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Zooplankton community structure at Kurnur Dam in Maharashtra (India) A Subtropical Freshwater Reservoir

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ABSTRACT

Environmental factors influence the distribution, density and diversity of zooplanktons. A case study was made at Kurnur dam in Solapur district Maharashtra (India) to find out influence of various factors affecting community structure of zooplanktons. The influence of qualitative parameters of water like temperature, dissolved solids, pH, hardness, dissolved oxygen etc were studied over abundance of Rotifera, Copepoda, Cladocera and Ostracoda members of zooplanktons community structure. The study was made through monthly observation for one year in 2014. Through out the study it was found that Rotifera dominated the Zooplankton community followed by Copepod, Cladocera and Ostracoda. The population of zooplankton was abundant during May low in August, March and December. August and March low are because of dilution effect of habitat which is due to addition of runoff water from monsoonal rainfall and pre-monsoon (Awakali) rainfall respectively, while December low is associated with temperature. The influx quality of influx of water depends on the economic activites of the catchment area. The influx of water induce the qualitative changes in the reservoir of water which affect community structure of zooplanktons. Thus rainfall and influx of water are important factors that influence the community structure of zooplanktons.

Key words: Zooplanktons, Freshwater, Maharashtra, India.

INTRODUCTION

Lakes and rivers are the important sources of water. In the world most of the human settlements are associated with water reservoirs. Therefore water quality is influential over the peoples surrounding reservoir as well as organisms existing the lakes like fishes etc. The healthy aquatic ecosystem should have healthy food chain. Zooplanktons are the heterotrophs that consume algae, phytoplanktons and grow in number as well as size, which

are feed by small fishes, larva, tadpoles etc. The large fishes feed on these food chain intermediated and grow in size. Small fishes, larva and tadpoles are the food of large fishes, therefore the fish production is associated withphytoplankton production. (Ryder et al., 1974). The quality parameters of water are very much influential overdiversity 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).

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. Planktons feeding on same resource in a homogenous environment cannot co-exist because of competitive exclusion (Hutchinson 1961). The species abundance is not same throughout 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 was fond in a study of Nigerian flood plain (Okogwu, 2010).

The relative abundance of zooplanktons community members are also consider indicators of pollution. In a study at Sadatpur reservoir *Sinantherina species Rotaria* and *Asplanchuna* were found relatively abundant which is indicator of water pollution (Gholap, 2014). Few members of rotifer when present in abundant number is indication of eutrophication of lakes, they are *Brachionus forficula, Brachionus nilsoni*, and *Trichocerca* sp (Azma Hanim Ismail et al, 2016). 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 physic 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 are abundant but bottom dwellers Ostracoda were least affected by any fluctuation (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 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. It 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 which are the tributaries of Bhima river. The dam covers the catchment area of 1,254 km² from Akkalkot and Tuljapur Tehasil.

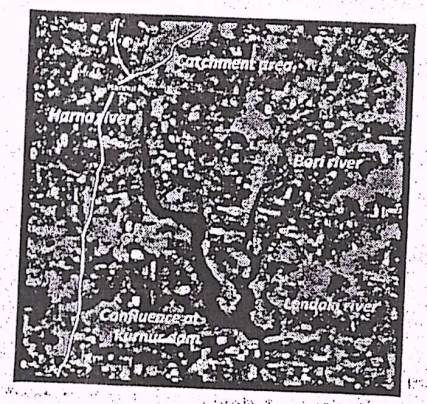

Figure 1 Google map of Bori Reservoir

Kurnur Dam located in drought prone rain shadow region of Western Ghats in Marathwada region. 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 catchment area therefore there is no certainty of annual inflow of water. In 2014, there was better rainfall as compared to normal rainfall in the month of March and August, both of these months are marked by different agricultural activity in catchment area of the reservoir. The good amount of rainfall from western disturbance locally known as ' *Awakali* ' in the month of February (13.9 mm) and March (19.9 mm) in catchment area almost made the reservoir full. This reduced the drought effect as in the month of April and May as it

happened in earlier year (2013). The good amount of rainfall intense the agriculture activity in the catchment area, frequent tilling, use of fertilizers and pesticides that dissolve in agricultural runoff and flow in 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 who are the main source domestic sewage and pollution of reservoir water.

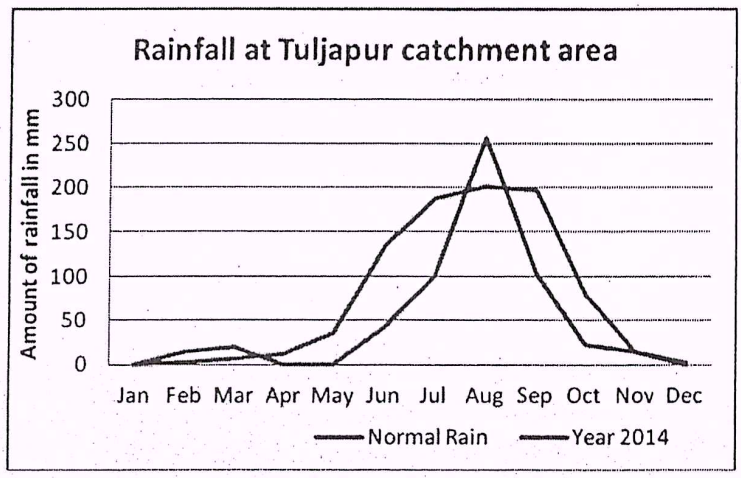

Figure 2 Rainfall Tuljapur catchment area

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) and 17th edition of Beuro of Indian standard methods of Sampling and Test (Physical and Chemical) for water and waste water (BIS-3025) 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 that need to be analysed immediately after sample collection were collected on 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 are analysed as per procedure mentioned in USGS manual and EPA government manuals (USGS Manual and eps.gov) (epa.gov manual). For the collection of Zooplanktons 80 mesh size net was used and 50 litter of water was filtered through 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 from the graph of rainfall status in Tuljapur tehasil Fig.2, it is observed that there was good amount of pre-monsoon (*Awakali*) rainfall in months of February and March (Fig.2) as compared to normal which lead more inlet of water and reservoir become 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 May and June. The onset of Monsoonal rainfall in June enriched the reservoir. Monsoon observed good amount of rainfall with 524.4 mm of rainfall with peak in month of August (Fig. 2).

Temperature is easily measured with help of glass thermometer. It was measured during sampling and recorded throughout the year. The temperature is recorded after two hours of sunrise while collecting water sample and the same time is maintained through the year. Temperature of water was recorded maximum in June and minimum in November, which is congruent

with atmospheric temperature (Table.1). Turbidity and Electric conductivity (EC) follow the rainfall and maximum during rainy season with the addition of water. Therefore both of these parameters are more in month of August and March which correlates with maxima of rainfall(Table.1). pH decreases with addition of rain water and during summer season at warmer temperature the ph is high which decreases with influx of fresh water during monsoon but even though it never reach below 7 or acidic level that is the fluctuation is within the range of basic pH(Table.1). Dissolved Oxygen (DO) follows the pattern of combined effect of temperature and rainfall. In summer season the dissolved oxygen decreases while the monsoonal rain running through various rapids enhance concentration of DO in water, therefore in 2014 it shows dual peaks one in March and other in August (Table.2). Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) though follow the same pattern but too low values of BOD over COD indicates the level of organic pollution in the reservoir from domestic sewage, human intervention and that too in summer season when quantity of water in reservoir was less(Table.2).

Table. 1 Physico-chemical parameters of water samples collected in 2014 at Kurnur Dam,

Months	Temp.	pH	EC	Sechi Depth	Turbidity	TDS	TSS	TS
January	23	7.9	461.44	98.20	7.7	335	9.48	343.86
February	20	7.8	488.17	94.66	8.9	354	10.80	364.55
March	26	7.6	552.88	87.02	9.3	400	11.46	412.10
April	27	7.9	541.78	83.60	8.5	392	10.67	403.27
May	29	7.5	482.62	84.50	8.3	349	10.28	360.00
June	31	7.7	579.21	77.80	9.6	420	12.12	431.84
July	28	7.1	633.72	76.59	12.6	459	14.75	473.97
August	23	7.1	769.26	71.60	15.6	558	23.49	580.93
September	26	7.3	729.10	54.40	15.0	528	23.18	551.51
September	19	7.5	695.07	67.18	13.6	504	17.65	521.32
October	22	7.6	646.28	75.83	11.7	468	14.75	483.07
November	19	7.8	538.50	79.39	11.5	390	14.09	404.31
December	20	8.0	502.69	76.70	10.4	364	13.12	377.39

Table. 2 Physico-chemical parameters of water samples collected in 2014 at Kurnur Dam,

Months	DO	BOD	COD	NO3	NO2	Ca	Mg	TH	P	S	Cl
January	4.04	4.47	36.59	0.13	0.31	147.82	104.93	252.76	2.58	12.37	17.97
February	4.50	3.82	31.35	0.29	0.28	156.38	111.75	268.14	2.30	13.64	20.48
March	4.72	8.30	67.68	0.38	0.27	177.12	128.26	305.38	2.30	15.12	18.58
April	4.32	5.02	41.09	0.21	0.30	173.56	125.43	298.99	2.58	16.02	17.29
May	3.90	4.86	39.72	0.05	0.33	154.61	110.34	264.95	2.67	15.09	16.66
June	5.38	3.58	29.35	0.67	0.22	185.55	134.97	320.53	1.93	17.19	19.65
July	6.01	3.02	24.79	0.94	0.18	203.02	148.88	351.89	1.65	18.18	23.92
August	7.53	2.31	19.04	1.60	0.07	246.43	183.45	429.88	0.92	19.33	38.09
September	7.15	1.15	9.62	1.44	0.09	233.57	173.20	406.77	1.11	18.53	37.58
September	6.66	0.93	7.85	1.22	0.13	222.67	164.52	387.19	1.29	16.21	28.62
October	5.75	1.39	11.59	0.83	0.19	207.04	152.08	359.12	1.84	14.45	27.96
November	4.97	2.23	18.40	0.49	0.25	172.51	124.59	297.10	2.11	12.69	26.71
December	4.82	2.93	24.02	0.42	0.27	161.04	118.50	279.54	2.21	12.05	24.36

Table. 3 Zooplanktons count from water samples collected in 2014 at Kurnur Dam, (Organisms/lit)

Months	Rotifera	Copepoda	Cladocera	Ostracoda
January	103	42	37	36
February	123	47	42	36
March	136	41	36	31
April	143	62	55	42
May	153	89	79	58
June	158	70	62	47
July	139	59	52	38
August	111	32	28	21
September	86	55	49	36
September	116	64	56	40
October	121	63	55	41
November	133	51	45	43
December	106	49	43	30

Table. 4 List of Rotifers observed from the sample collected from Kurnur Dam in 2013

Brachionus angularis	*Filinia longiseta*	*Keratella sp.*
Brachionus calyciflorus	*Keratella tropica*	*Kertella valga*
Brachionus caudatus	*Lecane bulla*	*Lecane bidentata*
Brachionus quadridentatus	*Notholca acuminata*	*lecane depressa*
Brachionus ureceolaris	*Rotaria spp.*	*Lecane pyriformis*
Epiphanes clovulata	*Trichocera spp.*	*Lepadella ovalis*
Euchlanis dilatata	*Asplanchna sp.*	*Lepadella patella*
Filinia opoliensis	*Brachionus falcatus*	*Monostyella sp.*
Keratella cochlearis	*Brachionus forficula*	*Notomata copeus*
Keratella procura	*Brancionous calciflorus*	*Proales decipiens*
Brachionus diversicornis	*Cephalodella exigna*	*Pseudoharringia similis*
Brachionus folculus	*Cephalodella forficula*	*Testudinella sp.*
Brachionus spp.	*Colurella adriatica*	*Testudinella patina*
Filina spp.	*Dicranophorus dolerus*	*Trichocerca tigris*
Tripleuchlanis spp		

Table. 5 List of Copepoda observed in the sample collected from Kurnur Dam in 2013

Cyclops sp.	*Cyclops viridis*	*Diaptamus spp.*	*Eudiaptomus gracilis Sars*
Mesocyclop sps	*Megacyclops sp.*	*Paracyclops fimbriatus*	*Mesocyclops leuckarti*
Nauplius larvae		*Heliodiaptomus contortus*	

Table. 6 List of Cladocera observed in the sample collected from Kurnur Dam in 2013

Alona	*Alona guttata Sars*	*Macrothrix goeldii (Richard)*	*Biapertura affinis (Leydig)*
Bosmina	*Bosmina longirostris*	*Ceriodaphnia pulchella Sars*	*Grimaldina brazzai (Richard)*
Daphnia sp	*Trophocyclops*	*Macrothrix spinosa (King)*	*Daphnia cucullata Sars*
Cypris	*Flurcularia sp*	*Ilyocryptus sordidus (Lievin)*	*Scapholeberis kingi Sars*
Biapertura	*Moina mircura*		

Table.7 List of Ostracoda observed in the sample collected from Kurnur Dam In 2013

Candocypris spp.	*Candona*	*Centrocypris*	*Cyprides*
Cyprinotus	*Cypris spp.*	*Darwinula*	*Ilyocypris*
Limnocythere	*Metacypris*	*Potamocypris*	*Stenocypris spp.*

Total Dissolved Solids (TDS), Total Suspended Solids (TSS) and Total Solids (TS) seems to follow the rainfall rather then temperature there fore premosoon tillage and agriculture runoff in rainy season may be responsible for increased TDS, TSS and TS. In comparison to TDS, Total Suspended Solids (TSS) is very less therefore the graph of TDS and TS appears to be same. In 2014 TDS, TS show two peaks corresponding to rainfall, one in March and other in August (Table.1). Calcium (Ca), Magnesium (Mg) and Total Hardness (TH) also follow the rainfall pattern as they are contributed by dissolution of soil partides(Table.2). The concentration of Nitrate and Nitrite inversely related. Nitrite concentration is related with bacterial and algal concentration that convert them in to either nitrate or ammonia fixing bacteria etc. Nitrate concentration is maximum during rainy season and minimum during summer season (Table.2). The Phosphate concentration is maximum during summer when volume of water is less due to evaporation losses and other losses. It means during rainy season the concentration of Phosphate is diluted and with gradual accumulation its concentration gradually increases (Table.2). Sulphate concentration gradually decreases in summer which reach minimum level in May and increases with influx rainwater which peak in August after that it start deplete gradually both in winter and summer (Table.2). The concentration Chlorine also follow the rainfall. It is maximum in rainy season in proportion to influx of water in the reservoir and gradually depletes in winter and further in summer reaching minimum level in March and April(Table.2).

Among zooplanktons Rotifera, Copepoda, Cladocera and Ostracoda are studied(Table.4,5,6 and 7). Rotifera dominates the community, 43 species of Rotifera are studied from collected water samples (Table.4). *Brachinus* species dominate among the Rotifera. Among zooplanktons 10 species of Copepodes (Table.5), 18 Cladocera (Table.6), and 12 species of Ostracoda (Table.7), are studied from the collected samples. Rotifera dominated the community throughout the year. In summer season especially in the month of May all the zooplanktons counted highest in number that is organisms per litter. In winter season that is in December organisms count is less (Table.3). In June is the month of onset of monsoon, and because of rainfall in catchment area (Graph. No. 2) habitat is diluted by influx of rain water therefore the organisms count shows drastic low. .

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 volume diluted the pollution effects of domestic sewage from the nearby village. The most common effect of rainfall distributed in less number of rainy days lead to dilution of water. In summer season from May to June the quantity of water in the reservoir is sufficient in comparision to previous years because of good rainfall in the month of February and March by westerly disturbances. 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 and as same in summer season Cladocera found to be least in count. 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 physicochemical parameters. Besides rainfall and quality of runoff influx influence the zooplankton community structure.

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