Golden Research Thoughts
ISSN 2231-5063
Impact Factor : 3.4052(UIF)
Volume - 5 | Issue - 2 | Aug – 2015

ZOOPLANKTON ABUNDANCE AND COMPOSITION IS NOT SAME IN ALL SEASONS OF A YEAR IN SAME LAKE

Sahebagouda S. Patil [1] and Dr. Vithal R. More[2]
[1] Dadapatil Rajale Arts and Science College, Adinathnagar, Tal.Pathardi Dist. Ahmednagar. Maharashtra (India) .
[2]Department of Zoology, Government college of Arts and Science, Aurangabad.

ABSTRACT

The quantity and quality of lake water is not same throughout the year. In summer season Kurnur reservoir in Solapur district of Maharashtra is almost dry with patches of water having algal boom. Variations in zooplankton composition and abundance were studied with respect to seasonal changes in physical and chemical properties of dam water from January to December 2014. Zooplankton composed of Rotifera, 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 summer season abundance of Rotifera is 62 % Copepoda (15%), Cladocera (14%), Ostracoda (6%) and Protozoa (3 %) of the total population. Abundance of zooplankton changed in winter and rainy season. In rainy season abundance of Rotifera is (47%), Copepoda (20%), Cladocera (17%), Ostracoda (11%) and Protozoa (5%). In winter season zooplankton composition and abundance is almost same as that of rainy season with slight variations. In winter season abundance of Rotifera is (49%), Copepoda (22%), Cladocera (15%), Ostracoda (9%) and Protozoa (5%). Amongst Rotifera species Brachionus forficula, Brachionus quadridentatus, Brachionus angularis and Trichocerca species dominated in summer season which are indicators of pollution.

KEY WORDS: *Zooplankton, freshwater reservoirs.*

INTRODUCTION

Lakes, reservoirs and rivers are the important sources of freshwater. In world, most of the human settlements are associated with water reservoirs. The quality of water influence over organisms found within the reservoir as well as surrounding to it including human beings. Healthy composition of zooplankton in the reservoir is indicator quality and health of aquatic ecosystem. Zooplankton are heterotrophic organisms, consume phytoplankton and grow in number as well as size. They are consumed by small fishes, larva, tadpoles etc. The large fishes feed on small fishes or larva and complete the food chain. As small fishes, larva and tadpoles are the food of large fishes, therefore the fish production is associated with plankton production **(Ryder et al., 1974).** The quality parameters of water are very much influential over diversity and abundance of zooplankton. Physical and chemical properties of water are responsible for quality and abundance of phytoplankton and zooplankton **(Odum et al., 1971).** Seasonal variation in amount and duration of rainfall, agricultural runoff, kind of agricultural practices in catchment area, domestic sewage discharge and industrial effluents are responsible for variation in physical and chemical properties of water.

Zooplankton community include Rotifera, Copepoda, Cladocera and Ostracoda and Protozoans. The community structure means, a relative composition and abundance of zooplankton at a specific period or time. The composition and abundance of plankton species depends on relative range of tolerance towards changing seasonal physical and chemical properties of water. The zooplankton abundance is not same throughout the year. The question arises which of physical and chemical factors influence the fluctuation in plankton population, how the zooplankton sustain their life in limited amount of water during summer drought, how they co exists. According to Huisman abundances of planktons allow the coexistence of many species on a handful of resources (**Huisman and Weissing 1999).**

During summer season due to lack of water pollutants from draininage from nearby villages accumulate in patches of water which lead to pollution of water. The polluted water has different composition of zooplankton in comparison to non polluted water. Appearance of few Rotifera is indicative of pollution. The relative composition and abundance of zooplankton is considered as indicators of pollution. In a study at Sadatpur reservoir *Sinantherina species, Rotaria* and *Asplanchuna* are found relatively abundant which is indicator of water pollution **(Avinash B. Gholap, 2014)**. In contradictory to that in one of a study at 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**). From these study it is clear that zooplankton are indicators of pollution and quality of water.

The objective of this research is to find out whether seasons influence the zooplankton community structure, if yes then what are the reasons for that in other words which of the physical and chemical factors are responsible for that.

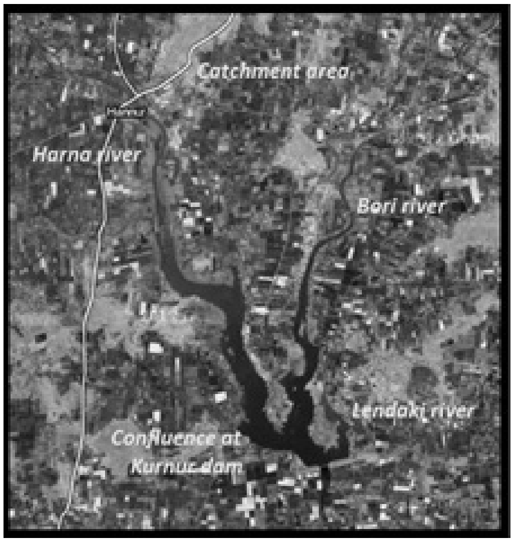


Fig.1. Confluence of Bori river reservoir

MATERIAL AND METHODS

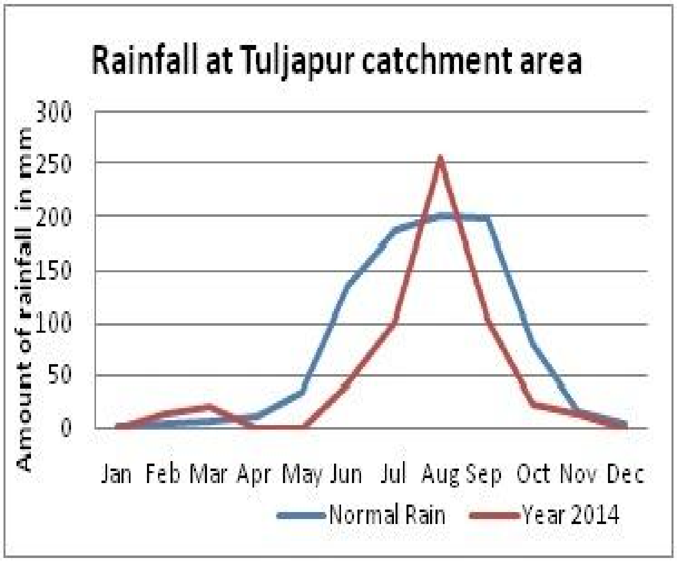
Kurnur Dam is nine gated earthen dam, located at 17°37'0"N latitude and 76°13'2"E longitude. It is constructed at confluence of Harna and Bori river. The dam covers the catchment area of 1,254 km^2 from Akkalkot and Tuljapur Tehasil. Dam is located in drought prone area and rain shadow region of Western Ghats of Maharashtra. The google map of dam is attached in Fig. No.1. The quantity of water in the reservoir depends upon monsoonal rainfall in its catchment area.

The samples were collected according to standards and procedure for examination of water and waste water as published in American Public Health Association (APHA-1989) as well as 10^{th} and 17^{th} edition of Burro of Indian standard methods of sampling and test for water and waste water (BIS-3025) which was used as a manual for water analysis. Water samples were collected at confluence of Harna, Bori and Lendaki river through suction pump method at different fixed spots on every alternate Sunday from January 2014 to December 2014. The field parameters which are essential to be measured immediately like temperature, pH, conductivity and nitrate were immediately collected at site or spot only. Chemical parameters were analysed in laboratory of Department of Zoology, Dadapatil Rajale College Adinathnagar, Tal. Pathardi Dist. Ahmednagar. These chemical parameters were 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) (epa.gov manual).

Zooplankton were collected with help of plankton net of mesh size 325 (44 micron size of eye) by pumping 50 litters of water from different strata and immediately preserved with 4% formalin mixed with borax powder. Zooplankton were analysed with the help of Sedgewick Rafter counting cells. Zooplankton were identified with help of taxonomic key (Idris 1983) to the lowest possible extent. Physical and chemical parameters were correlated with abundance of zooplankton with help of statistical applications. The data of relative abundance and composition is express in graphical presentation for tangible understanding.

RESULT AND DISCUSSION

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. 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 (Fig.No.2). This reduced the drought effect in the month of April and May as it happened every year

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

earlier. 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.

The physical and chemical parameters of dam water are mentioned in Graph no 1 to 8. These graphs are based on data collected from January 2014 to December 2014. Graph no.1 represent values for Temp, pH and turbidity of water in summer, rainy and winter season. Temperature is recorded highest in the month of June 31^{0}C and lowest in December 19 ^{o}C. The annual range of temperature is high. Summer is warm with average temperature of water 26 ^{o}C, rainy season is warm and humid while winter temperature is average 20 ^{o}C. Turbidity of water is high in July (12.6 NTU) and August (15.6 NTU) rainy season, which associated with agricultural practice and increased run off carrying more particles with high amount of rainfall as compared to other seasons. In winter season water is almost less turbid. Turbidity is almost same throughout the year except in rainy season. The dam water is basic in nature having average pH of 7.6. In rainy season pH is lower 7.1 and summer season pH is higher 7.9. The lowest value pH of water is also basic in nature (7.1). It means the dam water has no acidic pH but have basic pH throughout the year.

In Graph No. 2 electric conductivity is measures in term of mmho/cm**.** Conductivity is associated with addition of water to the reservoir in rainy season. It shows two peaks one in April (522.15 mmho/cm) and other in August (687.34 mmho/cm). The March peak is associated with *Awakali* rainfall which is smaller in amount as compared to monsoonal rainfall in August. Therefore conductivity is higher in rainy season and lower in winter and summer season.

Graph No. 3 represents all data related oxygen like 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 is more summer i.e in the month of March and April, when water is limited to small patches. COD is measure of organic pollution. In summer season addition of domestic sewage from Kurnur village increase COD level of water. Dissolved Oxygen is higher August (7.53 mg/L) and September (7.16 mg/L) which is associated with inlet of rain water through different rapids from watershed area. Dissolved Oxygen is lowest during winter season when there is high BOD and no addition of DO by inlet of water. In winter available oxygen is consumed by organisms for the metabolic activity. Dissolved oxygen is also low in summer because high COD.

Graph No. 4 measures Nitrogen level in water. Nitrogen exist in three forms Nitrate (NO_3), Nitrite (NO_2) and Ammonia (NH_3). In our study Ammonia is not considered for study. Nitrate (NO_3) is volatile and rapidly consumed therefore it should be analysed very quickly with the help of kit. Nitrite (NO_2) level is high in summer and winter and less in rainy season. Nitrite (NO_2) is maximum in May (0.33 mg /L) which is associated with pollution in water patches. The range of Nitrite (NO_2) fluctuation is less as compared to Nitrate (NO_3). Nitrate (NO_3) is more in amount in rainy season in the month of August (1.6 mg/L) and September (1.44 and 1.22 mg/L) which is associated with inlet of water through agriculture runoff. It means Nitrate is contributed by the agricultural fertilizers that farmer use to enhance their crop. The graph indicated Nitrate (NO_3) has high fluctuation range that is maximum in rainy season and minimum in winter and summer season. Similar results were found in a study of Ujani dam (**Kimbhar A C et al., 2006**).

Graph No. 5 Measures hardness of water which is summation of calcium and magnesium concentration. Calcium and magnesium concentration increase 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 is high in August (246.43 mg/L) and September (233.57 and 221.63 mg/L), and the same case with magnesium also August (183.45 mg/L) and September (173.2 and 164.52 mg/L). Therefore water is more hard in rainy season as compared winter and summer season. Total hardness of water in August (429.88 mg/L) and September (406.77 and 387.19 mg/L) are high in comparison to December (279.54 mg/L) winter season.

Graph No. 6 represents Phosphate, Sulphur and Chlorine level in dam water. The surrounding economic activities are responsible for contribution of these minerals in dam water. Use of sulphur and phosphate in fertilisers dissolve 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 April (2.58 mg/L) and May (2.68 mg/L) summer season while diluted in rainy season in August (0.92 mg/L) and September ((1.11 mg/L) in rainy season. There is little dilution effect found in March (2.3 mg/L) due to *Awakali* rains. The average sulphur concentration is (15.45 mg/L). From the graph it seems that Sulphur concentration gradually increases from January winter to summer and to rainy days of July and August, reaching maximum in August (19.33 mg/L) and start to decline gradually by winter. It means there is limit to its inlet through agricultural runoff after that inlet of rain water dilutes it. The concentration of chlorine shows two peaks one in March (18.58 mg/L) and other in August (38.09 mg/L). It means more the inlet of water more the its concentration.

Graph No. 7 represents suspended and dissolved solids. Total dissolved solids (TDS) and total suspended solids (TSS) are maximum in rainy season which is associated with energy in flowing water. In rainy season the soil particles dissolve in water and some of them are carried in suspended form. In August TDS is 558 mg/L and TSS is 23.49 mg/L and in September TDS is 528 mg/L and TSS 23.18 mg/L which are maximum in as compared to summer and winter season. In December TDS is 364 mg/L and TSS is 13.12 mg/L. Summer season has little higher TDS and TSS as compared to winter season. Total Solids (TS) is summation of TDS and TSS. TS is highest in August 580.93 mg/L and September 551.51 mg/L and lowest in December 377.39 mg/L

Graph No. 8 represents Sechi depth, that 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 is maximum in January 98.2 cm and February 94.66 cm and minimum in September 54.4 cm because of turbid water in rainy season.

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. 1, 2, 3 , 4 and 5.

Table. 1. 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. 2 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. 3 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. 4 Ostracoda species found in collected water samples in 2014 at Kurnur dam

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

Table. 4 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's as mentioned in figure no 3. In summer season March, April and May percentage of Rotifera is high in community composition. In all seasons Protozoan count is low which may be because of escape ability.

Fig.No.3 Abundance and composition of zooplankton in all seasons of 2014 at Kurnur dam.

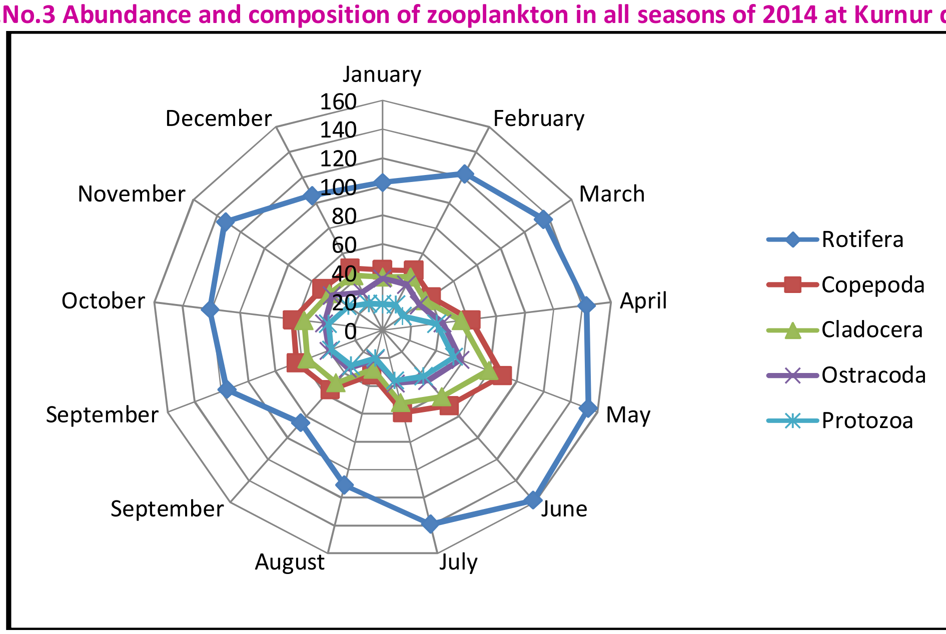


Fig. No. 4 Composition and abundance of zooplankton in Summer, Rainy and Winter season at Kurnur dam Solapur (2014)

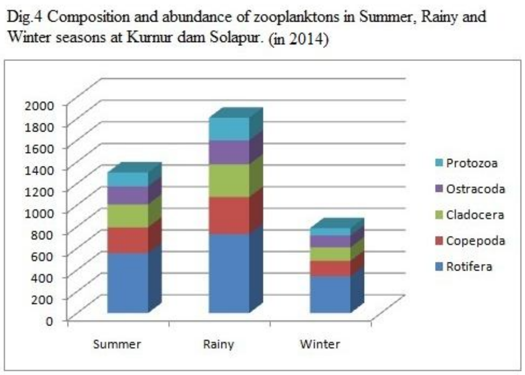
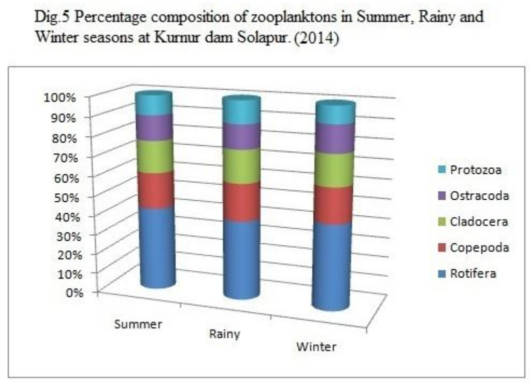


Fig. No. 5 Percentage composition of zooplankton in Summer, Rainy and Winter season at Kurnur dam Solapur (2014)



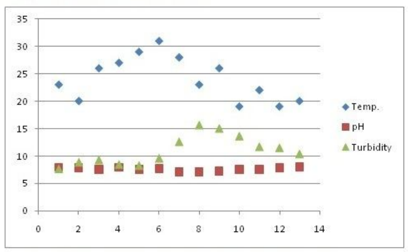
In summer season 24 species of zooplankton were identified, in rainy season 16 and in winter season 15 species were identified. Rotifera dominated in all seasons of the year followed by Copepoda, Cladocera, Ostracoda and Protozoa. In summer season abundance of Rotifera is 62 % Copepoda (15%), Cladocera (14%), Ostracoda (6%) and Protozoa (3 %) of the total population. In winter and rainy season abundance of zooplankton changed. In rainy season abundance of Rotifera is (47%), Copepoda (20%), Cladocera (17%), Ostracoda (11%) and Protozoa (5%) as in fig. No.5. In winter season zooplankton composition and abundance is almost same as that of rainy season with slight variations. In winter season abundance of Rotifera is (49%), Copepoda (22%), Cladocera (15%), Ostracoda (9%) and Protozoa (5%) as in figure no. 4 and 5. 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 are counted in warm months May 153 org/L and June 158 org/L. It coincides with temperature rather than any other factors. It means temperature is most important factor that govern reproductive ability of Rotifera. In rainy season their count was less i.e September 86 org/L which is because of dilution effect of influx of new water from rainfall in catchment area. The same thing happens with Copepoda and Cladocera. In May Copepod count is 89 org/L and Cladocera count is 79 org/L while in June they are respectively 70 org/L and 62 org/L which is quite high in comparison to December and January count. In December Rotifera 106 org/L, Copepoda 49 org/L, Cladocera 43 org/L and Ostracoda 30 org/L. From the fig.No.3 It is quite clear that Summer season is favourable for growth of all the planktons and winter season is unfavourable. There is 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 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

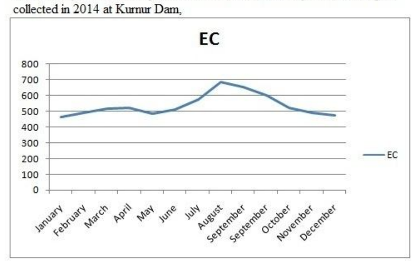
Temperature is the most important factors that govern the zooplankton community composition. Number of Rotifera, Copepoda, Cladocera and Ostracoda are more in water samples in summer season. Other factors are also influential either negatively or positively. In summer season water is found in patchy places with almost greenish appearance. The accumulation of pollutants in small quantity of water justifies the increased number of *Brachionus forficula, Brachionus quadridentatus, Brachionus angularis and Trichocerca species* Rotifera species.

Graph 1 Physico-chemical parameters Temperature. pH and Turbidity of water samples collected in 2014 at Kurnur Dam,

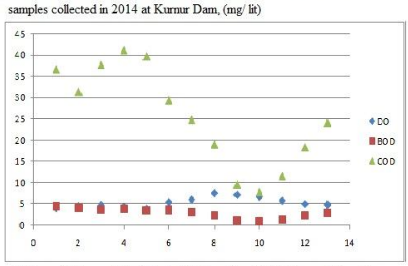


*1-January, 2- February, 3- March, 4- April, 5- May, 6- June, 7-July, 8- August, 9- September, 10- September, 11-October, 12- November, 13-December

Graph 2 Physico-chemical parameters electric conductivity of water samples collected in 2014 at Kurnur Dam,

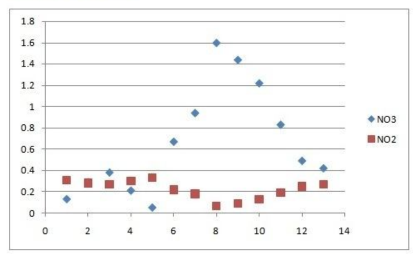


Graph 3 Physico-chemical parameters Dissolved Oxygen (DO), Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) of water samples collected in 2014 at Kurnur Dam, (mg/ lit)



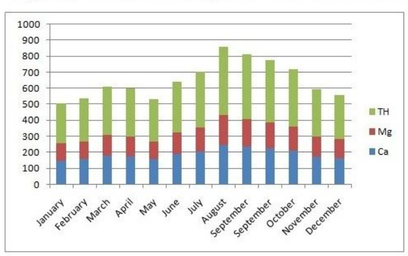
*1-January, 2- February, 3- March, 4- April, 5- May, 6- June, 7-July, 8- August, 9- September, 10- September, 11-October, 12- November, 13-December

Graph 4 Nitrate and Nitrite concentration in mg/ lit of water samples collected in 2014 at Kurnur Dam

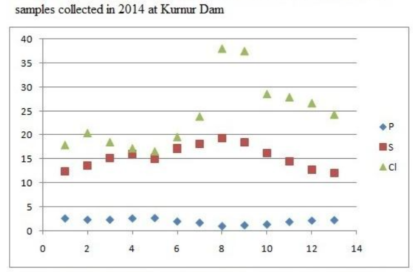


*1-January, 2- February, 3- March, 4- April, 5- May, 6- June, 7-July, 8- August, 9- September, 10- September, 11-October, 12- November, 13-December

Graph 5 Physico-chemical parameters Total Hardness, Calcium and Magnesium Concentration of water samples collected in 2014 at Kurnur Dam

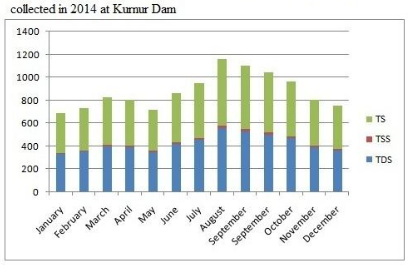


Graph 6 Phosphate, Sulpher and Chlorine concentration in mg/ lit of water samples collected in 2014 at Kurnur Dam

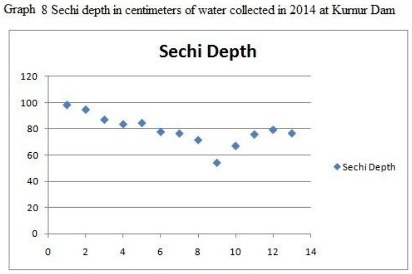


*1-January, 2- February, 3- March, 4- April, 5- May, 6- June, 7-July, 8- August, 9- September, 10- September, 11-October, 12- November, 13-December

Graph 7 Physico-chemical parameters Total Dissolved Solids (TDS), Total Suspended Solids (TSS) and Total Solids (TS) in mg/ lit of water samples collected in 2014 at Kurnur Dam



Graph 8 Sechi depth in centimeters of water collected in 2014 at Kurnur Dam



*1-January, 2- February, 3- March, 4- April, 5- May, 6- June, 7-July, 8- August, 9- September, 10- September, 11-October, 12- November, 13-December

REFERENCES

APHA, AWWA and WPCF Standard methods for the examination of Water and Wastewater Eds. A.D. Eaton, L.S. Cleseri and A.I. Greenberg, 1998 20th ed., American Public Health Association

Avinash B. Gholap 2014 Species diversity indices of zooplankton from Sadatpur reservoir, Ahmednagar, Maharashtra Annals of Biological Research, 2014, **5** (4):58-61

Beuro of Indian standard methods of Sampling and Test (Physical and Chemical) for water and waste water (IS-3025)

Huisman, J., and F. J. Weissing. 1999. Biodiversity of plankton by species oscillations and chaos. Nature **402**:407–410.

Idris 1983 BAG. Freshwater zooplankton of Malaysia, Crustacea, Cladocera. Selangor, Malaysia: Universiti Putra Malaysia;.

Kumbhar A.C. D.A.Kulkarni 2006, limnological study of ujani project of madha tahashil, dist. solapur" Thesis submitted to Dr.Babasaheb Ambedkar Marathwada University, Aurangabad.

Neves I F, Rocha O, Roche KF, Pinto AA. 2003 Zooplankton community structure of two marginal lakes of the River Cuiabá (Mato Grosso, Brazil) with analysis of Rotifera and Cladocera diversity. Braz J Biol. 2003 May;**63**(2):329-43. Epub August 2003.

Odum E.P 1971., Fundamentals of Ecology., W.B. Saunders Company, Philadelphia., (1971)

Okogwu OI1, 2010 Seasonal variations of species composition and abundance of zooplankton in Ehoma Lake, a floodplain lake in Nigeria. Rev Biol Trop. 2010 Mar; **58**(1):171-82

Ryder R.A., Kerr S.R., Loftus K.H. and Register H.A.et.al 1974, The morphoedaphic index, a fish yields estimator review and evaluation., Journal of Fisheries Research Board of Canada., **31**, 663 – 668.