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Seasonal changes in zooplankton community structure in relation to physico-chemical factors at Kurnur Dam Dist. Solapur (MS)

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Abstract
In several studies it found that seasonal variation in physico-chemical factors has great influence on population density, diversity as well community structure of zooplactons. The similar study was made at Kurnur dam in Solapur district to know whether the locational factors influence the physico chemical thus affecting the Zooplankton community structure. Various physico chemical parameters like temperature, transparency, TDS, water hardness, nutrient load like phosphate, nitrate, sulphate etc were considered to correlate seasonal variation in zooplankton community structure. Of the Zooplanktons Rotifera dominated throughout the year over Copepoda, Cladocera and Ostracoda. Overall zooplanktons dominated in month of May and October and they were counted less in October and December. October low can be compared with habitat dilution with external runoff in the reservoir while temperature is important factor for winter low in December. 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.

Keywords: Zooplanktons, Freshwater, Rotifer, Copepoda, Cladocera, Maharashtra, Kurnur dam

1. Introduction
Since ancient times the water is essential factor for survival of humankind and its culture. Most of the culture vanished and perished under influence of wide range of variation in quantitative and qualitative changes in water around settlement. To control and regulate the quantity of water man has constructed numerous lakes and reservoirs, the water from which is not only used for domestic consumption but also for agricultural practices. Fishing in one of the important economic activity that can be operated in lakes and reservoirs. For better fish culture, for domestic consumption and also for agriculture practices water should meet certain set of parameters for its safe use. Foe culture of better fish quality the environment in and surrounding water is essential to be good to maintain proper food chain.
Zooplanktons are the small sized animals and larval forms of large animals. They are herbivorous animals considered as primary consumers feeding on small algae, phytoplanktons, bacteria and unicellular organisms. They form important link between producers and secondary consumers. Varieties of zooplanktons like Rotifera, Copepoda, Cladocera and Ostracoda form a good network of food web giving the best selection opportunity for their predators. Over dominance of any one plankton community lead to deplete selection opportunity thus affecting the quality and quantity of secondary consumers and further on other members of the succeeding food chain. Therefore it is essential to study the community structure of zooplanktons to analyse the quality parameters of water that are essential to maintain healthy and sustainable ecosystem in water.
A lake is self-sustained ecosystem where phytoplanktons are autotrophs that use solar energy to synthesize food, which is consumed by zooplanktons. Zooplanktons are further consumed by small fishes which are further eaten by large fishes. Therefore the fish production is associated with phytoplankton production. (Ryder *et al*., 1974) [1]. Therefore some of the studies have given emphasis to phytoplankton. Phytoplankton diversity is unimodal function of productivity in freshwater lakes (Dodson *et al*. 2000) [2]. According to Odum there is close association of physico chemical factors with quality of flora and fauna of that ecosystem (Odum *et al*., 1971) [3].

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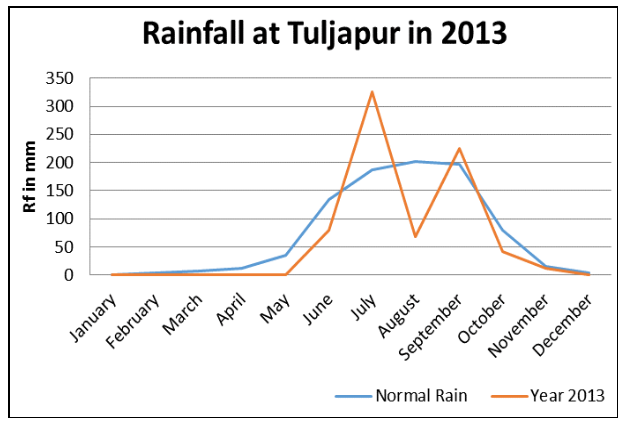
Phytoplankton and Zooplanktons form a highly diverse group microorganisms, and several studies have been made to understand maintenance of species diversity**.** In a comparison with species diversity and availability of resources Huisman found that oscillations and chaotic fluctuations in species abundances allow the coexistence of many species on a handful of resources (Huisman and Weissing 1999) [4]. According to Hutchinson the large number of species in most plankton communities from the perspective of principle of competitive exclusion suggest that in a homogeneous, well-mixed environment species that compete for the same resources cannot coexist (Hutchinson 1961) [5]. In a study of Zooplanktons in lake of Sadatpur reservoir, Ahmednagar Protozoa and Rotifera dominated 81.8% of sample collection and among the Rotifera Sinantherina species Rotaria and Asplanchuna recorded at relatively abundant indicating polluted water of the reservoir (Avinash B. Gholap, 2014) [6]. The Physicochemical factors plays important role in abundance of Zooplanktons, in a study of Sina Kolegaon Dam, Osmanabad district of Maharashtra the density of rotifers is found to be less in rainy season due to dilution of habitat, turbidity of water and less photosynthetic activity by primary producers. Copepoda nad Cladocers are abundant in rainy season but Ostracoda which are bottom dwellers did not show any remarkable fluctuation (Swati Jadhav, *et al*, 2012) [7]. In a similar study at Rishi lake of Karanja (Lad) Maharashtra zooplanktons were found in highest numbers in summer season and lowest in rainy season which show the influence of physico chemical factors (Kedar G.T. *et al* 2008) [8]. In a study of lake at Pune university campus Rotifera show high dominance and temporal community similarities. This study also positively correlates abundance of Rotifera with rainfall and temperature and negatively with pH and conductivity (Vanjare, Pai 2013) [9].

2. 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 km^2 from Akkalkot and Tuljapur Tehasil.

Fig 1.1: Kurnur Dam, Dist. Solapur

Kurnur Dam located in drought prone rain shadow region of Western Ghats in Marathwada region. The volume of water in the reservoir depends upon favour of 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 2013 there was drought like situation in from February to May because of absence of rainfall from western disturbance locally known as ' *Awakali* ', the volume of water in reservoir reached below the level of dead storage. The important economic activity in the catchment area is agriculture and there is no industrial belt in its catchment area besides some settlements are present on the bank of Harna River who are the main source domestic sewage. Because of drought prone area dry land agriculture is practiced in the catchment area, frequent tilling, use of fertilizers and pesticides that can be said agricultural runoff which influence the quality of discharge of water in the reservoir.



Graph: Annual rainfall pattern at Tuljapur 2013 (From metrological site of Gov. of Maharashtra)

3. 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 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) [12] (epa.gov manual) [13]. For the collection of Zooplanktons 125 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.

4. Results and Discussion

The rainfall in the basin is important factor that governs various physico-chemical factors. Some of the parameters are to be collected immediately while collecting sample like temperature, pH, Electric conductivity and Nitrate concentration etc. In 2013 from the graph of rainfall status in Tuljapur tehasil, it is observed that there was absolutely no pre-monsoon (*Awakali*) rainfall in months of March to May as compared to normal and this is accompanied by evaporation losses, which lead to decreases of water level in the reservoir below dead storage. Because of this organic and inorganic pollutants stated to get accumulate making water turbid with typical smell. In monsoonal season the rain fall followed almost normal course with typical high in the month of July and low in the month of August thus bringing added mineral nutrients from agricultural runoff.

Temperature is a simple parameter that can be easily measured with help of glass thermometer. It normally follow the diurnal range of temperature. The temperature is recorded during morning hours while collecting water sample almost at same time through the year. From temperature graph it can be concluded that temperature of water is maximum during May and minimum in December. Turbidity and Electric conductivity (EC) follow the rainfall and maximum during rainy season with the addition of water. pH decreases with addition of rain water, it means 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. Dissolved Oxygen (DO) follows the pattern of combined effect of temperature and rainfall. In summer the dissolved oxygen decreases while the monsoonal rain running through various rapids enhance concentration of DO in water. 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.

Total Dissolved Solids (TDS), Total Suspended Solids (TSS) and Total Solids (TS) seems to follow the rainfall rather than temperature therefore premosoon tillage and agriculture runoff in rainy season may be responsible for increased TDS, TSS and TS. In comparison to TDS, Total Suspended Solids is very less therefore the graph of TDS and TS appears to be same. Calcium (Ca), Magnesium (Mg) and Total Hardness (TH) also follow the rainfall pattern as they are contributed by dissolution of soil particles. The concentration of Nitrate and Nitrite inversely related. Nitrate concentration is related with bacterial and algal concentration that convert them in to either nitrate, ammonia fixing bacteria etc. Nitrate concentration is maximum during rainy season and minimum during summer season. 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. 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. 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 April.

Table 1: Physico-chemical parameters of water samples collected in 2013 at Kurnur Dam,

Months	Temp	pH	Turbidity	EC	DO	Nitrate
January	23	8.07	7.8	380	4.88	0.17
February	24	7.5	7.8	425.11	4.34	0.23
March	29	7.67	8.53	482.91	3.95	0.11
April	31	7.8	8.67	480.74	3.88	0.06
May	33	7.6	10	462.74	3.73	0.09
June	27	7.43	10.5	589.67	5.38	0.69
July	26	7.1	15.83	669.81	7.68	1.84
August	24	7.4	15.97	647.07	6.67	1.34
September	26	7.3	14.73	662.2	7.16	1.58
October	23	7.57	12.87	546.44	6.23	1.12
November	21	7.7	8.9	474.13	5.45	0.73
December	20	7.6	8.28	467.79	4.75	0.43

Table 2: Physico-chemical parameters of water samples collected in 2013 at Kurnur Dam,

Months	BOD	COD	TDS	TSS	TS
January	3.19	26.02	275.67	8.97	284.33
February	3.57	29.13	308	9.49	317.54
March	5.8	47.22	350.33	9.49	359.43
April	5.68	46.3	348.33	10.81	359.18
May	5.38	43.82	335.33	10.94	346.27
June	4.71	38.41	427	13.45	440.75
July	3.44	28.09	485.33	24.13	509.5
August	2.31	18.93	469	21.77	490.67
September	2.1	17.17	479.83	20.35	500.21
October	2.77	22.66	396	16.08	412.06
November	3.51	28.63	343.67	11.21	354.79
December	3.99	32.61	339.67	10.35	349.33

Table 3: Physico-chemical parameters of water samples collected in 2013 at Kurnur Dam,

Months	Ca	Mg	TH	Nitrite	P	S	Cl
January	121.73	93.21	214.94	0.31	2.58	13.98	17.4
February	136.18	101.29	237.48	0.3	2.48	13.15	18.42
March	154.71	115.21	269.91	0.32	2.58	12.47	15.39
April	154.01	117.12	271.13	0.33	2.58	12.24	17.53
May	148.24	111.31	259.55	0.32	2.58	10.78	17.75
June	188.91	136.37	325.28	0.22	1.93	14.42	21.88
July	214.57	150.9	365.48	0.03	0.37	15.76	39.3
August	207.29	148.5	355.79	0.11	1.01	17.18	35.29
September	212.14	152.95	365.09	0.07	0.74	16.54	33.1
October	175.05	133.08	308.14	0.15	1.38	14.92	31.22
November	151.89	122.47	274.36	0.21	1.93	13.25	21.75
December	149.86	113.7	263.57	0.27	2.3	12.81	19.87

Table 4: Zooplanktons count from water samples collected in 2013 at Kurnur Dam, (Organisms/lit)

Months	Rotifera	Copepoda	Cladocera	Ostracoda
January	122	65	52	66
February	126	87	68	89
March	140	112	74	126
April	152	127	101	137
May	167	141	116	152
June	177	113	98	123
July	102	73	51	60
August	142	81	56	80
September	125	55	43	64
October	134	51	42	53
November	118	46	40	49
December	116	39	31	51

Table 5: 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 6: 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	

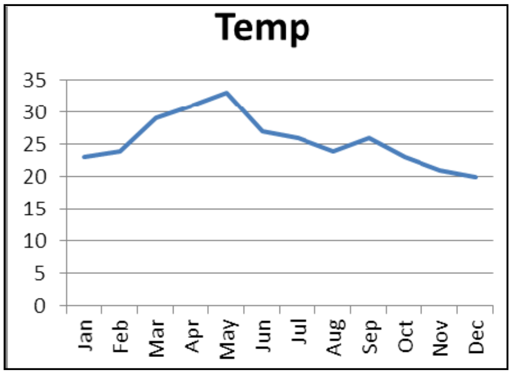
Table 7: List of Cladocera observed in the sample collected from Kurnur Dam in 2013

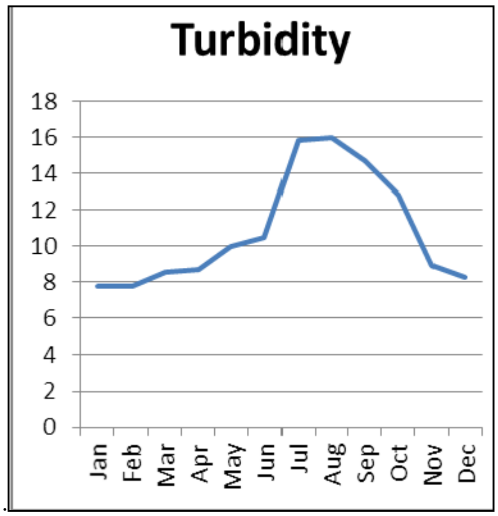
Alona	Alona guttata Sars	Macrothrix goeldii (Richard)	Biapertura affinis (Leydig)
Bosmina	Bosmina longirostris	Ceriodaphnia pulchella Sars	Grimaldina brazzai (Richard)
Daphnia sp	Trophocyclops	Macrothrix spinosa (King)	Daphnia cucullata Sars
Cypris	Flurcularia sp	Ilyocryptus sordidus (Lievin)	Scapholeberis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

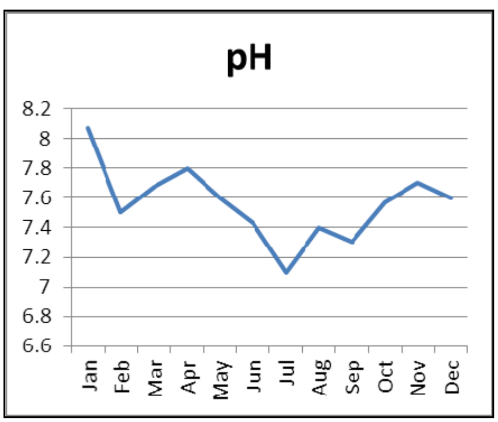
Table 8: List of Ostracoda observed in the sample collected from Kurnur Dam in 2013

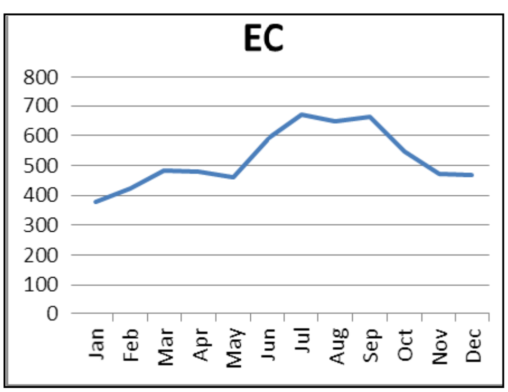
Candocypris spp.	*Candona*	*Centrocypris*	*Cyprides*
Cyprinotus	Cypris spp.	*Darwinula*	*Ilyocypris*
Limnocythere	*Metacypris*	*Potamocypris*	Stenocypris spp.

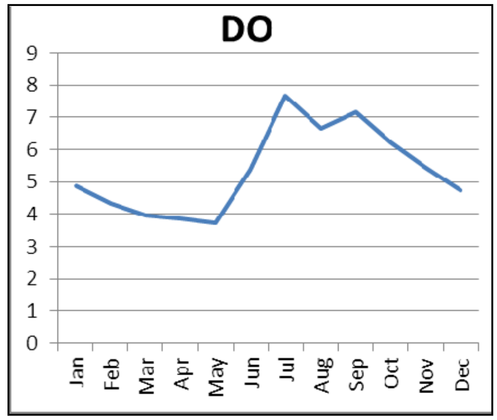
5. Graphical presentation of seasonal changes in physico-chemical factors.

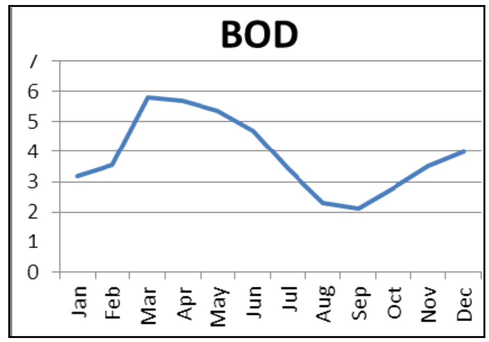


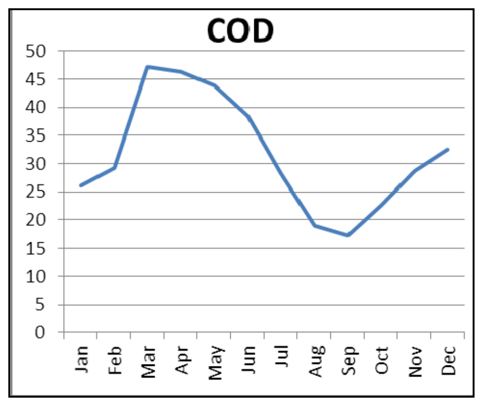


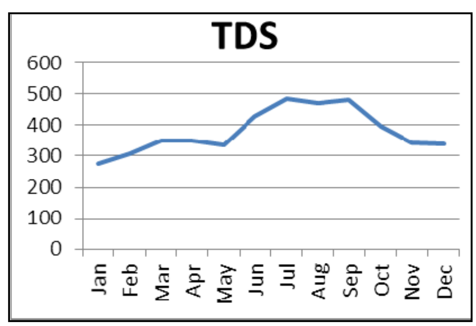


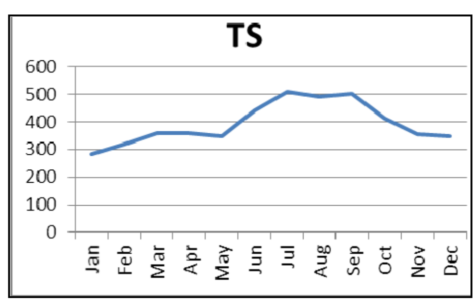


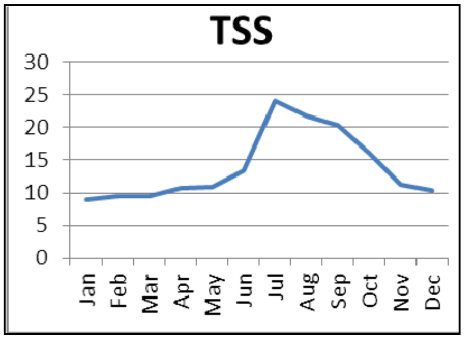











TSS
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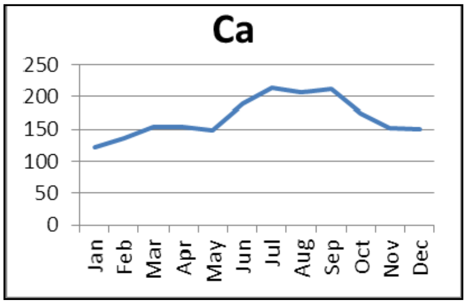
Ca
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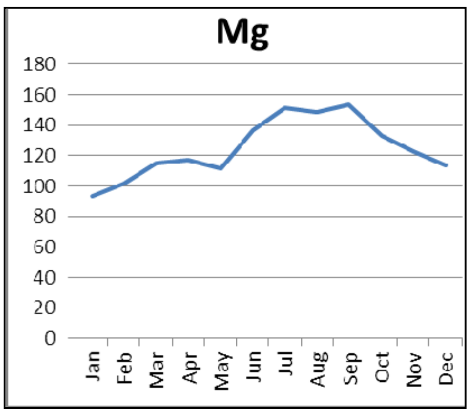
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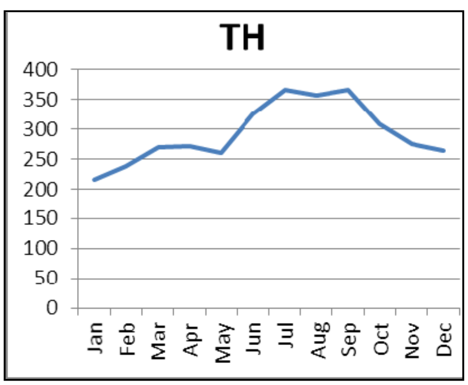
TH
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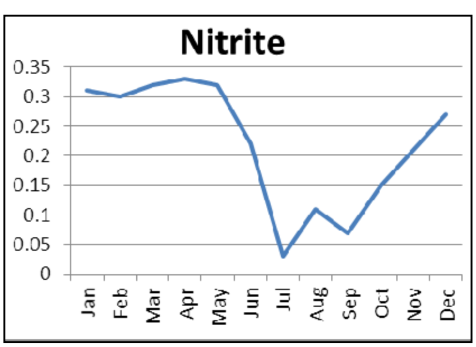
Nitrite
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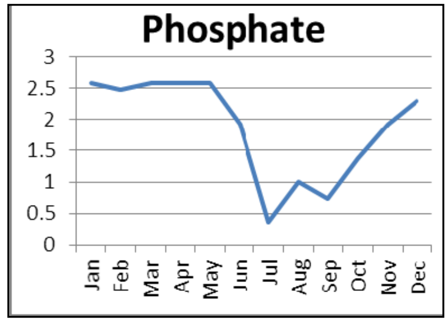
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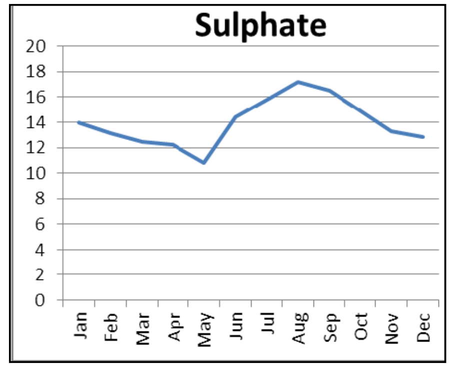
Sulphate
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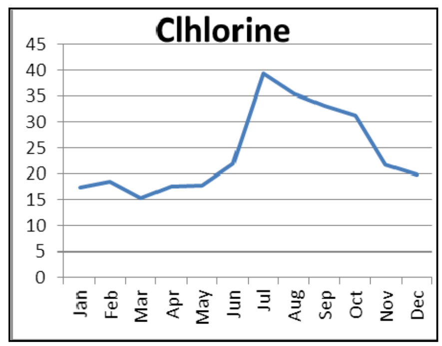
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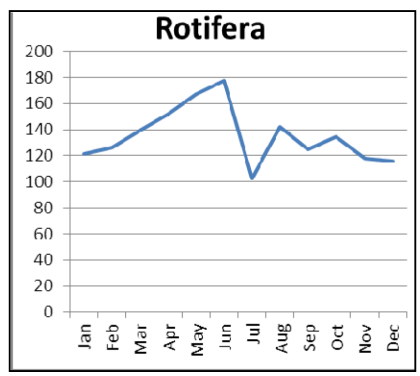
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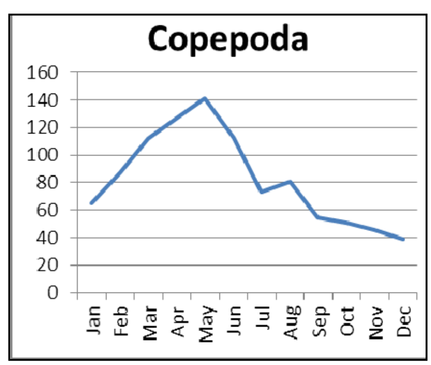
Copepoda
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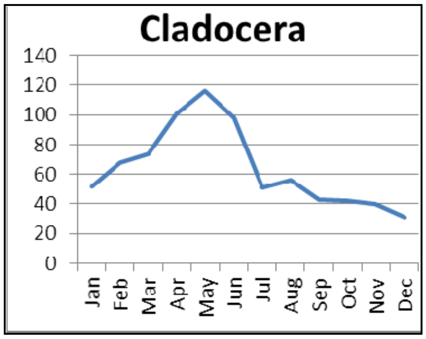

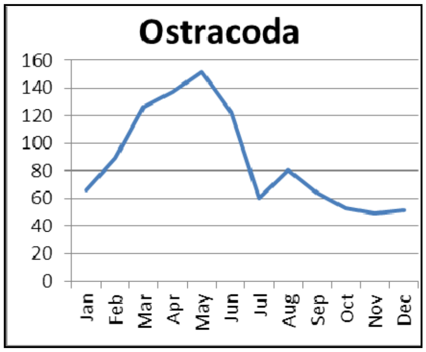

6. Conclusion

In flux of rain water through agricultural runoff is one of the crucial factor that governs the physico chemical factors of the reservoir. Influx of water relies on quantity as well as spatial and temporal distribution of rainfall in monsoonal season. The common effect is habitat dilution. In summer season from February to May the quantity of water in the reservoir is less but Rotifera, Copepoda, Cladocera and Ostracoda predominate in terms of quantity 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 (May) which may be because of high temperature and lowest in winter season (December) because of low temperature. In winter season also Rotifera followed by Ostracoda and then Copepoda dominate the community while Cladocera is least. 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.

7. Acknowledgement

Peoples have keen interest in studies related nature, I found one of the interesting team which helped me to collect sample and analyse it. Prof. Patil Subhash chandra helped to collect sample from the site therefore I must say special thanks to him. I grateful to Dr. Sawant, Prof. Rokade A.U, Prof. Dr. Bharate. S.R. and Prof. Dr. Bagale M.B. who guided me and assisted me to complete this project.

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