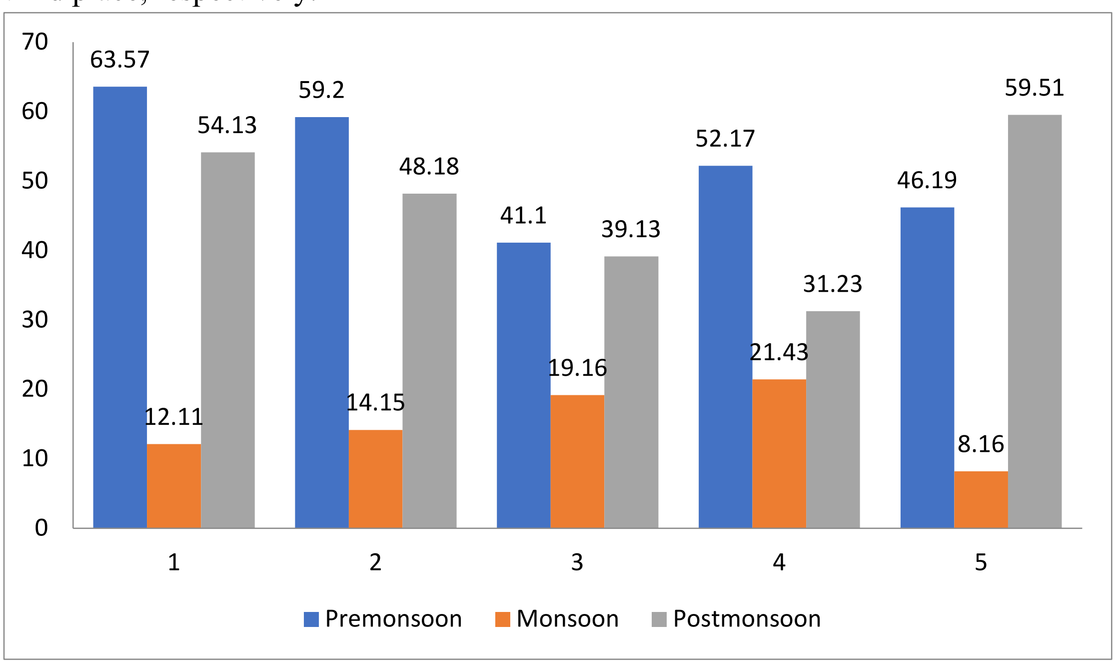

Fig. 5.11 Seasonal distribution of Rotifera (mean) in all sampling stations of Kolar reservoir

5.3.6 Cladocera

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In terms of the reservoir's overall zooplankton population, cladocerans occupied the second spot. With an average quantity of 92.80/l and percentage composition contributing 19.88% of the total zooplankton, a total of 8 species from 5 genera were identified. (Table 5.1). They were the following: Alona pulchella, Sida, Bosmina, Macrothrix, Moina brachiata ,Daphnia carinata,Leydigia and Ceriodaphnia cornuta. The Cladoceran group was dominated by the species Daphnia carinata, which made up 22.73% of the group. Moina brachiata (16.57%) and Ceriodaphnia cornuta (15.38%) were the next two most prevalent species. The lowest percentage was recorded by the species Leydigia, which made up only 3.63% of the total. Daphnia carinata, Bosmina, Moina brachiata , and Ceriodaphnia cornuta were the four species that appeared most frequently during the survey. (Table 5.2).

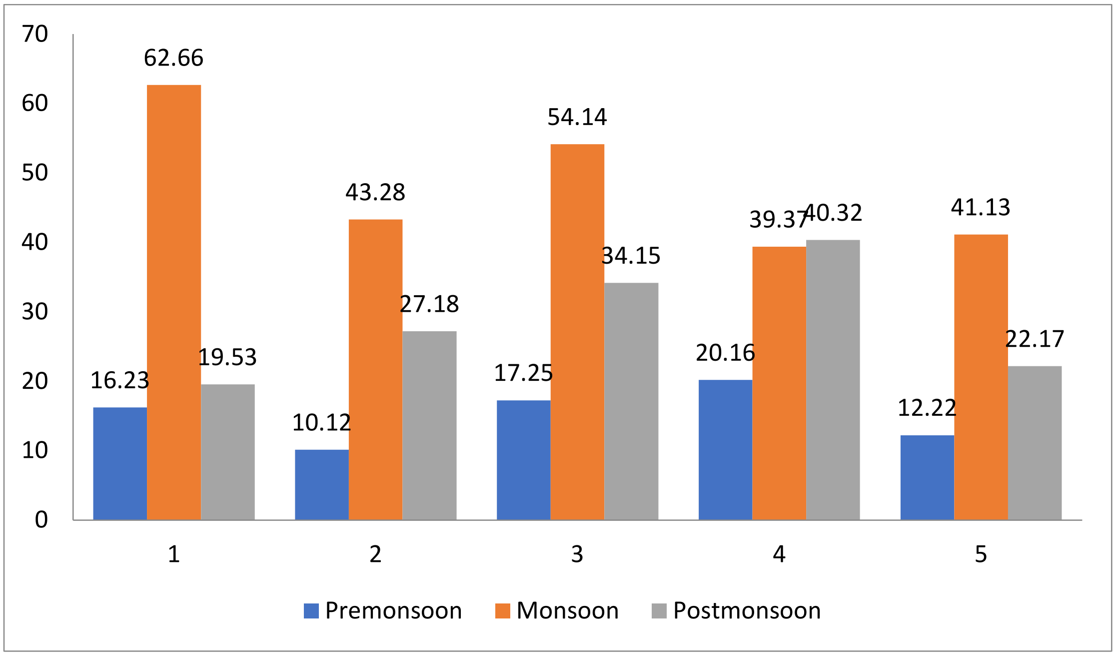
In Table 4 (Appendix III), the results of an ANOVA for the Cladocera group showed a significant variation in the total zooplankton count between seasons ($P < 0.05$), but no significant difference between stations ($P > 0.05$).

During the two years of the study, Cladocerans were detected in the highest density during the monsoon season (52.11/l) and the lowest density during the premonsoon season (10.45/l). In the post-monsoon season, their modest density (30.24/l) was observed. (Table 5.2).

Only six species, Alona pulchella, Sida, Bosmina, Moina brachiata ,Daphnia carinata, and Ceriodaphnia cornuta, were identified in the reservoir during the premonsoon season,(Table 5.2). These six species made up 10.52%, 4.97%, 8.81%, 21.05%, 35.88%, and 17.99%, respectively, of the entire Cladoceran community. Macrothrix, and Leydigia were not observed during this season. The average two-year analysis of the stations revealed that station 4 had the highest density of Cladocera (20.16/l), whereas station 2 had the lowest density (10.12/l). (Fig. 5.12). Daphnia carinata, Moina brachiate and Ceriodaphnia cornuta was discovered in 5 stations while Sida, Bosmina, and Alona pulchella, were only identified in two and four station, respectively. (Table 5.4).

All eight species of the Cladocera group were present during the monsoon season. (Table 5.2). Daphnia carinata (17.65%) and Sida (15.04%) were the two most common species. Alona pulchella (14.31%), Bosmina, (13.18%) Moina brachiata (13.04%), Ceriodaphnia cornuta (12.08%) and Macrothrix (11.20%)were its immediate competitors. The least dominant species was Leydigia with an average percentage of (3.45%). The station with the highest average Cladocera density (62.66/l) was station 1, whereas the station with the lowest density (39.37/l) was station 4. (Fig. 5.12). Daphnia carinata was the only species to be present at each of the five locations. Four stations recorded Alona pulchella. A total of 1, 2, and 3 stations, respectively, recorded Sida, Bosmina, Moina brachiate, Macrothrix, Ceriodaphnia cornuta and Leydigia. (Table 5.5).

Six Cladoceran species were spotted in the reservoir during the postmonsoon season: Daphnia carinata, Ceriodaphnia cornuta, Moina brachiata, Bosmina ,Leydigia and Macrothrix. (Table 5.2). This season no records of the species Alona pulchella and Sida were found. Daphnia carinata, which made up 26.95% of the entire Cladocera, was the species with the highest numerical dominance, followed by Moina brachiata, (21.09%), Ceriodaphnia cornuta (20.17%), and Macrothrix 14.02%. Only 12.56% of all Cladocaran species were members of the Bosmina genus, while only 5.19% of all Cladocera were members of Leydigia. Between the stations, station 4 had the highest average density of Cladocera (40.32/l), whereas station 1 had the lowest density (19.53/l). (Fig.5.12). Bosmina ,Leydigia and Macrothrix were recorded from a total of 4, 2 and 1 stations, respectively, while Daphnia carinata,Moina brachiata,and Ceriodaphnia cornuta ,were recorded from 4 stations each. (Table 5.6).



5.3.6 Copepoda

The third largest contributor to the zooplankton population during the study period, the copepodas had an average number of 110.65/l and made up 23.70% of the overall zooplankton population. (Table). The Nauplius larvae and four species from three different genera made up the Copepoda group. They were Cyclops, Heliodiaptomus viduus, Diaptomus, and Mesocyclops leuckarti. Nauplius larva (43.51%) was the most prevalent Copepoda species, followed by Mesocyclops leuckarti (24.56%) and Cyclops (21.03%) (Table 5.1). The lowest percentage was recorded by the species Diaptomus, which made up only 3.61%. Mesocyclops leuckarti and Nauplius larvae were the most prevalent species seen during the course of the investigation. (Table 5.2).

ANOVA revealed a significant difference in the overall copepod count between seasons (P 0.05), but no difference across stations ($P > 0.05$) was found. (Appendix III, Table). Premonsoon season saw the highest density of Copepoda (55.30/l), while monsoon season saw the lowest incidence (15.21/l), and postmonsoon season saw the highest density (40.14/l). (Table 5.2).

All four species and Nauplius larvae were seen in the reservoir during the premonsoon season. (Table 5.2). The most numerous larvae found in the reservoir during this season were Nauplius larvae (26.86/l), which made up roughly 48.57% of all Copepoda. Cyclops 10.26/l (18.55%), Mesocyclops leuckarti 8.33/l (15.06%), Diaptomus 6.30/l (11.39%) were the species that came after it, in that order. Heliodiaptomus 3.55/l , which made up only (6.41%), of all Copepoda species in the reservoir during the premonsoon season, had the lowest abundance. (Table 5.2).The average of a two-year research of the stations revealed that, during premonsoon season, station 3 had the maximum density of Copepoda (68.64/l), while station 5 had the lowest density (45/l). (Fig. 5.10). Mesocyclops leuckarti and Nauplius larvae were found in each of the five locations. They were the most widespread and numerous species. Cyclops, Heliodiaptomus viduus and Nauplius larvae were recorded in all 5 stations, Mesocyclops leuckarti and Diaptomus were both limited to 3 stations each. (Table 5.4).

All species of Copepoda and Nauplius larvae were discovered in the reservoir during the postmonsoon season. (Table 5.2). The Nauplius larvae, which made up 40% of all Copepoda during this season and had the highest density (16.06/l), were also the most numerous. Cyclops (25.48%), Mesocyclops leuckarti (18.38%), and Diaptomus (12.70%) were its immediate competitors. Heliodiaptomus viduus, which made up only 3.41% of the species in the reservoir during the postmonsoon, was the least prevalent. The station with the highest average Copepoda density (54.57/l) was station 4, whereas the station with the lowest density (18.59/l) was station 2. (Fig.5.10). At all 5 stations, Nauplius larvae were the only species found. From 4 stations, Mesocyclops leuckarti was collected. Total recordings from Cyclops, Heliodiaptomus viduus, and Diaptomus were made at 1,3 and 2 stations, respectively. (Table 5.6).

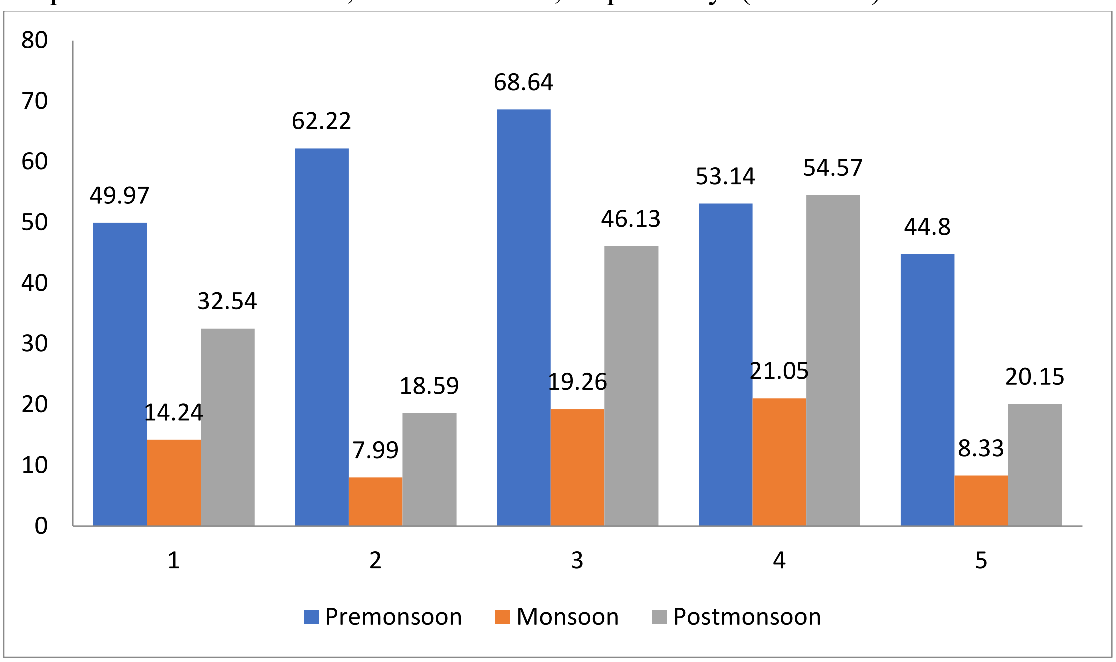


Fig. 5.10 Seasonal distribution of Copepoda (mean) in all sampling stations of Kolar reservoir

5.3.7 Ostracoda

Ostracods were in poor numbers in the reservoir and were ranked fifth overall in the zooplankton community. The representative genera Stenocypris, Cypris, and Cyprionotus were found during the investigation period, but they only constituted 4.53% of the total zooplankton, with an average number of 21.15/l. (Table 5.1).

The total Ostracoda count significantly varied across seasons ($P< 0.05$) and stations ($P >0.05$) according to ANOVA (Appendix III, Table 5). The Cypris, was found to vary seasonally, reaching its peak count of 5.15/l in the postmonsoon season and its lowest density of 4.25/l in the premonsoon season. (Table 5.2). In the reservoir, they weren't noted during the monsoon season. The station with the highest average density of ostracoda (15.66/l) during premonsoon season was station 3, while the stations with the lowest average density (10.16/l) were stations 1 and 4. (Fig.5.13). During this season, they are only shown on 3 stations. (Table 5.4). The stations 3 and 4 recorded the maximum density of ostracoda (13/l), while station 5 recorded the lowest (8/l) during the postmonsoon season.(Fig.5.13). Ostracoda was recorded in 3 stations this season. (Table 5.6).

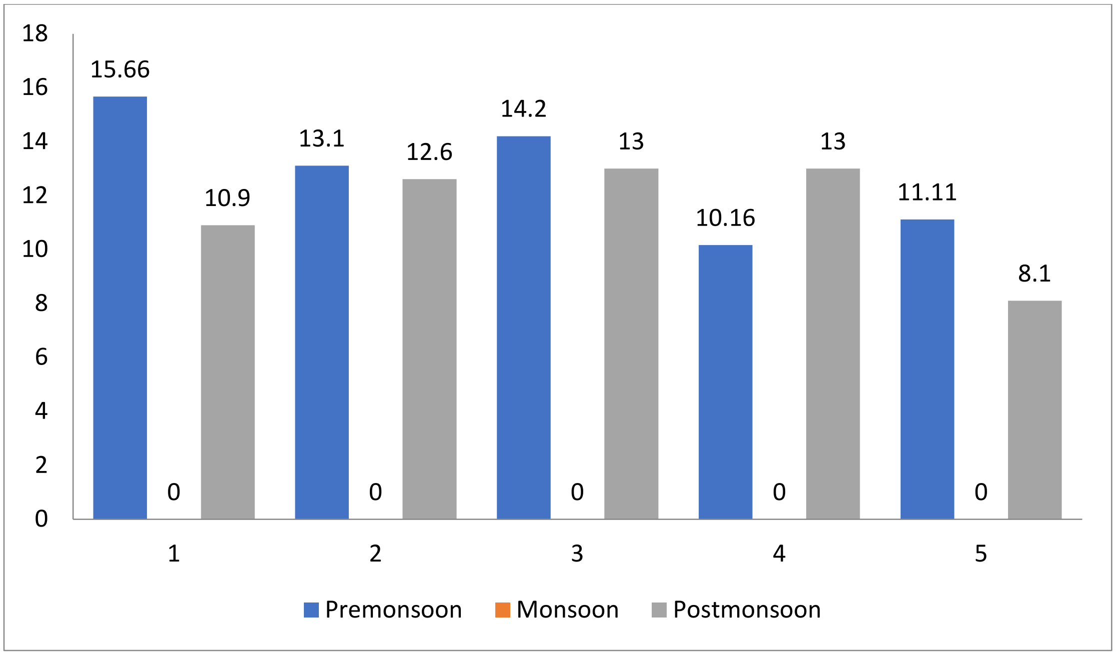


Fig. 5.13 Seasonal distribution of Ostracoda (mean) in all sampling stations of Kolar reservoir

5.3.8 Correlation analysis of zooplankton with physico-chemical parameters and phytoplankton

In Table 5.7, the results of the Pearson correlation analysis of total zooplankton and groups with physico-chemical variables and phytoplankton groups are presented. Total zooplankton, groups Rotifera, Copepoda, and Ostracoda, on the other hand, exhibited positive correlations with all other parameters, total phytoplankton, and various phytoplankton groups, while the group Cladocera exhibited negative correlations with all other physico-chemical parameters, total phytoplankton, and various phytoplankton groups.

Positive correlation was revealed between total zooplankton and water temperature ($r = 0.921$),transparency ($r = 0.867$), electrical conductivity ($r = 0.932$), TDS ($r = 0.943$),pH ($r = 0.919$), total alkalinity ($r = 0.765$), chloride ($r =0.766$), total hardness ($r=0.824$), calcium ($r = 0.788$), magnesium ($r = 0.879$),BOD ($r = 0.768$), phosphate ($r = 0.897$), Cyanophyceae ($r =0.993$), Chlorophyceae ($r = 0.990$), Bacillariophyceae ($r=0.997$),Euglenophyceae ($r = 0.994$) total

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phytoplankton (r =0.996) and Rotifera (r = 0.995), Copepoda (r = 0.929) and Ostracoda (r =0.936) whereas negative correlation was observed between total zooplankton and turbidity (r=-0.796), DO (r = -0.939), nitrate (r = -0.851) and Cladocera (r= -0.902) (Table 5.7).

Statistically significant positive correlations were found between Copepoda and water temperature (r = 1.00), electrical conductivity (r = 1.00), pH (r = 1.00), total alkalinity (r = 0.948), chloride (r = 0.950), total hardness (r = 0.975), calcium (r = 0.959), magnesium (r = 0.992), BOD (r = 0.951), phosphate (r = 0.674),Cyanophyceae (r = 0.972),

Chlorophyceae (r=0.968), Bacillariophyceae (r=0.945), Euglenophyceae (r = 0.963), total phytoplankton (r = 0.955), and Rotifera (r =0.960) but recorded a negative relation with turbidity (r = -0.963), DO (r = -1.00), nitrate (r = -0.985) and Cladocera (r = -0.998) (Table 5.7).

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	Positive correlation was revealed between total zooplankton and water temperature (r = 0.921),transpa														
2															
3		0.254	1												
4		-0.124	0.894	1											
5		-0.258	-0.897	-0.584	1										
6		0.894	0.894	0.894	0.897	1									
7		0.589	0.584	0.874	0.548	0.874	1								
8		0.847	0.254	0.984	0.548	0.874	0.845	1							
9		0.894	0.548	0.895	0.748	-0.589	0.584	0.598	1						
10		0.584	0.894	0.584	0.894	0.998	0.889	0.548	0.584	1					
11		0.894	0.598	0.548	0.589	0.548	0.845	0.584	0.584	985	1				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	Cladocera showed positive correlations with turbidity (r = 0.979), DO (r = 0.996), and nitrate (r													
2														
3		-0.895	0.895	1										
4		0.589	0.584	0.698	1									
5		0.598	0.589	0.589	0.985	1								
6		-0.598	0.985	0.845	0.895	-0.589	1							
7		0.989	-0.894	0.589	0.898	0.859	-0.898	1						
8		0.258	0.598	0.898	-0.598	0.895	0.989	0.898	1					
9		0.895	0.589	0.256	0.849	0.599	0.897	0.478	0.598	1				
10		0.897	0.587	-0.584	-0.589	-0.894	0.894	0.989	0.589	0.989	1			
11		0.884	0.965	0.784	-0.594	0.589	0.478	0.258	0.589	0.898	0.488	1		
12														

Ostracoda and water temperature were positively correlated with EC (r = 0.743), pH (r = 0.719

	A	B	C	D	E	F	G	H	I	J	K
3		0.898	1								
4		0.2548	-0.598	1							
5		-0.985	-0.5984	0.589	1						
6		0.598	-0.589	0.154	895	1					
7		0.895	0.145	0.989	-0.584	0.985	1				
8		0.598	0.989	-0.589	**0.985**	-0.584	-0.584	1			
9		-0.584	-0.589	0.589	0.879	0.895	0.589	0.9854	1		
10		-0.589	0.847	0.958	0.589	9854	0.001	0.089	0.085	1	
11		0.589	0.089	0.099	0.0895	0.548	0.589	0.584	0.895	0.895	1

Rotifera showed positive correlation with water temperature (r = 0.955), Electrical conductivity (r = 0.962), pH (r = 0.952),total alkalinity (r = 0.822), chloride (r = 0.825), total hardness (r = 0.874),calcium (r = 0.842),magnesium(r=0.919),BOD(r=0.826),phosphate(r=0.854),Cyanophyceae(r=0.997)Chlorophyceae (r=1.00), Bacillariophyceae (r=0.998), Euglenophyceae (r =1.00), and total phytoplankton (r = 1.00). Rotifers were negatively correlated with turbidity (r = -0.850), dissolved oxygen (r = -0.967) and nitrate (r = -0. 898) (Table 5.7).

Cladocera showed positive correlations with turbidity (r = 0.979), DO (r = 0.996), and nitrate (r = 0.994), while it showed negative correlations with water temperature (r = -0.999), electrical conductivity (r = -0.997), pH (r = -0.999), total alkalinity (r = -0.967), total hardness (r = -0.988), calcium (r = -0.976), magnesium (r = 0.998). Total phytoplankton (r = -0.932), Cyanophyceae (r = -0.953), Chlorophyceae (r = -0.949), Bacillariophyceae (r =-0.921), Euglenophyceae (r = -0.943), and Rotifera (r = -0.939) are all negatively correlated. (Table 5.7).

Ostracoda and water temperature were positively correlated with EC (r = 0.743), pH (r = 0.719), total alkalinity (r = 0.486), total hardness (r = 0.570), calcium (r = 0.518), magnesium (r = 0.649), BOD (r = 0.494), and phosphate (r = 0.996). Total phytoplankton (r = 0.906), Cyanophyceae (r = 0.877), Chlorophyceae (r = 0.884), Bacillariophyceae (r = 0.918), Euglenophyceae (r = 0.893), Rotifera (r = 0.897), and Copepoda (r = 0.739). Ostracoda, on the other hand, had a negative connection with turbidity (r = -0.531), DO (r = -0.756), nitrate (r = -0.611), and Cladocera (r = -0.691). (Table 5.7).

Discussion

Eutrophication affects the composition and organisation of zooplankton communities (Ostozic, 2000; Licandro and Ibaney, 2000). These communities may be useful as markers of shifting trophic conditions (Kudari and Kanamadi, 2008). In an aquatic environment, zooplankton are essential for the transformation of plant matter into animal feed as well as for higher creatures as a source of food. Fish mostly eat zooplankton, which can also be used to determine the trophic level of aquatic bodies (Verma and Munshi, 1987).

Five kinds of zooplankton, including Copepoda, Cladocera, Ostracoda, Rotifera, and Protozoa, were identified in the Kolar reservoir's zooplankton samples. Throughout the course of the examination, a total of seven species of Rotifera, nine species of Protozoa, eight species of

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Cladocera, four species of Copepoda and Nauplii, and three species of Ostracoda were identified from the reservoir. Protozoa was the dominant group among zooplankton, followed in order by Rotifera, Cladocera, Copepoda, and Ostracoda. In the current study, zooplankton demonstrated a clear seasonal variation. The premonsoon season was characterised by the highest zooplankton density, whereas the monsoon season saw lower levels of observations. In the Wanprakalpa reservoir in Maharashtra, Salve and Hiware (2010) similarly noted that the summer was the peak time for zooplankton, with winter following and the monsoon season bringing the lowest numbers. The monsoon season at Kolar Reservoir was determined to have the lowest zooplankton density. The diluting impact, lower photosynthetic activity by primary producers, and relatively high turbidity during this season could be the cause of the zooplankton fall during the monsoon. Salve and Hiware (2010) as well as Bais and Agrawal (1993) discovered comparable outcomes. During the monsoon season, the fresh water flood from upstream also significantly reduced the density of zooplankton population, as further evidenced by studies by Padmavathi and Goswami (1996), Walujkar and Hiware (2006), and Perumal et al. (2009).

Conclusion

In this study, preliminary data are presented on the zooplankton diversity, abundance, community structure, ecological factors, and the impact of ecological variables on zooplankton in the dam of a tropical coastal region. The significant density of zooplankton demonstrates the appropriateness of the dam for aquaculture despite the low number of zooplankton species that were observed. Eutrophication events, which frequently occur in small-scale tropical fish dams, may be to blame for the lack of species. The zooplankton communities were dominated by Copepoda, Rotifera, and Cladocera, as is typical for fish dam. TDS, phosphates, and nitrates were discovered by the CCA to have a substantial influence on the abundance of the zooplankton species among the investigated ecological variables. Certain zooplankton species, like Mesocyclops sp., Bosmina sp., and Brachionus sp., suggest a large amount of suspended matter in the water body, which may result in eutrophication of the water body. The environment is inappropriate for fish and other species because of the suspended particles from bathing and washing, pets, clothing, and dwellings. The results of the current study are helpful for preserving a balanced ecology for fish farming in the investigated dam. Additionally, they offer fundamental information for future studies on zooplankton diversity, abundance, ecological characteristics, and how these factors affect zooplankton in dam.

References

1.Batish, S.K. 1992. Freshwater zooplankton of India. Oxford and IBK Publishing Co., New Delhi. Dhanapathi, M.V.S.S.S. 2000. Taxonomic notes on the rotifers from India (from 1889-2000). Indian Association of Aquatic Biologists (IAAB),Hyderabad .

2.*Ghosal; Rogers; Wray, S.; M.; A.* "The Effects of Turbulence on Phytoplankton". *Aerospace Technology Enterprise. NTRS*. Retrieved 16 June 2011.

3.Lindsey, R., Scott, M. and Simmon, R. (2010) "What are phytoplankton". NASA Earth Observatory.Darwin Project Massachusetts Institute of Technology.

4.*Michael J. Behrenfeld; et al. (30 March 2001).* "Biospheric primary production during an ENSO transition" (PDF). *Science.* ***291*** *(5513): 25947.* Bibcode:2001Sci...291.2594B. doi:10.1126/science.1055071. PMID 11283369. S2CID 38043167.

5.Padmavathi, G. and Goswami, S.C. 1996. Zooplankton ecology in the Mandovi-Zuari estuarine system of Goa, west coast of India. Ind. J. Mar.Sci., 25: 268-273.

6. *Parker, Micaela S.; Mock, Thomas; Armbrust, E. Virginia (2008). "Genomic Insights into Marine Microalgae". Annual Review of Genetics.* ***42****: 619–645.* doi:10.1146/annurev.genet.42.110807.091417. PMID 18983264.

7.Perumal, N.V., Rajkumar, M., Perumal, P. and Rajasekar, K.T. 2009. Seasonal variations of plankton diversity in the Kaduviyar estuary, Nagapattinam,south east coast of India. J. Environ. Biol., 30 (6): 1035-1046.

8.Pierella Karlusich, Juan José; Ibarbalz, Federico M; Bowler, Chris (2020). "Exploration of marine phytoplankton: from their historical appreciation to the omics era". *Journal of Plankton*

9.Research. ***42****: 595–612.* doi:10.1093/plankt/fbaa049.

Salve B, Hiware C. Zooplankton diversity of Wan reservoir, (Nagpur) (MS), India. Trends research in Science and Technology 2010. 2(1): 39-48.

10.Thurman, H. V. (2007). Introductory Oceanography. Academic Internet Publishers. ISBN 978-1-4288-3314-2.

Tonapi, G.T. 1980. Fresh water animals of Ind1.ia (an ecological approach).Oxford and IBH. Publ. Co., New Delhi, 341 Pp.

11.Trivedi, M.K. and Goel, P.G. 1984. Chemical and biological methods for pollution studies. Environmental Publication, Karad, 247 Pp.

12.Walujkar, A.G. and Hiware, C.J. 2006. Seasonal variation in zooplankton population of Shirsatwadi reservoir from Pathardi Tehasil(Maharashtra), India. (In Biodiversity and Environment, Edtd by B.N.Pandey and G.K. Kulkarni, APH Publishing Corporation, New Delhi).

13.Ward, H.B. and Whipple, G.C. 1959. Freshwater biology. In Edmondson,W.T. (Ed.) 2nd edn., John Wiley and Sons, Inc., New York, 1248 Pp.