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***Review Article***

# ASSESSMENT OF ZOOPLANKTON COMPOSITION IN THE RESERVOIRS OF KARNATAKA: A REVIEW

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**ABSTRACT**
The zooplankton composition in the reservoirs of Karnataka is reviewed based on the published data. Globally, due to rapid population growth, there has been a significant impact on natural water resources and this has deteriorated the water quality. Evaluation of zooplankton gives information about the management and restoration of aquatic ecosystem. Zooplanktons are minute aquatic animals that live all or part of their life as plankton. They play an important role in the aquatic food chain especially for fishes and aquatic animals. They act as pollution indicators. Zooplankton are susceptible to environmental variation, their distribution depends upon the biotic and abiotic factors. From the review it was found that Protozoans, Ostracoda, Copepoda and Rotifers are dominant in Tungabhadra reservoir. Crustaceans are only present in Haroor dam. Cladocerans are the dominant group in Karanja, Nagaral and Bachanki reservoirs.

***Keywords****: Groups, Zooplankton, Reservoirs, Lentic water bodies, Karnataka*

## INTRODUCTION

Water occurrence in synthetically unadulterated structure is uncommon. It is a decent dissolvable and found to convey wide assortment of constituents. This has offered ascend to the term nature of water. The nature of water relies upon countless individual hydrological, physical, synthetic and organic components. Substance boundaries are the most significant records, which portray the nature of water. Some synthetic substances, if present more than as far as possible in drinking water may comprise peril to the wellbeing (Ramesh and Majagi, 2016).

The consumption of freshwater is rising exponentially throughout the years to meet the consistently expanding human requirements for drinking, agribusiness and industries. Among the different characteristic operators at work, streams are the most significant rivers of drinking water in tropics and subtropics. However, in the previous four to fifty years, there has been an uncommon decrease in the nature of water in numerous waterways of world ensuing to different kinds' of anthropogenic exercises (Padmalal *et al.,* 2012).

Zooplanktons are the littlest living beings present in practically all the water body and they can be watched distinctly through magnifying lens. They constantly structure a fundamental segment for new water networks and contribute huge to organic efficiency. Zooplankton goes about as principle wellsprings of nourishment for some fishes and assumes a significant job in early recognition and observing the contamination of water. Zooplankton group dispersion relies upon a portion of the complex factors viz, change of climatic conditions, physical and chemical parameters and vegetation spread (Rocha *et al.,* 1999; Neves *et al.,* 2003). Most of the planktonic living beings are cosmopolitan in distribution (Mukherjee, 1997)

The world wide fresh water bodies are collectively undergoing high rates of degradation leading to eutrophication. Due to this, considerable attention is now being paid towards the study of inland water. The inland water bodies are closed ecosystems, in which zooplankton hold a key position in the metabolism of water bodies, trophic levels, food chains and energy flow. Planktons play an important role in transformation of energy from one trophic level to next trophic level. Higher trophic level includes

fishes which are final product of aquatic environment. Planktonic animals in fresh water are dominated by rotifers, cladocerans and copepods. The occurrence of zooplankton in fresh water ecosystem depends on its productivity, which in turn is influenced by physico-chemical parameters and level of nutrients.

The zooplankton occupies a central position between the autotrophs and other heterotrophs and or an important link in food web of a freshwater ecosystem. The abundance of zooplankton depends on its yield which in turn, is influenced by physico-chemical parameters and nutrients in the water. The zooplankton in general consists of taxonomic groups like Rotifera, Cladocera, Ostracoda, Protozoans and Copepoda. The zooplankton community constitutes an important component of aquatic ecosystem and many species are suitable as live feed in aquaculture. The copepoda and cladocera are the dominant groups of crustaceans found in the fresh water habitats. Under natural conditions environmental factors affect microbes and they change according to the season and locality. Each species of the characteristic life style is related to their food habits, growth rate, habitat preference and physiological tolerance (Hatano and Watanabe, 1981).

***Details of the Reservoirs***

Bhadra reservoir is located near Kuvempu University, Shankaraghatta, a tributary of Tungabhadra in Chikkamagalur district of Tarikere taluk in Western parts of Karnataka with latitude: 13º 42'.00" N, and longitude: 75º 38'.20" E. Some of the benefits getting from the reservoir storage are irrigation, hydroelectric power generation, fisheries, drinking water and industrial usage

The Khaji Kotnoor reservoir a perennial reservoir located near Gulbarga city, which is 22 km away from the Gulbarga University campus falls under 17°22′30″ N latitude and 76°59′0″ E longitude. The total catchment area of Khaji Kotnoor is 265.70 Sq.Km and live storage capacity is 5.1784 mm3 and grass storage of the reservoir is 6.2180 mm3 . This reservoir water is used for drinking and irrigation purpose. The maximum depth of reservoir is 9 meters.


**Figure 1: Study area map** (*Source*: *http://www.onefivenine.com/india/villag/state/Karnataka*)

Hattikuni is one of the Village in Yadgir District in Karnataka. It is located 10 km away from the Yadgir District. Hattikuni Reservoir is a perennial fresh water body located 01 km away from Hattikuni village. It lies between Longitude and Latitudes of 16052'50" North and 77010'21" East respectively. Its water spread area is 2145 hectares.

Heroor reservoir is constructed on Bennithora Heroor reservoir 30 km away from Kalaburagi city, Karnataka. The Almatti reservoir is one of the perennial resources of the district and is located at about 63 kms away from Bijapur. It lies between 160° 19″ North latitude and 75° 53′ 15″ East longitude. The catchment area of the reservoir is 13,871 miles.

Karanja reservoir is a perennial reservoir and situated at Byalhalli village in Bidar district, which is 110 km away from the Gulbarga University campus which falls under 17°22′30″ N latitude and 76°59′0″ E longitude. The submergence area is 5,673 ha. This reservoir is exclusively used for irrigation and drinking

***Zooplankton Abundance in the Reservoirs***

***Bhadra reservoir***

Shivashankar and Venkataramana (2013) studied the zooplankton species abundance and diversity of Bhadra reservoir, chikkamagalur district, Karnataka, India during June 2010 to May 2011. They recorded a total of 23 species of which rotifers comprised of 8 species (22.78%), Cladocera 5 (22.17%), Copepods 3 (25.13%), Ostracoda 2(14.69 %) and 5 protozoan species (13.25%). Some of the dominant zooplankton were present throughout the year. The season wise zooplankton analysis showed an average abundance of species in winter, lower in winter and maximum occurrence in summer due to the different environmental and inflow characteristics of the reservoir.

***Mani reservoir***

Veerendra *et al.,* (2012) studied the relationship between zooplankton abundance and water quality parameter in Mani reservoir between January and December 2008. They recorded 10 genera of zooplankton of which 05 genera of cladocerans, 03 genera of copepods and 02 genera Rotifer, were identified in Mani reservoir. The relation among zooplankton and water quality parameters ranging from place to place depending upon the condition of the reservoir water.

***Khaji Kotnoor reservoir***

Rajashekhar *et al.,* (2010) provided a quantitative information on the seasonal variations of zooplankton in relation to physico-chemical variables and it is located at Gulbarga district. In their study, they have recorded 24 species of which, 10 species belongs to rotifera, 6 species of cladocera, 5 species of copepoda and 3 species of ostracoda. Among them particularly rotifera was the dominant group. Their results shows that distribution and density of zooplankton are influenced by physic-chemical factors of the environment.

***Attiveri and Bachanki reservoirs***

Kudari *et al.,* (2006) recorded 33 zooplankton species *i.e.,* 17 species of Rotifers, 11 species of Cladocerans and 5 species Copepods of which 32 species were recorded in Bachanki reservoir whereas, 23 species in Attiveri reservoir.

***Mallapur reservoir***

Basavarajeshwari *et al.,* (2015) provide quantitative information on the diversity of zooplankton from a Mailapur reservoir in the Yadgir district, Karnataka. During 2013-14 they have recorded 23 genera of zooplankton, of which 13 genera belong to rotifera, 5 genera belong to cladocera, 4 genera belong to copepod and 2 genera were belong to ostracoda. Rotifera was the dominant group and maximum count

was recorded in the northeast monsoon season, preceeded by summer and winter season. Zooplankton species are influenced by physical and chemical variables.

***Heroor reservoir***

Ramalingappa *et al.*, (2015) studied the zooplankton in Heroor reservoir and that includes Rotifera, Copepada, Cladocera and Ostracoda. Rotifera are represented by 06 species, Copepods by 04 species. Cladocera consists of 06 species, 03 species recorded among Ostracoda. However, Nauplii were encountered throughout the year.

***Tungabhadra reservoir***

Charantimath (2013) reported 51 genus and 66 species, 12 species of Protozoa, 25 species of Rotifera, 08 species of Cladocera, 12 species of Copepoda and 09 species of Ostracoda .

Takamura et al. (1989) have reported a large number of Rotifera indicated high eutrophic nature of water body. Sladeck (1983) pointed out that low density of Rotifera indicates good water quality. This was in agreement at S5 which is located far east of the reservoir with high wind action along East to West creating water currents towards west. According to Goel and Chavan (1991) the species of *Keratella* and *Brachionus* were the pollution tolerant species and indicate accumulation of organic matter. TBR findings support these findings. More work is still required to designate regional indicator species from different parts of India.

***Almatti reservoir***

Huliyal and Kaliwal (2008) recorded 4 different groups such as cladocera, copepoda, ostracoda and rotifera represented the zooplankton community. 21 species belong to 16 genera from the surface water of the reservoir, in which 5 genera belonged to cladocera (six species) 4 genera to copepoda (four species), one genera to ostracoda (one species) and 6 genera to rotifera (10 species) contributed to zooplankton richness in the reservoir. The total zooplankton density in Almatti reservoir ranged from 251 org/l to 492 org/l during 2003 and 253 org/l to 571 org/l in 2004.However, the Almatti reservoir water is not polluted but Brachious and Keratella spp. were observed by Huliyal and Kaliwal (2008) indicated the presence of organic matter.

***Karanja reservoir***

Majagi and Vijaykumar (2009) studied the Zooplankton seasonal distribution and diversity in Karanja reservoir, Bidar district for the period of two years from October 2001 to September 2003. They have recorded 36 species of which, 15 species belongs to rotifera, 11 species to cladocera, 09 species belongs to copepoda and ostracoda with 03 species.

***Hattikuni reservoir***

Abundance of zooplankton in Hattikuni reservoir, Yadgir District, Karnatakas were studied by Siddaram et al (2016) with respect to their distribution and seasonal abundance. They recorded 23 species of which 9 species belongs to rotifera, 6 species belongs to cladocera, 5 species belongs to copepod and 3 species belongs to ostracoda. Numerically rotifers were dominant group. Season wise zooplankton analysis showed an average abundance of species in winter season, lower in monsoon and maximum occurrence in summer season , due to different environmental condition of the reservoir.

***Lentic water bodies of Chikmagalur & Shivamogga districts***

Ramesh and Kiran (2019) have carried out zooplankton composition in few lentic water bodies of Chikmagalur and Shivamogga districts. During their study 18 different species belonging to 4 different groups namely 33.33% of Rotifera and Cladocera, 22.22% Copepoda and Protozoa 11.11% of total zooplankton recorded. Among the 4 zooplankton groups the Cladocera was represented by 5 genera and 6 species. Rotifers was represented by 4 genera and 6 species. However, Copepoda represented by 4

genera and 4 species and protozoan by 2 genera and 2 species respectively. Occurrence of *Paramecium* and *Vorticella* species in Lakkavalli and Tarikere tanks indicated that the water bodies are eutrophicated.

Kiran *et al.*, (2007) studied the diversity and seasonal fluctuation of zooplankton in fish ponds of Bhadra fish farm at Karnataka. They recorded 07 species of Rotifers, 04 species of Cladocera and 2 species each of Copepoda and Ostracoda respectively.

**Table 1: Different groups of zooplankton in the reservoirs of Karnataka studied by various researchers**

| *Reservoir* | *Protozoa* | *Cladocera* | *Crustacea* | *Copepoda* | *Ostracoda* | *Rotifera* | *References* |
|---|---|---|---|---|---|---|---|
| *Almatti* | 0 | 6 | 0 | 4 | 1 | 10 | Huliyal & Kaliwal, 2008 |
| *Mailapur* | 0 | 5 | 0 | 4 | 3 | 13 | Basawarajeshwari *et al.*, 2015 |
| *Bhadra* | 5 | 5 | 0 | 3 | 2 | 8 | Shivashankar & Venkataramana, 2013 |
| *Tungabhadra* | 12 | 8 | 0 | 12 | 9 | 25 | Nagabhushana Charantimath, 2013 |
| *Bachanki* | 0 | 11 | 0 | 5 | 0 | 17 | Kudari *et al.*, 2006 |
| *Haroor* | 0 | 6 | 1 | 4 | 3 | 6 | Ashok Ramalingappa *et al.*, 2015 |
| *Karanja* | 0 | 11 | 0 | 9 | 3 | 15 | Majagi & Vijaykumar, 2009 |
| *Khaji Kotnoor* | 0 | 6 | 0 | 5 | 3 | 10 | Rajashekhar *et al.*, 2010 |
| *Mani* | 0 | 5 | 0 | 3 | 0 | 2 | Veerendra *et al.*, 2012 |
| *Chitravati dam* | 0 | 5 | 0 | 2 | 1 | 8 | Ramesh & Majagi, 2016 |
| *Jakkal madagu dam* | 0 | 4 | 0 | 1 | 1 | 7 | Ramesh & Majagi, 2016 |
| *Nagaral dam* | 0 | 11 | 0 | 6 | 2 | 12 | Anita *et al.*, 2019 |
| *Hattikuni* | 0 | 6 | 0 | 5 | 3 | 9 | Siddaram *et al.*, 2016 |

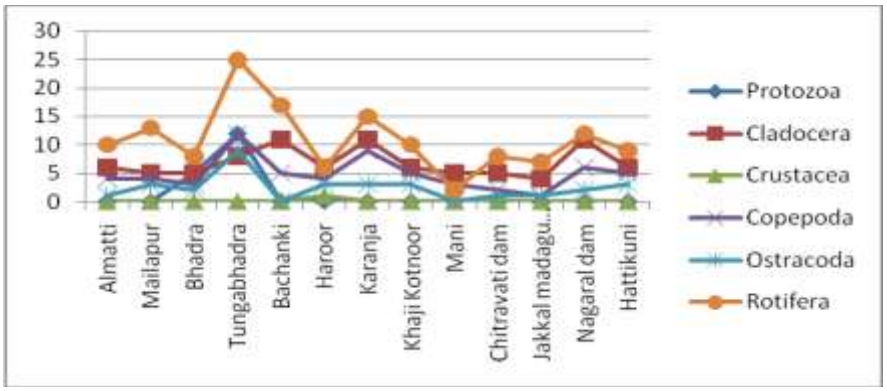


**Figure 2: Occurrence of different groups of zooplankton in the reservoirs of Karnataka**

## DISCUSSION

The important feature of zooplankton is its immense variety over space and time, thus, similar water system may have dissimilar assemblages of organisms varying in space, composition and biomass. Further in spite of convergent similarities, zooplankton species have different types of life histories influenced by seasonal variation of abiotic factors, feeding biology and predation force (Pathani and Upadhaya, 2006).

The production of the aquatic ecological unit is directly correlated with the compactness of zooplankton. Biodiversity of zooplankton is essential to keep one ecosystem healthy because each species plays a specific role in recycling of nutrients, food and maintain of soil fertility in the ecosystem and some species may allow natural ecosystem to functional a well manner (Jeelani *et al.*, 2007). Nonliving and living influences exert a control on the structure and dynamics of zooplankton so as to determine the distribution and abundance of the species (Gyllstorm and Hansson, 2004).

Cladocerans and Copepods are considered as aquatic Crustaceans. In terms of their size, abundance and diversity of way of life, they can be regarded as the insects of the seas (Ranga Reddy, 2001). Crustaceans are more abundant in littoral than pelagic areas. Large species of Crustaceans find shelter in temporary, weedy ponds (Arcifa, 1984).

Rotifers are the smallest animals occur world wide primarily in fresh water habitats. They have a rapid turnover and high metabolic rates and feed on detritus. These organism serve as bio-indicators to depict water quality and are extensively cultured for use as fish feed. Bimodal pattern were reported by Zutshi *et al*., (1980), Pandey *et al*., (1994), Mishra and Saksena (1990) during their limnological studies.

The preference of different groups of zooplankton as follows: Rotifera> Copepoda>Cladocera>Ostracoda>Protozoans>Crustacea.

***One Way ANOVA & Tukey HSD test***

| .Source | DF | Sum of Square | Mean Square | F Statistic | P-value |
|---|---|---|---|---|---|
| Groups (between groups) | 5 | 1053.602631 | 210.720526 | 19.227377 | 4.18932e-12 |
| Error (within groups) | 72 | 789.076851 | 10.959401 | | |
| Total | 77 | 1842.679482 | 23.930902 | | |

p-value010
power010.329

One Way ANOVA test, using F distribution df (5,72) (right tailed)

***H0 hypothesis***

Since p-value<α, H0 is rejected. Some of the groups' averages consider to be not equal. In other words, the difference between the averages of some groups is big enough to be statistically significant.

***P-value***

p-value equals 4.18932e-12, [p( x ≤ F ) = 1.00000 ]. This means that the chance of type1 error (rejecting a correct H0) is small: 4.189e-12 (4.2e-10%).The smaller the p-value the stronger it support H1.

***The statistics***

The test statistic F equals 19.227377, is not in the 95% critical value accepted range: [-∞ : 2.3418]

***Effect size***

The observed effect size f is large (1.16). That indicates that the magnitude of the difference between the averages is large.

The η2 equals 0.57. It means that the group explains 57.2% of the variance from the average (similar to R2 in the linear regression).

***Tukey HSD / Tukey Kramer***

The means of the following pairs are significantly different: x1-x2, x1-x6, x2-x3, x2-x5, x2-x6, x3-x4, x3-x6, x4-x6, x5-x6.

***Tukey HSD / Tukey Kramer data***

| Pair | Difference | SE | Q | Lower CI | Upper CI | Critical Mean | p-value |
|---|---|---|---|---|---|---|---|
| x1-x2 | 5.538462 | 0.918167 | 6.032085 | 1.736676 | 9.340248 | 3.801786 | 0.000821093 |
| x1-x3 | 1.230769 | 0.918167 | 1.340463 | -2.571017 | 5.032555 | 3.801786 | 0.932454 |
| x1-x4 | 3.538462 | 0.918167 | 3.853832 | -0.263324 | 7.340248 | 3.801786 | 0.0826475 |
| x1-x5 | 1.076923 | 0.918167 | 1.172905 | -2.724863 | 4.878709 | 3.801786 | 0.961082 |
| x1-x6 | 9.615385 | 0.918167 | 10.472369 | 5.813599 | 13.417171 | 3.801786 | 2.88526e-9 |
| x2-x3 | 6.769231 | 0.918167 | 7.372548 | 2.967445 | 10.571017 | 3.801786 | 0.0000246607 |
| x2-x4 | 2.000000 | 0.918167 | 2.178253 | -1.801786 | 5.801786 | 3.801786 | 0.639763 |
| x2-x5 | 4.461539 | 0.918167 | 4.859180 | 0.659753 | 8.263325 | 3.801786 | 0.0121583 |
| x2-x6 | 4.076923 | 0.918167 | 4.440284 | 0.275137 | 7.878709 | 3.801786 | 0.0284394 |
| x3-x4 | 4.769231 | 0.918167 | 5.194295 | 0.967445 | 8.571017 | 3.801786 | 0.00588231 |
| x3-x5 | 2.307692 | 0.918167 | 2.513368 | -1.494094 | 6.109478 | 3.801786 | 0.486697 |
| x3-x6 | 10.846154 | 0.918167 | 11.812832 | 7.044368 | 14.647940 | 3.801786 | 2.50744e-12 |
| x4-x5 | 2.461539 | 0.918167 | 2.680927 | -1.340247 | 6.263325 | 3.801786 | 0.413180 |
| x4-x6 | 6.076923 | 0.918167 | 6.618537 | 2.275137 | 9.878709 | 3.801786 | 0.000185466 |
| x5-x6 | 8.538462 | 0.918167 | 9.299464 | 4.736676 | 12.340248 | 3.801786 | 9.83133e-8 |

| Group | x2 | x3 | x4 | x5 | x6 |
|---|---|---|---|---|---|
| x1 | 5.54 | 1.23 | 3.54 | 1.08 | 9.62 |
| x2 | 0.0 | 6.77 | 2.00 | 4.46 | 4.08 |
| x3 | 6.77 | 0.0 | 4.77 | 2.31 | 10.85 |
| x4 | 2.00 | 4.77 | 0.0 | 2.46 | 6.08 |
| x5 | 4.46 | 2.31 | 2.46 | 0.0 | 8.54 |

## CONCLUSION

Fluctuation of zooplankton occurs distinctly in the reservoirs of Karnataka and normally in rainy season there is a less population due to the dilution factors and its effects leads to less photosynthetic activity by primary producers (Singh *et al.*, 2002). The population increases a bit higher level during winter season due to favorable environmental conditions and presence of excess of food in the form of bacteria and suspended detritus, but in summer where inflow is less to compare with other seasons resulted in stability of water body and availability of food is more due to decomposition of organic matter and the density of zooplankton might be high due to less predators.

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