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STUDY OF ZOOPLANKTON COMMUNITY STRUCTURE IN DIFFERENT SEASONS AT KURNUR DAM (MS)

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ABSTRACT

A case study was made at Kurnur dam near Solapur district Maharashtra (India) to find out influence of various physic-chemical factors affecting community structure of zooplanktons. In this study, influence of various parameters like temperature, mineral contents, dissolved solids, pH, hardness, dissolved oxygen etc were studied with respect to their influence over abundance of zooplankton like Rotifera, Copepoda, Cladocera and Ostracoda. In this case study only these members of zooplankton were considered to study community structure. The study was made through monthly observation for one year from June 2014 to May 2015. During the study period it was found that among zooplankton only Rotifera dominated throughout the year. The other members of Zooplankton community like Copepod, Cladocera and Ostracoda follow Rotifera. The zooplankton count per litter was reduce in rainy and winter season. In rainy season of 2014 abundance of Rotifera is (31%), Copepoda (21%), Cladocera (16%), Ostracoda (23%) and Protozoa (9%). In winter season from Novemebr 2014 to February 2015 abundance of Rotifera is (35%), Copepoda (20%), Cladocera (15%), Ostracoda (22%) and Protozoa (8%). In summer season of 2015 abundance of Rotifera is (33 %) Copepoda (21%), Cladocera (16%), Ostracoda (21%) and Protozoa (8%) of the total population of zooplankton. Amongst Rotifera species Brachionus forficula, Brachionus quadridentatus, Brachionus angularis and Trichocerca species dominated in summer season which are indicators of pollution. The seasonal variation in zooplankton community structure depends upon temperature, quality and quantity of influx of water in the reservoir.

KEY WORDS: *Zooplanktons, Rotifera, Freshwater, Maharashtra.*

INTRODUCTION

Water is essence of life. Most of world settlements are around lakes and rivers, which are the important sources of water. The quality of water is influential over the peoples surrounding to the reservoir and also it affect organisms lake water and surrounding lakes or reservoirs. The healthy aquatic ecosystem should have healthy food chain. Zooplankton are important part of food chain. Zooplanktons are the heterotrophs of different size, shape and species whose movement mainly depends on jerks in water. They consume algae, phytoplankton and grow in number as well as size. They are the food of small fishes, larva, tadpoles etc. Large fishes feed on small fishes in this way completes the food chain. As small fishes, larva and tadpoles are the food of large fishes, therefore the fish production is associated with phytoplankton production. **(Ryder et al., 1974).** The quality parameters of water are very much influential over diversity and

abundance of zooplanktons. There is a relation between the chemical and physical properties of water with quality and abundance of phytoplanktons and zooplanktons **(Odum et al., 1971).** In a similar study of urban lakes of Nagpur city, seasonal variation emphasise the abundance of zooplankton in different months due to variations in physico-chemical parameters of lake water, large number of diverse zooplanktonic forms rich biodiversity which fluctuate monthly as well as seasonally **(Shashikant Sitre, 2012).**

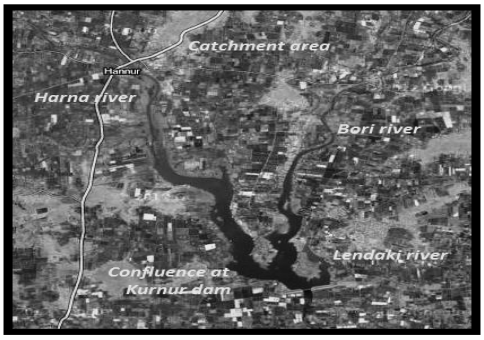
Zooplanktons community include Rotifera, Copepoda, Cladocera and Ostracoda. The relative abundance of each other is influential over community structure, which depends upon the relative range of tolerance towards changing seasonal physico chemical properties of water as well as relative abundance of resource available. In a study of Al-Huwaiza marsh, Central and Al-Hammar marshes it is found that Rotifera is more sensitive to water quality changes, particularly salinity, than the Cladocera **(Salman D., 2014).** Planktons compete for food if their resources are same. Planktons feeding on same resource in a homogenous environment can not co exist because of competitive exclusion **(Hutchinson 1961).** The species abundance is not same through out the year. The question arises which factor is more influence and lead to fluctuation in species. According to Huisman abundances allow the coexistence of many species on a handful of resources (**Huisman and Weissing 1999) .** Species richness and abundance of zooplanktons are inversely related. Richness of species was highest in summer season and abundance is recorded in rainy season. In rainy season Cladocera dominate while in summer season Rotifera dominate, which was fond in a study of Nigerian flood plain **(Okogwu OI1, 2010)**

The relative abundance of zooplanktons is also considered as indicators of pollution. In a study at Sadatpur reservoir *Sinantherina species, Rotaria* and *Asplanchuna* were found relatively abundant which is indicator of water pollution **(Avinash B. Gholap, 2014)**. In a study of lake Parque Atalaia in America, Rotifera diversity was markedly low during dry season under the influence of pollution of water by inlet of domestic sewage **(Neves. Et.al., 2003)**

The inlet water quality during rainy season depends on the economic activity practised in catchment area, which alters the physical chemical properties of water in the reservoir. The changes induced by inlet of water influence the community structure of zooplanktons. In a study at Sina Kolegaon Dam Rotifera density is found to be less in rainy season, while Copepoda and Cladocers were abundant but bottom dwellers Ostracoda were least affected by any fluctuation **(Swati Jadhav, et al, 2012).** Kedar studied Rishi lake of Karanja (Lad) in Maharashtra where he found similar results where zooplanktons were more in summer season than rainy season **(Kedar G.T. et al 2008).** Vanjare at Pune university found positively correlation between abundance of Rotifera with rainfall and temperature and negatively correlation with pH and conductivity. The objective of this research to study influence of seasonal variation on zooplankton community structure.

SITE SELECTION AND STUDY AREA

Kurnur Dam which is also known as *Bori Dharan*, which is a small gated dam exactly located at 17°37'0"N latitude and 76°13'2"E longitude. It is a earthfill dam which was constructed at confluence of Harna and Bori river, both are the tributaries of Bhima river. The dam covers the catchment area of 1,254 km^2 from Akkalkot and Tuljapur Tehasil. Kurnur Dam located in drought prone area of rain shadow region of Western Ghats in Marathwada. The volume of water in the reservoir depends upon monsoonal rainfall in catchment area. As there is no certainty in monsoonal rainfall and drought in the catchment area has no certainty of annual inflow of water in the reservoir.



In rainy season of 2014, there was better rainfall as compared to normal rainfall in the month of August and it was marked by different agricultural activity in catchment area. There was good amount of rainfall from western disturbance locally known as ' *Awakali* ' in the month of April (44 mm) which was much higher than normal rainfall in that month. This reduced the drought effect as in the month of April and May. The good amount of rainfall intensified the agriculture activity in the catchment area, frequent tilling, use of fertilizers and

pesticides that dissolved in agricultural runoff and flow in to the reservoir. There is no industrial belt in the catchment area so no question of industry effluent related **Fig.1 Map of Bori Project** pollution but some settlements are present on the bank of Harna river which is the main source domestic sewage and pollution of reservoir water.

MATERIAL AND METHODS

The study was carried to correlate and analyse physico chemical factors and Zooplanktons. The samples were collected according to standards and procedure for examination of water and waste water American Public Health Association **(APHA-1989)**[10] and 17th edition of Beuro of Indian standard methods of Sampling and Test (Physical and Chemical) for water and waste water **(BIS-3025)**[11] as a manual for analysis. The water samples were collected at confluence of Harna, Bori and Lendaki river through suction pump method. The field parameters that includes Temperature, pH, conductivity and Nitrate, that need to be analysed immediately after sample collection weregathered at site only. General parameters that were to be analysed in laboratory which includes Total Hardness, Turbidity, TDS(Total Dissolved Solids) BOD, COD etc. Cations and anions include Ca, Mg, Sulphates, Nitrate, Phosphate were analysed as per procedure mentioned in USGS manual and EPA government manuals **(USGS Manual and eps.gov)**[12]**(epa.gov manual)**[13]. For the collection of Zooplanktons 125 mesh size net was used and 50 litter of water was filtered though net to collect planktons in sample bottle tied at the end. The net was properly rinsed to assure full sample collection from filtered water.

RESULTS AND DISCUSSION

The quantity of rainfall and the quality of the run off from the catchment area important factor that governs various physico-chemical parameters of reservoir water. Some of the physic-chemical parameters are to be noted immediately while sampling, for example temperature, pH, Electric conductivity and Nitrate concentration etc. In 2014 rainfall status in Tuljapur tehasil (Fig.2), had a good amount of pre-monsoon (*Awakali*) rainfall in months of April in 2015 as compared to normal which made the reservoir almost full. The addition of water diluted the habitat in terms of concentration. The reservoir water was used extensively for agriculture and domestic purpose, that depleted water level by end of May and June. The onset of Monsoonal rainfall in June enriched the reservoir with water. Monsoon observed good amount of rainfall with 255.6 mm peak rainfall in month of August (Fig. 2). The good amount of rainfall intensified the agriculture activity in the catchment area, frequent tilling, use of fertilizers and pesticides that dissolved in agricultural runoff and flowed in to the reservoir. There is no industrial belt in the catchment area so no question of industry effluent related pollution but some settlements are present on the bank of Harna river which is the main source domestic sewage and pollution of reservoir water.

The samples were collected on every fourth Sunday, thus all the parameters show double reading in the month of September. The data are classified into seasons. Month of November, December and January climate is relatively cold so considered as winter season. February, March, April and May are having high temperature so considered as summer season and June, July, August, September and October are considered as rainy season of monsoonal rainfall.

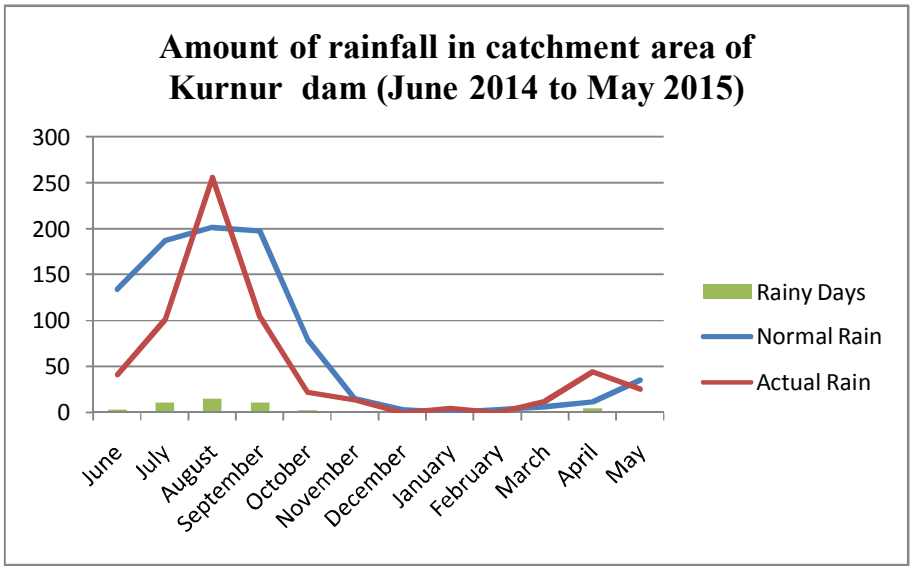


Fig.2 Rainfall in 2014-2015 and Normal rainfall in catchment area of Bori river.

Table. 1 Physico-chemical parameters of water samples collected during June 2014 to May 2015 at Kurnur Dam.

Factors	Rainy Season 2014	Winter season 2014-15	Summer Season 2015
Temp	25.06	21.6	27.9
pH	7.38	7.76	7.45
Turbidity	13.52	10.86	15.09
EC	697.11	524.44	532.54
DO	6.01	4.32	4.86
BOD	2.48	3.77	5.74
COD	20.43	30.84	46.84
TDS	505.18	383.31	387.67
TSS	16.98	12.76	17.41
TS	522.13	396.06	405.07
Ca	223.32	169.46	171.38
Mg	165.04	124.90	128.30
TH	388.37	294.35	299.67
Nitrate	0.94	0.22	0.45
Nitrite	0.53	0.90	0.78
P	1.64	2.46	2.14
S	17.40	13.37	16.97
Cl	28.35	23.62	28.22
Sechi	68.41	79.68	63.24

The physical and chemical parameters of dam water are mentioned in Table.No.1 which is based on data collected from June 2014 to May 2015. Temperature is recorded highest in the month of June 2014

30^0C and lowest in December 20.8 ^{o}C, but the average seasonal temperature was high 27.9 ^{0}C in summer season of 2015 (March to May). Summer was warm with average temperature of water 27.9 ^{0}C rainy season was warm and humid while winter temperature was average 21.6 ^{o}C. Turbidity of water was high in summer season 15.9 NTU which was associated with pre-monsoonal rainfall in April 2015. In winter season water was almost less turbid with turbidity 10.86 NTU. The dam water was basic in nature having average pH of 7.6. In rainy season pH is lower 7.38 and in winter season pH is higher 7.76. In summer season of March and April 2015 pH was recorded low despite of high temperature and evaporation losses because of addition of water by pre-monsoonal rainfall.

Electric conductivity was measured in term of mmho/cm**.** Conductivity varies associated with addition of water to the reservoir in rainy season. It shows two peaks one in August 2014 (785.1 mmho/cm) and other in April 2015 (567.66 mmho/cm). The April peak was associated with *Awakali* rainfall which is smaller in amount as compared to monsoonal rainfall in August 2014. Therefore conductivity was higher in rainy season 697.11 mmho/cm and lower in winter 524.44 mmho/cm and summer season 532.54 mmho/cm.

The presence of oxygen measured in the form of Dissolved Oxygen (DO), Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD). COD has wide range of fluctuation in comparison to DO and BOD, which means oxidation of organic compound was more summer i.e in the month of March and April 2015 measured about 46.84 mg/L, when water was limited to small patches in March 2015.. COD measures organic pollution. In summer season addition of domestic sewage from Kurnur village increase COD level of water. Dissolved Oxygen was higher rainy season (6.01 mg/L) and which was because of inlet of rain water through different rapids from watershed area. Dissolved Oxygen is lowest during winter season 4.32 mg/L. In summer available oxygen is consumed by organisms for the metabolic activity therefore BOD was high in summer 5.74 mg/L. Dissolved oxygen was also low in summer because high BOD and COD.

Nitrogen level in water measured three forms Nitrate (NO_3), Nitrite (NO_2) and Ammonia (NH_3). In our study Ammonia was not considered for study. Nitrate (NO_3) , a volatile molecule and rapidly consumed therefore it should be analysed very quickly with the help of kit. Nitrite (NO_2) level was high in summer and winter and less in rainy season. Nitrite (NO_2) was maximum in winter season 0.90 mg /L) which may be associated with pollution in water patches. The range of Nitrite (NO_2) fluctuation was less as compared to Nitrate (NO_3). Nitrate (NO_3) was measured in more amount in rainy season 0.94 mg/L. which is associated with inlet of water through agriculture runoff. It means Nitrate was contributed by the agricultural fertilizers that farmer use to enhance their crop. Similar results were found in a study of Ujani dam (**Kimbhar A C et al., 2006**).

Hardness of water is associated with amount of calcium and magnesium in water. Calcium and magnesium concentration increased in rainy season and decrease in winter and summer season. It means the runoff water dissolve surface calcium and magnesium and bring it to dam water. Calcium level was high in rainy season of 2014 223.32 mg/L and 171.38 mg/L in summer season of 2015 and low 169.46 mg/L in winter season of 2014. The same case with magnesium high in rainy season 165.04 mg/L but with little difference winter season 2014 and summer season 2015, whic measured 124.90 mg/L and 128.30 mg/L respectively. Therefore water was more hard in rainy season (388.37 mg/L) as compared winter (294.35 mg/L) and summer season (299.67 mg/L).

Other minerals like Phosphate, Sulphur and Chlorine level was also determined. The surrounding economic activities are responsible for contribution of these minerals in dam water. Use of sulphur and phosphate in fertilisers, dissolved in agricultural runoff and enters the dam water. The chlorine is contributed by tar used in construction of roads in the catchment area, use of bleaching powder that is dissolved in domestic sewage etc. Even though Phosphate and Sulphur is contributed by the agricultural runoff their concentration is more in summer season rather than rainy season. It is because of the rate of utilization of these minerals by organisms do not match with rate of influx, therefore they accumulate with evaporation of water and diluted with inlet of water. Phosphate content is more in winter season 2.46 mg/L than summer season 2.14 mg/L which was due to influx of water by pre- monsoonal rainfall. The average sulphur concentration was in rainy season 17.40 mg/L and second high was observed in summer season of 2015 16.97, both of these peaks were associated with rainfall which ensures that sulphur was contributed

from agricultural practices. In winter sulphur was measured 13.37 mg/L. The concentration of chlorine clearly indicates the influence of rainfall, due to influx of water chlorine was measured high in rainy season 28.35 mg/L and summer season 28.22 mg/L, but in winter it measured about 23.62 mg/L. It means more the inlet of water more the concentration of chlorine.

Dissolved and suspended solids also contribute to the quality of water which are measured in terms of Total dissolved solids (TDS) and Total Suspended Solids (TSS). TDS was maximum in rainy season 2014 measured about 505.18 mg/L which was due to energy in flowing water. In rainy season the soil particles dissolve in water and some of them are carried in suspended form. In winter and summer season TDS was 383.31 mg/L and 387.67 mg/L respectively. Total suspended solids were measured in more in summer season 17.41 mg/L which was much higher than winter season 12.76 mg/L. In rainy season it was 16.98 mg/L. Agricultural practices in the catchment area are major contributors for the TSS. March and April months are the period of tillage and if it is associate with rainfall then it lead to enhance the TSS in reservoir water. Total solids is summation of both TDS and TSS. In 2014-15 TS was highest in rainy season522.13 mg/L and followed by summer season of 2015 measured about 405.07 mg/L and in winter 396.06 mg/L.

Sechi depth, is associated with transparency of water. The transparency is more in undisturbed and unpolluted water. In rainy and summer season Sechi disc cant be viewed from far depth due to turbid water. Sechi depth was maximum winter season 79.68 cm and very shallow in summer season 63.24 cm. In rainy season sechi depth was measured 68.41 cm.

Zooplankton include Rotifera, Copepoda, Cladocera, Ostracoda and Protozoa. Totally 41 planktons were studied including protozoa's. Rotifera 18 species, Copepoda 6, Cladocera 6, Ostracoda 5 and Protozoa's 5 as mentioned in Table No. 4 , 5,6, 7and 8.

Table. 2 Zooplanktons count from water samples collected during June 2014 to May 2015 at Kurnur Dam, (Organisms/lit)

Months	Rotifers	Copepoda	Cladocera	Ostracoda	Protozoa
Jun	153	99	78	110	41
Jul	136	80	62	89	33
Aug	93	62	49	67	26
Sep	108	86	67	95	35
Oct	125	89	69	97	36
Nov	123	65	49	74	26
Dec	101	45	35	52	18
Jan	112	63	45	65	25
Feb	119	94	66	91	37
Mar	126	89	73	101	37
Apr	133	83	59	80	33
May	158	90	66	88	36

Table. 3 Zooplanktons count from water samples collected during June 2014 to May 2015 at Kurnur Dam, (percentage)

Seasons	Rainy Season 2014	Winter Season 2014-15	Summer Season 2015
Rotifers	31	35	33
Copepoda	21	20	21
Cladocera	16	15	16
Ostracoda	23	22	21
Protozoa	9	8	8

Table. 4. Rotifera species found in collected water samples in 2014 at Kurnur dam

Brachionus calyciflorus	*Keratella quadrata*	*Euchlanis dilatata*
Brachionus caudatus	*Keratella tropica*	*Filinia longiseta*
Brachionus falcatus	*Lecane bulla*	*Filinia spp*
Brachionus angularis	*Lecane pyriformis*	*Testudinella sp.*
Brachionus forficula	*Monostyella sp.*	*Trichocerca tigris*
Brachionus quadridentatus	*Notholca acuminata*	*Rotaria spp*

Table. 5 Copepoda larvae species found in collected water samples in 2014 at Kurnur dam

Mesocyclop sps	*Diaptamus spp.*	*Cyclops viridis*
Nauplius larvae	*Paracyclops spp.*	*Mesocyclops leuckarti*

Table. 6 Cladocera species found in collected water samples in 2014 at Kurnur dam

Alona spp	*Daphnia sp*	*Bosmina*
Alona rectangula	*Moina mircura spp*	*Ceriodaphnia pulchella Sars*

Table. 7 Ostracoda species found in collected water samples in 2014 at Kurnur dam

Candocypris spp.	*Cypris spp.*	*Stenocypris spp.*
Centrocypris	*Metacypris*	

Table. 8 Protozoa species found in collected water samples in 2014 at Kurnur dam

Amoeba	*Arcella*	*Diffluga spp.*
Paramoecium	*Euglena*	

Rotifera dominated the zooplankton community in all seasons followed by Copepoda, Cladocera, Ostracoda and Protozoa.

In summer season 24 species of zooplankton were identified, in rainy season 16 and in winter season 15 species were identified. Rotifera dominated in all seasons of the year followed by Copepoda, Cladocera, Ostracoda and Protozoa. In rainy season of 2014 abundance of Rotifera was 31 % Copepoda (21%), Cladocera (16%), Ostracoda (23%) and Protozoa (9 %) of the total population. In winter season of 2014-15 abundance of Rotifera is (35%), Copepoda (20%), Cladocera (15%), Ostracoda (22%) and Protozoa (8%). In summer season 2015 zooplankton composition and abundance was Rotifera is (33%), Copepoda (21%), Cladocera (16%), Ostracoda (21%) and Protozoa (8%) as shown in Table. No 3. Amongst Rotifera species *Brachionus forficula, Brachionus quadridentatus, Brachionus angularis and Trichocerca species* dominated in summer season which are indicators of pollution. Highest number of Rotifera were counted in warm months May 158 org/L and June 2014 counted about 153 org/L. It coincides with temperature rather than any other physic chemical factors. It means temperature is most important factor that govern reproductive ability of Rotifera. In rainy season their count was less that is September 2014 counted about 93 org/L which was because of dilution effect of influx of new water from rainfall in catchment area. The same thing happened with Copepoda and Cladocera. In May Copepod count was 90 org/L and Cladocera count is 50 org/L while in June they the count was respectively 99 org/L and 78 org/L which is quite high in comparison to December count 45 Org/L and 35 org/L respectively. In December Rotifera 101 org/L, Copepoda 45 org/L, Cladocera 35 org/L and Ostracoda 52 org/L. Were counted. From the data it is quite clear that Summer season was favourable for growth of all the planktons and winter season was unfavourable. There was wide range of fluctuation in community composition especially for Rotifera. Zooplankton composition indicates species richness that is number of species occurred and abundance of zooplankton means number of individuals in population of each species. In one of the study it was found that species richness was inversely related to abundance, as species richness was highest in summer season while abundance of plankton

was highest in rainy season. In rainy season Cladocera dominated and in summer season Rotifera dominated. This was the study made in Nigerian floodplain by Okogwu **(Okogwu OI1, 2010)**

If the planktons community composition is correlated with the a biotic factors, it is found that Rotifera population show strong and positive correlation with temperature, but weakly positively related with pH, BOD, COD, NO_2, Phosphate and Sulphate concentration. Rotifera are negatively correlated with electric conductivity, turbidity, TDS,TSS,TS, DO, NO_3, Ca,Mg,TH and Cl. Copepoda and Cladocera are not correlated with pH. Copepoda and Cladocera is correlated strongly and positively with temperature and weakly positively correlated with phosphate and sulphate concentration. Ostracoda is strongly and positively correlated with temperature and weekly positively correlated with pH, Sechi depth, BOD, COD, NO2 and Phosphate. While strongly negatively correlated with suspended solids. Protozoa's are strongly positively correlated with temperature and weakly positively correlated with electric conductivity, calcium, and magnesium, phosphate and sulphate concentration.

CONCLUSION

The quantity of rainfall and the quality of inlet water through agriculture runoff along with temperature are the important factors that directly or indirectly govern all other abiotic factors considered here like total dissolved solids, pH of water and mineral concentration. During summer season especially in the month of April and May the reservoir water volume decreases by evaporation loss as well as dam discharge, which enhance the pollution effects of domestic sewage from the nearby village. The rainfall distributed in less number of rainy days lead to dilution of water rapidly. In 2015 summer season that is from March to May the quantity of water in the reservoir was sufficient in comparison to previous years because of good rainfall in the month of March and April by pre-monsoon rainfall (*Awakalis)*. In summer season Rotifera, Copepoda, Cladocera and Ostracoda predominate in terms of quantity and diversity than other seasons. In summer season zooplankton community is dominated by Rotifera followed by Ostracoda and then Copepoda and least is Cladocera. Growth rate of population may be highest in summer season especially in the month of June which follow high temperature and count is lowest in winter season during November and December. In winter season also Rotifera dominates the community followed by Ostracoda and Copepoda as same in summer. Cladocera found to be least in count in both seasons. Thus temperature is the important physical factors that govern the community either directly by influencing the population growth rate or indirectly that is by influencing other dependant physicochemical parameters. Besides, rainfall and quality of runoff influx influence the zooplankton community structure.

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