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A Study on Seasonal Variation in Zooplankton Abundance in Kadasgatti Minor Irrigation Tank of Bailhongal Taluk, Belagavi District, Karnataka State, INDIA.

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Abstract

Objectives: A study on seasonal variation in zooplankton community was undertaken to evaluate the present status of water quality at Kadasgatti minor irrigation tank (MIT) located in the northern transitional zone of Belagavi district. **Methods and Statistical Analysis:** Water samples were collected from January 2017 to December 2017. Physico-chemical parameters and qualitative and quantitative analysis of zooplankton were carried out. Pearson correlation was calculated using SPSS, IBM Version 21 software to find out interrelationships between water quality and zooplankton groups. **Findings:** A total of 52 species of zooplanktons were recorded during the study period with a total zooplankton abundance of 14327 individuals with a relative abundance of 35.42%. Rotifera was the dominant group with 27 species, followed by Cladocera, Copepoda and Ostracoda. The highest zooplankton abundance was observed in summer while minimum in post-monsoon season. Copepoda was highest abundant group during the entire study period with its maximum abundance during winter and gradually declined and reached to its minimum in post-monsoon. The presence of eutrophic indicator species like *Brachionus calyciflorus, Brachionus angularis, Filina longiseta* suggests eutrophication of the tank. **Novelty:** The study provides baseline data on the present status of the water body indicating that, anthropogenic activities, agricultural runoff are the main cause of eutrophication. Sustainable and holistic conservational strategies have to be adopted to protect the water body.

Keywords: Cladocera; Copepoda; Eutrophication; Rotifera; Seasonal variation; Zooplankton abundance

1 Introduction

Zooplankton occupies a critical position in the food web and is food for many fishes, aquatic insects and other zooplankton. These are more valuable as indicators of tropic conditions and respond more rapidly to the environmental changes than fishes[1–4]. The structure of plankton community depends on complex factors like; morphometric and regional climatic conditions, which govern the important physical and chemical characteristics of water-bodies determined by edaphic features and vegetation on the diversity of the plankton [5]. The changes in zooplankton abundance, species diversity and its community composition are usually considered to be the best indicator of environmental changes [6]. The density and diversity of the zooplankton are controlled by the several physico-chemical factors of water [7].

Internationally there are several studies on zooplanktons which include structure of zooplankton populations in the littoral macrophyte zone of Colorado lakes [8]; Life history patterns in zooplanktons [9]; Spatial and temporal patterns in distribution of zooplankton in Jurumirim Reservoir of Sao Paulo, Brazil [10]; Seasonal variations of zooplankton abundance in the freshwater reservoir Valle de Bravo (Mexico) [11]; Effects of hydrology on plankton biomass in shallow lakes [12]; Overwintering strategies of copepods [13]; Zooplankton response to extreme drought in a large subtropical lake [14]; Contrasting effects of chemical and thermal variability on lake zooplankton abundance in temperate zone lakes of North America and Europe [15]; Spatial distribution of zooplankton diversity in temporary pools of semiarid regions of Brazil [16]; Influence of bioclimatic factors on species richness in ponds and lakes of Albania and North Macedonia [17]; Zooplankton biodiversity monitoring in polluted freshwater ecosystems of China [18].

Baird [19] and Anderson [20] initiated taxonomic studies on Indian freshwater Cladocera and Rotifera respectively. Subsequently there are several reports on zooplankton studies from different parts of India that includes the studies on zooplankton composition in the limnetic zones of two subtropical lakes, Nainital and the Bhimtal of Uttar Pradesh, India [21]. Investigations on rotifer, cladocera and copepoda group has been carried out from eastern, North West and North East part of India [22–26]. Zooplankton emergence pattern and resting egg diversity of dried water bodies in north Maharashtra [27].

In southern India, limnological studies and distribution of micro and macro-invertebrates have been studied from Hyderabad [28] and Telangana [29,30]; Preliminary survey of plankton in Irrukkagudi reservoir in Tamil Nadu [4]; A new species, Megadiaptomus Kiefer, 1936 was reported from the Western Ghats [31]; The first report of freshwater rotifers from south Andaman [32].

Karnataka is one of the agriculturally and industrially leading states in India. It is also known for its large number of water-bodies like, small impoundments and bigger tanks, which are mainly used for irrigation, fisheries, washing, bathing etc. The studies in Karnataka include characterization of some selected lentic habitats of Dharwad, Haveri and Uttara Kannada districts [33,34]; Diversity and seasonal fluctuation of zooplankton from fish ponds of Bhadra fish farm [35]; Monthly changes in the abundance and biomass of zooplankton and water quality parameters in Kukkarahalli lake and zooplankton abundance of Kalale, Alanahalli and Dalvoy lakes of Mysore [36,37]; Water quality assessment of Almatti Reservoir of Bijapur [38]; Trophic status of three fresh water lakes of Gulbarga [39]; Zooplankton studies of Tungabhadra river near Harihar [40]. Studies on zooplankters of Belagavi district are restricted to the rotifer diversity, water quality assessment of fort lake, Belgaum [41] and Sogal pond [42].

Seasonal studies on zooplankton abundance of a given water body not only explain the factors responsible for the presence or absence of certain taxa but also interpret changes in the patterns of species diversity in addition it will also help in assessment of water body to evaluate its present status. As there are no such reports from Bailhongal taluk, the present work was undertaken to study the species richness, diversity, abundance and seasonal variations in zooplankton at Kadasgatti minor irrigation tank (MIT).

2 Materials and Methods

2.1 Study area:

Belagavi district is located east of the Western Ghats and is situated in the northwest part of Karnataka state and it lies 15°00 and 17°00 north latitudes and between 74° 00' and 75° 30' east longitude. Its topography is predominantly undulating. The terrain marks with hilly region at the western parts of Khanapur and Belagavi taluk. Agro-climatically, the district can be divided into three zones; hilly zone, northern transitional zone and northern dry zone. Kadasgatti MIT falls in Bailhongal taluk at 15.639193 N, 74.873916 E that lies in the northern transitional zone. It has the catchment area of 15.54 km^2 with water spread area of 1,03,819.72 m^2 and located 680.06 m above sea level. The average rainfall in this area is 862 mm (Figure 1).

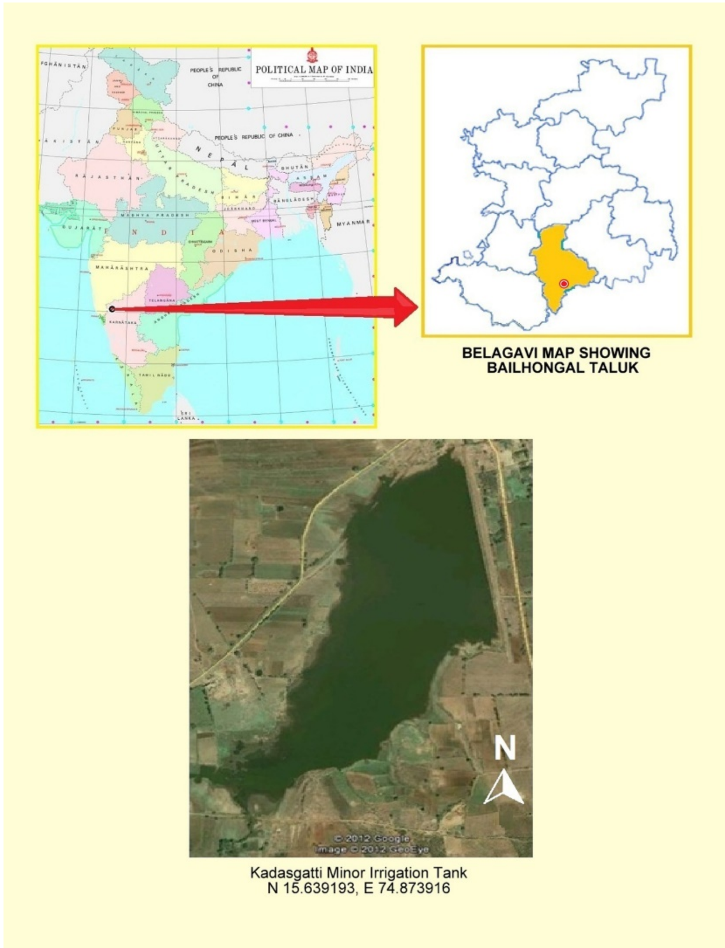

Fig 1. Map of study area showing Kadasgatti Minor Irrigation Tank (MIT) of Bailhongal**,** Belagavi District, Karnataka State, INDIA.

2.2 Physico-chemical and Plankton Analysis:

For the present study water samples were collected at monthly intervals from January, 2017 to December, 2017 between 6:00 am to 10:30 am. Physical factors like atmospheric and water temperature were measured at the study site by using mercury thermometer, transparency by secchi disk and humidity by hygrometer. Eutech PS Testr 35 multi-parameter probe was used to measure pH, electric conductivity (EC), total dissolved solids (TDS) and salinity in the field itself. For measuring other parameters samples were brought to the laboratory and estimations were carried out by following standard methods mentioned in APHA[(43)]. For the plankton study, water was collected from the surface with minimal disturbance and filtered in a plankton net made of nylon bolting cloth (30cm in diameter and 68μm pore size). The volume of water sieved for zooplankton analysis was 100 litres. The sieved samples stored in 1 litre bottles were preserved by adding 3ml of 4% formalin. The preserved samples were kept for 24 hours undisturbed to allow the sedimentation of plankton suspended in the water. After that, the supernatant was discarded carefully without disturbing the sediments and the final volume of concentrated sample was 120ml. The qualitative and quantitative analysis was performed by Lackey's drop count method using MAGNUS MLX - TR optical compound binocular microscope. Species identification was carried out by using available taxonomic keys[(6,22,24,25,32,44–52)]. SPSS, IBM Version 21 software was used for statistical analysis. Pearson correlation was formed to find interrelation between zooplankton groups and physicochemical factors.

3 Results and Discussion:

The maximum and minimum values and seasonal variations in physico-chemical factors recorded from January 2017 to December, 2017 and their interrelationships with zooplankton groups are summarized (Tables 1 and 4).

Table 1. Maximum and minimum values of physicochemical factors of in Kadasgatti MIT of Bailhongal taluk during January, 2017 to December, 2017.

Parameters	Maximum Value	Minimum Value
Atm Tempt, ° C	29	10
Water Tempt, ° C	27.1	16
Transparency, cm	45	1.5
Humidity, %	79	58
pH	9.48	7.8
Salinity, ppm	629	0.9
TDS, ppm	891	1.53
EC, μS/cm	1299	2.12
DO, mg/Lt	9.137	3.225
Free CO2, mg/Lt	85.8	2.2
Total Alkalinity, mg/Lt	216.5	6.65
Total Hardness, mg/Lt	420.69	28
Chloride, mg/Lt	690.97	12.297
Sulphate, mg/Lt	26	6
Nitrates, mg/Lt	30	10
COD, mg/Lt	228	16.4
BOD, mg/Lt	84.8	4.86
Phosphates, mg/Lt	0.3	0.01
Rainfall, mm	155	14

During the 12 month study, a total of 52 species of zooplankters were recorded. Rotifera was the dominant group represented with 27 species followed by Cladocera with 14 species, Copepoda with 8 species and only three species were recorded from Ostracoda (Table 2). Seasonal variations in zooplankters reveals that, maximum of 4821 individuals were recorded during summer followed by 4045 in winter, 3092 in monsoon and a minimum of 2369 individuals during post-monsoon respectively (Figure 2).

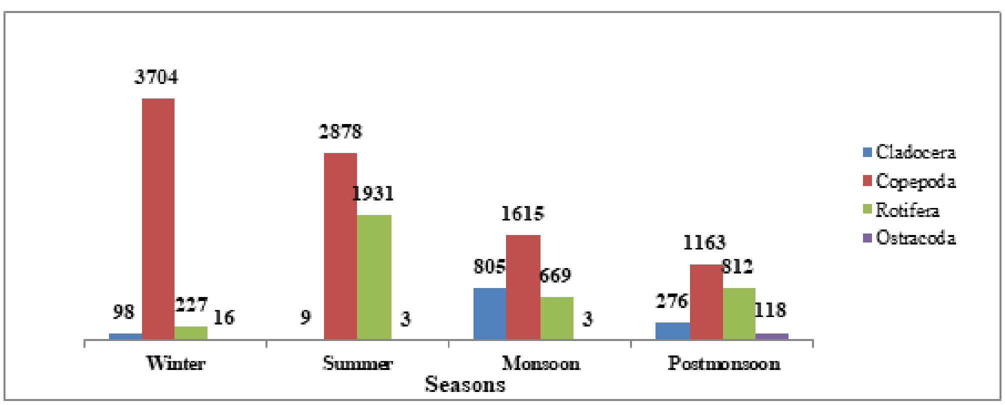

Fig 2. Seasonal variation in zooplankton abundance recorded in Kadasgatti MIT from January to December, 2017

Table 2. Seasonal variations in zooplankton abundance (ind/L) of Kadasgatti MIT from January, 2017 to December, 2017

Zooplankton / Season	Winter (Jan to Feb)	Summer (Mar to May)	Monsoon (Jun to Sept)	Post-monsoon (Oct to Dec)
CLADOCERA				
Alona Baird, 1843	2	1	0	4
Alonella GO Sars, 1862	12	0	0	1
Bosminopsis deitersi Richard, 1985	0	0	0	19
Bosmina longirostris O.F Muller, 1776	12	0	0	7
Bipertura karua	0	0	0	3
Ceriodaphnia corunata	49	1	0	37
Diaphanosoma exicusm Sars, 1885	0	0	4	28
Diaphanosoma sarsi Richard, 1894	2	0	72	60
Echinisca odiosa	2	0	0	0
Macrothrix goeldi Richard, 1897	1	0	4	2
Macrothrix spinosa King, 1853	3	0	0	0
Moina micrura Kurz, 1875	15	1	648	105
Moina brachiate Jurine, 1820	0	4	60	0
Moina daphnia	0	2	17	10
Total	98	9	805	276
COPEPODA				
Heliodiaptomus viddus Gurney, 1916	129	0	278	305
Sinediaptomus indicus	109	0	12	308
Neodiaptomus strigilipes	76	0	0	468
Paracyclops fimbriatus Fischer, 1853	1024	1094	604	20
Paracyclops psilosus	0	18	0	0
Tropocyclops prasinus Fischer, 1860	923	744	455	23
Mesocyclops leuckarti Claus, 1857	951	299	211	3
Thermocyclops hyalinus Rehberg, 1880	455	117	31	1
Nauplii	37	606	24	35
Total	3704	2878	1615	1163
ROTIFERA				
Anueropsis coelata	7	11	0	24
Anueropsis fissa	1	13	0	0
Anueropsis navicula	0	10	0	0
Brachionus leydigi Cohn, 1862	10	0	0	28
Brachionus plicatilis Gosse, 1851	4	16	2	4
Brachionus rubens Ehrenberg, 1838	3	28	2	9
Brachionus caudatus Barrois & Daday, 1894	5	25	1	11
Brachionus urceolaris Muller, 1773	2	11	0	6
Brachionus diversicornis Daday, 1883	6	13	0	16
Brachionus angularis Gosse, 1857	6	7	569	56
Brachionus calyciflorus Pallas, 1766	13	2	23	0
Brachionus calyciflorus var. *dorcus*	3	13	11	15
Brachionus quadridentata	1	4	3	7
Filina longiseta	0	1194	9	0
Filina opoliensis	3	25	18	2
Lepadella biloba Hauer, 1958	45	5	0	6
Lepadella rhomboides Gosse, 1886	52	0	1	3
Lepadella sp.	21	0	3	27
Lacinularia socialis	0	0	0	51
Pompholyx sulcata Hudson, 1885	2	5	0	2
Philodina Erhenberg, 1830	0	373	0	4
Rotifer tardus Erhenberg, 1838	24	51	0	4
Sinantherina sp.	0	34	0	537
Keratella tropica Apstein, 1907	8	1	27	0
Lecane stenroosi Meissner, 1908	3	2	0	0

Continued on next page

Table 2 continued

Polyarthra Ehrenberg, 1834	0	84	0	0
Rotaria neptunia Erhenberg, 1830	8	4	0	0
Total	227	1931	669	812
OSTRACODA				
Hemicypris fossulata	3	1	0	11
Ilyocypris sp.	10	2	3	72
Stenocypris sp.	3	0	0	35
Total	16	3	3	118

Copepoda was the most abundant group that was observed throughout the study period. Their occurrence was highest in winter (92%) and declined gradually in summer (60%) to monsoon (52%) and minimum in post-monsoon (49%) (Figures 3, 4, 5 and 6). Cyclopoids like *Paracyclops fimbriatus, Tropocyclops prasinus, Mesocyclops leuckarti and Thermocyclops hyalinus* were the major contributors for the maximum abundance. Similar observations were made at the Almatti reservoir of Bijapur[38]. In the present study, calanoids were absent during summer while cyclopoids were present in all the seasons except *Paracyclops psilosus* which was recorded only during summer. Copepoda shows a positive correlation with Sulphate (Table 4). Sent it separate sheet

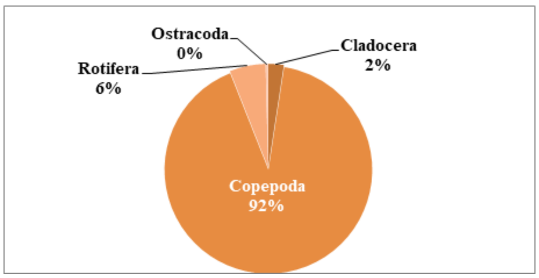

Fig 3. Abundance of zooplankton groups during the winter season in Kadasgatti MIT

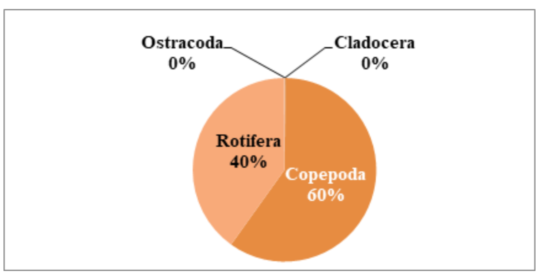

Fig 4. Abundance of zooplankton groups during the summer season in Kadasgatti MIT

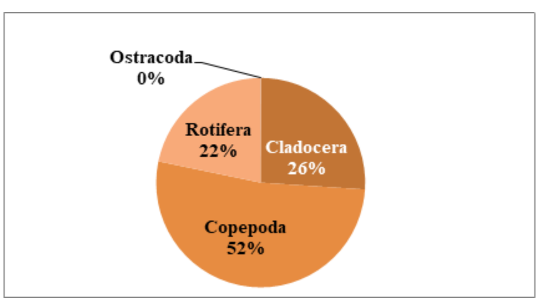

Fig 5. Abundance of zooplankton groups during the monsoon season in Kadasgatti MIT

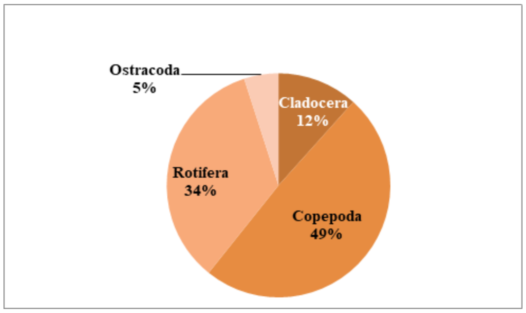

Fig 6. Abundance of zooplankton groups recorded during the post-monsoon season in Kadasgatti MIT

Rotifers play an important role as suspension feeders among the zooplankton community. They exhibit marked differences in their tolerance and adaptability to changes in the physicochemical and biological factors[53]. Several studies indicated that rotifer abundance generally increase during summer[10,11,42,53–58]. In the present study Rotifers were represented with 27 species exhibiting the highest species richness and their abundance was highest during summer (40%), and least in winter (6%). Contreras et al.,[59] also observed lowest density of rotifers during winter and highest during summer. Higher rotifer assemblage in summer can be attributed to the hyper-tropical conditions of the water body with high temperature and low water level[60,61]. Dominance and abundance of rotifers are associated with the increase in trophic conditions due to their capability to ingest smaller organisms like bacteria and other organic detritus, which are abundant in eutrophic ecosystem. *Brachionus calyciflorus* is considered to be a good indicator of eutrophication. *Brachionus angularis, Filina longiseta* and *Lecane* sp. are indicators of semi-polluted waters[62]. In the present study, *Filina longiseta* was the most abundant species with the highest abundance of 1194 individuals observed in summer. According to Hutchinson[63], Brachionus species are very common in temperate and tropical waters. Presence of *Brachionus plicatilis, B rubens, B caudatus, B angularis, B calyciflorus* var. dorcus and *B quadridentata* throughout the study period indicates their ability to tolerate varying ecological conditions. Keratella tropica is stenothermal species that was least during summer and highest during monsoon whereas, *Brachionus angularis, Brachionus calyciflorus, Brachionus rubens, Polyarthra sp* are eurythermal[64]. Except *Polyarthra sp*. other species were present throughout the study period. Several studies report decline of rotifers in monsoon[29,65]. Decline of rotifers during monsoon can be interpreted to the dilution factors. Inflow of water during rains can affect the feeding habitat of zooplankton[55]. In the present study also we report minimum rotifers during monsoon. Rotifers showed positive correlation with COD and Phosphate (Table 4). In the present study, the rotifer abundance increased (1931 ind/ L) with increase in Phosphate concentration (0.3mg/L) in summer and its decreased (669ind/L) with the decrease in phosphate concentration during monsoon. Major source of phosphorus in most of the waterbodies is municipal and agricultural runoffs.

A total of 14 species of Cladocera were recorded from the water body during the study period. They were abundant in monsoon and in post-monsoon and their number was drastically reduced to 9 individuals in summer. Cladoceran increase during monsoon season was also reported in earlier studies[35,54]. Monsoon season might have favored their abundance due increase in transparency, reduced water temperatures and availability of food. Cladocera were abundant when the temperature and salinity values were low and dissolved oxygen was more in the environment. They exhibited positive correlation with rainfall (Table 4). Salinity forms one of the most influential environmental variables in aquatic ecosystems[66]. Cladocera are highly sensitive to salinity and salinity concentration restricts the survival of most large bodied cladocerans compared to other zooplankton groups[67] and electric conductivity can be considered as an indirect measure of salinity[68]**.** Green[69] quotes that 'a decrease in the relative abundance of cladocerans in microcrustacean zooplankton as salinity increases'. Many cladocera, especially daphnids, do not survive at salinity values above 3-4 per mille[70,71] **.** During the study, highest salinity (629ppm) was recorded during May, 2017 (summer) during which lowest abundance of cladocera with 9 individuals were recorded. Moina micrura appeared to be the major contributor for cladoceran abundance

Ostracods were represented with 16 individuals during winter whereas declined in summer and monsoon season with 3 individuals. During post-monsoon they elevated to 118 individuals. Ilyocypris sp. was the highest recorded species among ostracods that was found throughout the study period. Most freshwater ostracods prefer alkaline or slightly acidic waters although some have been reported to tolerate wide range of pH[72]. In the present study, the water was found alkaline throughout the study. Ostracods being the least abundant group exhibited positive correlation with transparency, total alkalinity and total hardness (Table 4).

The total zooplankton abundance recorded at Kadasgatti MIT was 14327 individuals. The Dominance value recorded is 0.0930; Simpson_1-D value recorded is 0.9069; Shannon Diversity (H) valve recorded is H=2.788 while Evenness (E) value is E=0.7023 (Table 3).

Table 3. Abundance, Relative abundance, Dominance, Simpson, Shannon Diversity and Evenness of the Kadasgatti Minor irrigation tank of Bailhongal taluk, Belagavi District

CLADOCERA	Abn.	ROTIFERA	Abn.
Alona Baird, 1843	7	Anueropsis coelata	42
Alonella GO Sars, 1862	13	Anueropsis navicula	10
Bosminopsis deitersi Richard, 1985	19	Anueropsis fissa	14
Bosmina longirostris O.F Muller, 1776	19	Brachionus caudatus Barrois & Daday, 1894	42
Bipertura karua	3	Brachionus leydigi Cohn, 1862	38
Ceriodaphnia corunata	87	Brachionus diversicornis Daday, 1883	35
Diaphanosoma exicusm Sars, 1885	32	Brachionus angularis Gosse, 1857	638
Diaphanosoma sarsi Richard, 1894	134	Brachionus calyciflorus Pallas, 1766	38
Echinisca odiosa	2	Brachionus calyciflorus var. dorcus	42
Macrothrix goeldi Richard, 1897	7	Brachionus quadridentata	15
Macrothrix spinosa King, 1853	3	Brachionus rubens Ehrenberg, 1838	42
Moina micrura Kurz, 1875	769	Brachionus urceolaris Muller, 1773	19
Moina brachiata Jurine, 1820	64	Brachionus plicatilis Gosse, 1851	26
Moina daphnia	29	Filina opoliensis	48
COPEPODA		Filina longiseta	1203
Heliodiaptomus viddus Gurney, 1916	712	Lacinularia socialis	51
Sinediaptomus indicus	429	Lepadella rhomboides Gosse, 1886	56
Neodiaptomus strigilipes	544	Lepadella biloba Hauer, 1958	56
Paracyclops fimbriatus Fischer, 1853	2742	Lepadella sp.	51
Paracyclops psilosus	18	Lecane stenroosi Meissner, 1908	5
Tropocyclops prasinus Fischer, 1860	2145	Pompholyx sulcata Hudson, 1885	9
Mesocyclops leuckarti Claus, 1857	1464	Polyarthra Ehrenberg, 1834	84
Thermocyclops hyalinus Rehberg, 1880	604	Philodina Erhenberg, 1830	377
Nauplii	702	Keratella tropica Apstein, 1907	36
OSTRACODA		Sinantherina sp.	571
Hemicypris fossulata	15	Rotifer tardus Erhenberg, 1838	79
Ilyocypris sp.	87	Rotaria neptunia Erhenberg, 1830	12
Stenocypris sp.	38		
Abundance	14327	Shannon_H	2.788
Dominance_D	0.0930	Evenness_E	0.7023
Simpson_1-D	0.9069	Note: Abn - Abundance	

4 Conclusion

Fifty two species of zooplanktons were recorded in Kadasgatti Minor irrigation tank. Rotifers were represented with highest species richness with 27 species and their abundance was maximum during summer. Copepods were the most abundant groups and they were found in maximum number during winter declined gradually and their minimum abundance was observed during post-monsoon. Filina longiseta was a rotifer was the most abundant species in the water body. Cladocera and Ostracoda groups preferred higher water levels and water transparency and lower temperature. Hence their abundance was observed during monsoon and post-monsoon seasons.

Anthropogenic activities, agricultural runoff and presence of eutrophic indicator species like *Brachionus calyciflorus, Brachionus angularis, Filina longiseta* and *Lecane sp*. suggests the eutrophication of water body. The study provides a baseline data on the present status of the water body. In order to protect the water body from further degradation, authorities need to focus on adopting the sustainable and holistic approach for its maintenance and conservation.

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Table 4. Pearson Correlation with respect to physico-chemical parameters and plankton group on monthly basis recorded at Kadasgatti MIT

	Rain	AT	WT	TP	Hum	pH	Sal	TDS	EC	DO	CO2	TA	TH	Cl	S	Ni	COD	BOD	P	Cla	Cop	Rot	Ost
Rain	1.00																						
AT	.21	1.00																					
WT	.16	.89**	1.00																				
TP	-.12	-.09	.12	1.00																			
Hum	-.03	.77**	.92**	.13	1.00																		
pH	.04	.79**	.91**	.31	.94**	1.00																	
Sal	-.21	.22	.41	.13	.32	.38	1.00																
TDS	-.33	.17	.46	.15	.42	.41	.91**	1.00															
EC	-.33	.16	.46	.13	.43	.40	.87**	1.00**	1.00														
DO	.08	.62*	.70*	.41	.57	.70*	.54	.55	.54	1.00													
CO2	-.10	.43	.10	-.24	.11	.18	-.32	-.40	-.40	.20	1.00												
TA	-.26	.00	-.06	.33	.08	.25	-.01	-.04	-.05	.36	.59*	1.00											
TH	-.09	-.02	.20	.78**	.26	.46	.29	.31	.30	.55	.01	.70*	1.00										
Cl	-.18	.49	.22	-.33	.18	.23	-.02	-.08	-.07	.33	.92**	.55	.02	1.00									
S	.23	.41	.43	-.09	.53	.49	-.12	-.04	-.03	.20	.13	-.03	-.13	.05	1.00								
Ni	-.12	.75**	.66*	-.18	.65*	.72**	.45	.36	.34	.58*	.58*	.44	.19	.72**	.35	1.00							
COD	-.11	.28	.28	.03	.21	.31	.68*	.60*	.58*	.63*	.03	.23	.14	.21	.29	.53	1.00						
BOD	-.02	.48	.40	-.08	.23	.33	.64*	.54	.52	.76**	.34	.32	.17	.58*	.08	.69*	.84**	1.00					
P	-.12	.13	.15	-.22	.13	.13	.51	.49	.47	.29	-.12	-.16	-.18	-.03	.35	.24	.68*	.44	1.00				
Cla	.90**	.13	.18	-.05	.08	.10	-.20	-.23	-.23	.10	-.14	-.18	.08	-.22	.17	-.17	-.27	-.15	-.09	1.00			
Cop	.01	.02	.22	-.06	.35	.25	.13	.22	.22	-.03	-.28	-.30	-.12	-.30	.68*	.03	.07	-.17	.53	.17	1.00		
Rot	-.03	.20	.23	-.01	.15	.20	.45	.42	.40	.34	-.21	-.23	-.17	-.16	.52	.19	.74**	.42	.88**	-.15	.51	1.00	
Ost	-.25	-.36	-.17	.69*	.00	.15	.23	.23	.21	.26	-.12	.71**	.86**	-.13	-.19	.01	.20	.06	-.18	-.13	-.18	-.18	1.00

Note: Values are Pearson correlation coefficient, a 2tailed test was applied and calculated after log10 transformation of allvariables after scaling so that all values were >1, *P < 0.05, **P <0.01and N = 12, Rain – Rainfall, AT – Atmospheric temperature, WT- Watertemperature, TP – Transparency, Hum-Humidity, Sal-Salinity, TDS-Total dissolvedsolids, EC-Electric conductivity, DO-Dissolved Oxygen, CO_2-FreeCarbon-di-oxide, TA - Total Alkalinity, TH - Total Hardness, Cl-Chloride, S -Sulphate, Ni-Nitrate, COD - Chemical Oxygen Demand, BOD-Biological OxygenDemand, P - Phosphate, Cla-Cladocera, Cop-Copepoda, Rot-Rotifera, Ost-Ostracoda.Signs within parenthesis indicate positive (+) or negative (-) correlations.

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