*CIBTech Journal of Zoology ISSN: 2319–3883*
*Online, International Journal, Available at http://www.cibtech.org/cjz.htm*
*2022 Vol.11, pp.193-204/Atul et al.*
***Research Article** (Open Access)*

# DIVERSITY INDICES OF MEIOBENTHIC FAUNA IN KAGZIPURA LAKE NEAR AURANGABAD (MS), INDIA

**Atul R. Chourpagar[1], Rumana S. Shaikh[2] and T. S. Pathan***
*[1]Department of Zoology, Dadapatil Rajale Arts, Science & Commerce College, Adinathnagar, Tal. Pathardi, Dist. Ahmednagar (MS), INDIA (https://orcid.org/0000-0001-7127-6731), [2]Department of Zoology, Sarda College, Ahmednagar (MS), INDIA and *Department of Zoology, Kalikadevi Arts, Science and Commerce College, Shirur (Ka), Dist. Beed (MS), INDIA.*
**Author for Correspondence*: *drtanvir7981@gmail.com*

## ABSTRACT
In the present study, species diversity of different groups of meiobenthic fauna was surveyed from 2008 to 2009 at Kagzipura Lake in Aurangabad District (MS), India, and an analysis of meiobenthic fauna using diversity indices like the Simpsons index, Shannon Wiener Index, Evenness. The value of the Shannon-Wiener index is less than 3 throughout the study period, therefor water quality of Kagzipura lake appears to be moderately polluted. The highest Simpsons index (D) of the Rotifera group was in August (0.178), cladocera in November (0.219), Copepoda in July (0.232,) and Ostracoda in March (0.273). The maximum Shannon Wiener Index (H) of the Rotifera was in December (2.453), cladocera in January (2.271), Copepoda in May (1.781), and Ostracoda in December (1.928). The highest species uniformity (the evenness) of the rotifera group was in December (0.987), cladocera in January (0.986), Copepoda in May (0.994), and Ostracoda in December (0.991). The present study deals with the population dynamics of the dominant group of meiobenthic fauna, i.e. Copepoda is followed by Rotifera, Cladocera, and, Ostracoda. Meiobenthic fauna is the key indicator of aquatic environmental pollution and stress and can be used as effective tools in biomonitoring programs to assess the overall health, conservation, and management of the bioresources of Kagzipura lake.

***Keywords:** Kagzipura Lake, Meiobenthic fauna, Simpson's index, Shannon Wiener Index evenness*

## INTRODUCTION
Meiobenthic fauna, because of their short life cycles, responds quickly to environmental changes, and hence their standing crop and species composition are likely to indicate the quality of the water in which they are found. They are strongly influenced by such Physicochemical and aesthetic aspects of water quality as pH, dissolved oxygen, color, taste, and odor, providing clues to the water quality (Abbasi, 1998).

Most, if not all, aquatic ecosystems are exposed to multiple external factors that influence population dynamics and food web interactions. Two of the most important factors are nutrient loading and climate variability (Straile *et al*., 2003; Jeppesen *et al.*, 2005). Meiobenthic faunal populations in aquatic ecosystems will be directly and indirectly influenced by these two forcing factors (Straile and Geller, 1998). However, studies analyzing in detail the effects of such multiple environmental factors on zooplankton populations are still rare.

The dominant groups of meiobenthic faunal density in freshwater ecosystems are micro-crustaceans like copepods, cladocerans, and ostracods. Generally, meiobenthic fauna occupies a central position in the trophic link between primary producers and higher trophic levels. They are also good bio-indicators of aquatic environments' physical and chemical conditions, which cause changes in the qualitative and quantitative composition of meiobenthic fauna and influence their densities (Karabin, 1985; Matveeva, 1991).

The density and diversity of the Meiobenthic fauna are controlled by several Physico-chemical factors of water. The pattern of algal distribution and its density is the main biological factor affecting the density and diversity of the meiofauna. Temperature, dissolved oxygen and organic matter are important factors which control meiofaunal growth (Hanazto and Yasuno, 1985; Bhati and Rana, 1987). Zooplanktons are also reported as biological indicators of eutrophication and pollution (Verma *et. al*., 1978). From the ecological point of view, rotifers, cladocerans, copepods and ostracods are considered to be the most important components which play a vital role in energy transformation. The present study deals with the population dynamics of the dominant group of meiobenthic fauna, i.e. Copepoda, followed by Rotifera, Cladocera, Ostracoda. The study was carried out at Kagzipura Lake near Aurangabad (MS), INDIA.

## MATERIALS AND METHODS

***Field Sampling:***

The present study was conducted for a period from February 2008 to January 2009. Meiobenthic faunal samples were collected from the freshwater Lake at Kagzipura two times a month. Sediment samples were collected during the early hours of the day using Ekman drag. Samples were collected from four sites of each freshwater body for analysis and results were averaged. Sediment samples were collected in a plastic bag for quantitative and qualitative analysis.

***Laboratory processing:***

In the laboratory, meiobenthic fauna was extracted from the sediment using a 42 µm sieve for the lower size limit and a 500 µm sieve for the upper size limit (Mare, 1942; Hakenkamp *et. al*., 2002). Meiobenthic fauna was narcotized with 1% MgCl2 for 10-15 min, fixed at 4% formalin with Rose Bengal as described by Hummon *et al*., (1978).

***Quantitative analysis:***

Quantitative analysis of meiobenthic samples using the Sedgewick-Rafter chamber for counting and classification into higher taxa was carried out under a stereoscopic microscope as per the method of Higgins and Thiel, (1988). In this study, the abundance of meiobenthic fauna was standardized as individuals per 10 cm2, which is a generally accepted unit in meiobenthic faunal studies (Pfannkuche and Hjalmar, 1988). The abundance of taxa was calculated based on the individual number (n) recorded from the sample and the original sample sized (3.14 X 1.5 X 1.5 cm2), i.e., Abundance = (n X 10)/ (3.14 X 1.5 X 1.5 cm2) individuals/10 cm2

Meiobenthic faunal diversity and population dynamics were analyzed by various indices, such as Species diversity indices, Shannon Wiener indices, Hill diversity indices, and Evenness indices as given by Bakus, (2007).

***Diversity indices (1949)***

***A. Simpson index (D):***

$$\mathbf{D}= \sum_{i=1}^{s} \binom{ni}{n} 2$$

Where: λ = Simpson index
ni = Total population of each species in community
n = Total population of all species in community.

***B. Shannon's index (H'):***

$$\mathbf{H'}= \sum_{i=1}^{s} \left(\binom{ni}{n} In \binom{ni}{n}\right)$$

Where: H' = Shannon's index
ni = Total population of the species in community
n = Total population of all species

***C. Hill's Diversity Number (1973):***

1) Hill's diversity number (N1): N1 = eH'
Where: N1 = Hill's $1^{st}$ diversity number
H' = Shannon's index.

2) Hill's $2^{nd}$ diversity number (N2): N2 = 1/λ
Where: N2= Hill's $2^{nd}$ diversity number
λ = Simpson's index.

***D. Evenness indices: (1981):***

1) Evenness index 1st (E1) – given by Alatalo, (1981): $E1 = \frac{H'}{In\,(S)}$ *or* $E1 = \frac{In\,(N1)}{In\,(N0)}$

*Where*, E1 = Evenness index 1
N1 = Hill's 1st diversity number
N0 = S = Total number of all the species.

Statistical analysis was performed by the various methods such as Standard Deviation (SD), Standard Error of Mean (SEM), and Simple Correlation coefficient (r) as per the methods of Mungikar, (2003).

**RESULTS**

In the present study, species densities of different groups of meiobenthic fauna (Copepoda, Rotifera, Cladocera, Ostracoda, Protozoans and other fauna) observed during Feb 2008 to Jan 2009 are depicted in Table 1. Species diversity indices of Rotifera, Cladocera, Copepoda and Ostracoda during Feb 2008 to Jan 2009 are given in Table 2. A simple correlation coefficient of meiobenthic fauna with physico-chemical parameters and primary productivity during Feb 2008 to Jan 2009 is depicted in Tables (3 -4).

The most abundant species among the Rotifera are *Brachionus forficula*, *Brachoinus angularis, Phillodina sp., Brachionus caudatus, Brachionus bidenta, Brachionus diversicornia, Brachionus quadridenta*, *Keratella tropica valga, Asplanchna priodonta*, *Euchlain dilatata, Filinia terminalis, Trichotri tetractis, Polyarthre major* and *Lecan luna*. Among the Cladocera, the most abundant species are *Daphnia longiramus, Moina macrocuppa, Moina micrura, Ceriodaphnia reticulata*, *Macrothrix rosea, Chydorus sphericus, Ceriodaphnia cornuta, Acantholebris, Diaphanosoma sursi, Leydigio acanthocercoids* and *Chydorus reticulatus*. The most abundant species of Copepoda are *Tropocyclops parasinus, Paracyclops fermbrialis, Mesocylops leuckarti, Mesocyclops hylanus, Rahinodiaptom indicus*, and *Heliodiaptomus viduus*. *Cypricircu reticulates, Cyprinus nuddus, Cyprioconcha alba, Cypriodapsis halvetica, Cyclocypris sharpi*, *Candona suburban* and *Hemicypris fossulata* are the most abundant species of Ostracoda. *Verticella Stentor* and *Euplotes* are also observed amongst the group of protozoans.

Rotifers *Brachoinus caudatus, Brachionus angularis*, were present throughout the study period. *Euchlain dilatata*, and *Lecan luna* were absent from June to September. *Brachionus quadridenta* and *Asplanchana periodonta* are present from June to September and October to January and both are absent from February to May. *Trichotri teteractis* are only seen in November, December and January. Among cladocerans, *Daphnia longiramus* is present throughout the study period. *Macrothrix rosea* and *Ceriodaphnia reticulate* were absent during October to January. *Cydorus reticulatus* is present only from June to September. Whereas *Moina macrocuppa, Moina micrura* and *Diaphanosoma sursi* are absent from October to January.

Copepoda was the dominant group as compared to others. The *Mesocylops leuckarti, Eodiaptomus japonicus* and *Nauplius larvae* of Copepoda were present throughout the study period. *Heliodiaptomus viduus* is absent during June to September. Among Ostracoda, *Cypricircu reticulates, Cyprinus nuddus, Cyprioconcha alba, Cypriodapsis halvetica* are the most abundant species. *Candona suburban* and *Hemicypris fossulata* were absent in the month of February to May as compared to other species and Cyclocypris sharpi was absent in February and March.

In Kagzipura Lake, the highest Simpsons index (D) of the Rotifera group was in August (0.184), Cladocera in October (0.224), Copepoda in July (0.232) and Ostracoda in March (0.278). The Maximum Shannon Wiener Index (H) of the Rotifera group was in December (2.393), Cladocera in January (2.227), Copepoda in May (1.781) and Ostracoda in the month of December (1.931). The highest species uniformity (Evenness) of the Rotifera group was in November (0.981), Cladocera in January (0.99), Copepoda in May (0.994) and Ostracoda in December (0.992).

The data of simple correlation coefficient show that Rotifera has a significantly positive correlation with pH, total alkalinity and chloride ($P < 0.01$) and water temperature, transparency ($P < 0.05$) is negatively

**Table 1: Monthly record of Species density of meiobenthic fauna (individual/10cm$^2$) of Kagzipura Lake during Feb 2008 to Jan 2009**

| Name of Meiobenthic Fauna | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Jan |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Rotifera** | | | | | | | | | | | | |
| ***Brachionus bidenta*** | 11 | 16 | 24 | 20 | -- | -- | 12 | 12 | -- | 7 | 9 | 9 |
| ***Brachionus caudatus*** | 15 | 11 | 10 | 10 | 9 | -- | 15 | 20 | 11 | 13 | 11 | 7 |
| ***Brachionus angularis*** | 16 | 16 | 13 | 11 | 18 | 12 | 10 | 13 | -- | -- | 9 | 12 |
| ***Brachionus forficula*** | -- | -- | -- | 10 | 18 | 14 | 15 | 20 | 12 | 12 | 8 | -- |
| ***Brachionus quadridenta*** | -- | -- | -- | -- | 5 | 6 | 6 | 10 | 21 | 7 | 8 | 14 |
| ***Brachionus diversicornia*** | 9 | 9 | 11 | 7 | -- | -- | -- | 7 | -- | 8 | 10 | 12 |
| ***Keratella tropica valga*** | 10 | 11 | 7 | 10 | 7 | 7 | -- | -- | -- | 4 | 6 | 7 |
| ***Aspalnchna priodonta*** | -- | -- | -- | -- | 5 | 10 | 12 | 13 | 12 | 12 | -- | -- |
| ***Phillodina*** | 17 | 18 | 18 | 17 | 15 | -- | -- | 7 | 10 | 9 | 15 | 15 |
| ***Euchlain dilatata*** | 5 | 10 | 11 | 10 | -- | -- | -- | -- | 12 | 9 | 12 | 11 |
| ***Filinia terminalis*** | 11 | 11 | 9 | 11 | 13 | 15 | -- | -- | -- | 11 | -- | 8 |
| ***Trichotria tetractis*** | -- | -- | -- | -- | -- | -- | -- | -- | -- | 6 | 6 | 4 |
| ***Polyarthra major*** | -- | -- | 11 | 12 | 13 | 16 | -- | -- | -- | -- | 10 | 10 |
| ***Lecan luna*** | 5 | 2 | 5 | 5 | -- | -- | -- | -- | 8 | 10 | 11 | 6 |
| **Total** | **99** | **102** | **118** | **124** | **101** | **80** | **69** | **101** | **86** | **107** | **113** | **114** |
| **Cladocera** | | | | | | | | | | | | |
| ***Macrothrix rosea*** | 10 | 13 | 14 | 18 | 14 | 15 | 20 | 24 | -- | -- | -- | -- |
| ***Chydorus sphericus*** | -- | -- | -- | -- | 14 | 14 | 16 | 11 | -- | -- | 10 | 13 |
| ***Ceriodaphnia reticulata*** | 14 | 14 | 19 | 18 | 14 | 11 | 6 | 9 | -- | -- | -- | -- |
| ***Ceriodaphnia cornuta*** | 10 | 13 | 16 | 17 | -- | -- | -- | 16 | 17 | 10 | 8 | 8 |
| ***Chydorus reticulatus*** | -- | -- | -- | 3 | 7 | 9 | 5 | -- | -- | -- | 8 | 8 |
| ***Moina macrocupa*** | 12 | 17 | 25 | 21 | 23 | 9 | 11 | 10 | 12 | -- | -- | 8 |
| ***Moina microra*** | 20 | 22 | 21 | 26 | 14 | 11 | 9 | 5 | -- | -- | 10 | 11 |
| ***Moina Branchiata*** | 6 | 2 | 4 | 3 | -- | -- | -- | -- | 6 | 5 | 5 | 10 |
| ***Diphanosoma sursi*** | 3 | 2 | 6 | 3 | 15 | 8 | -- | 8 | -- | 14 | 12 | 13 |
| ***Diphanosoma orientalis*** | -- | -- | - | -- | 6 | 6 | 6 | 11 | -- | -- | 6 | 12 |
| ***Leydigio acanthocercoids*** | 9 | 5 | 3 | 4 | -- | -- | -- | 7 | 8 | 11 | 12 | 14 |
| ***Daphnia longiramus*** | 15 | 14 | 14 | 17 | 14 | 14 | 16 | 9 | 7 | 14 | 13 | 6 |
| **Total** | **97** | **101** | **120** | **129** | **119** | **98** | **88** | **107** | **49** | **54** | **83** | **102** |
| **Copepoda** | | | | | | | | | | | | |
| ***Tropocyclops parasinus*** | 16 | 21 | 26 | 21 | 27 | 33 | 13 | 15 | 19 | 20 | 18 | 13 |
| ***Paracyclops fermbrialis*** | 23 | 31 | 31 | 31 | 34 | 14 | 10 | 14 | 16 | 18 | 16 | 16 |
| ***Mesocyclops leuckarti*** | 26 | 26 | 23 | 25 | 24 | 13 | 17 | 13 | 19 | 19 | 15 | 12 |
| ***Mesocyclops hylanus*** | 14 | 12 | 13 | 21 | 19 | 14 | 13 | 5 | 9 | 5 | 11 | 14 |
| ***Heliodiaptomus viduus*** | 22 | 23 | 18 | 21 | -- | -- | -- | -- | 11 | 14 | 16 | 22 |
| ***Rhinodiaptomus indicus*** | 28 | 29 | 30 | 25 | 18 | 22 | 14 | 9 | 12 | 9 | 6 | 10 |
| ***Nauplius larvae*** | 24 | 22 | 14 | 19 | 32 | 36 | 30 | 11 | 20 | 17 | 11 | 12 |
| **Total** | **150** | **162** | **154** | **161** | **153** | **131** | **96** | **67** | **106** | **101** | **93** | **98** |
| **Ostracoda** | | | | | | | | | | | | |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Cypricircu reticulates*** | 18 | 17 | 20 | 18 | 34 | 33 | 11 | 18 | 15 | 12 | 9 | 17 |
| ***Cyprinus Nudues*** | 13 | 8 | 17 | 15 | 21 | 19 | 15 | 19 | 17 | 19 | 14 | 18 |
| ***Candona suburbana*** | -- | -- | -- | -- | 13 | 12 | 19 | 23 | 13 | 25 | 13 | 10 |
| ***Cyclocypris sharpi*** | -- | -- | 23 | 18 | 22 | 35 | 9 | 10 | 23 | 25 | 13 | 11 |
| ***Hemicypris fossulata*** | -- | -- | -- | -- | 23 | 28 | 30 | 31 | 12 | 18 | 18 | 20 |
| ***Cyprio choncha alba*** | 12 | 12 | 11 | 9 | 14 | 17 | 14 | 20 | 11 | 12 | 12 | 20 |
| ***Cypriodapsis halvetica*** | 10 | 9 | 10 | 10 | 10 | 10 | 7 | 16 | 13 | 15 | 14 | 16 |
| **Total** | **53** | **45** | **81** | **69** | **136** | **155** | **103** | **135** | **104** | **125** | **92** | **111** |

**Table 2: Species diversity indices of Rotifera, Cladocera, Copepoda and Ostracoda in Kagzipura Lake during Feb 2008 to Jan 2009**

| Meiobenthic Fauna | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Jan |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Rotifera** | | | | | | | | | | | | |
| **Species Richness (S)** | 9 | 9 | 10 | 11 | 9 | 7 | 6 | 8 | 7 | 12 | 12 | 12 |
| **Simpsons Index (D)** | 0.127 | 0.128 | 0.119 | 0.102 | 0.131 | 0.157 | 0.178 | 0.142 | 0.157 | 0.09 | 0.089 | 0.093 |
| **Shannon Wiener Index (H)** | 2.122 | 2.105 | 2.214 | 2.337 | 2.102 | 1.893 | 1.753 | 2.011 | 1.903 | 2.44 | 2.453 | 2.427 |
| **Evenness (E)** | 0.966 | 0.958 | 0.962 | 0.975 | 0.957 | 0.973 | 0.979 | 0.967 | 0.978 | 0.982 | 0.987 | 0.977 |
| **Cladocera** | | | | | | | | | | | | |
| **Species Richness (S)** | 9 | 9 | 9 | 10 | 9 | 9 | 8 | 10 | 5 | 5 | 9 | 10 |
| **Simpsons Index (D)** | 0.132 | 0.148 | 0.144 | 0.141 | 0.124 | 0.119 | 0.153 | 0.122 | 0.233 | 0.219 | 0.12 | 0.106 |
| **Shannon Wiener Index (H)** | 2.098 | 2.002 | 2.032 | 2.064 | 2.136 | 2.16 | 1.968 | 2.207 | 1.532 | 1.557 | 2.156 | 2.271 |
| **Evenness (E)** | 0.955 | 0.911 | 0.925 | 0.896 | 0.972 | 0.983 | 0.946 | 0.959 | 0.952 | 0.967 | 0.981 | 0.986 |
| **Copepoda** | | | | | | | | | | | | |
| **Species Richness (S)** | 6 | 6 | 6 | 6 | 5 | 5 | 5 | 5 | 6 | 6 | 6 | 6 |
| **Simpsons Index (D)** | 0.176 | 0.178 | 0.179 | 0.17 | 0.211 | 0.232 | 0.206 | 0.222 | 0.179 | 0.192 | 0.181 | 0.178 |
| **Shannon Wiener Index (H)** | 1.763 | 1.754 | 1.752 | 1.781 | 1.582 | 1.537 | 1.595 | 1.548 | 1.754 | 1.706 | 1.742 | 1.759 |
| **Evenness (E)** | 0.984 | 0.979 | 0.978 | 0.994 | 0.983 | 0.955 | 0.991 | 0.962 | 0.979 | 0.952 | 0.972 | 0.982 |
| **Ostracoda** | | | | | | | | | | | | |
| **Species Richness (S)** | 4 | 4 | 5 | 5 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 |
| **Simpsons Index (D)** | 0.262 | 0.273 | 0.219 | 0.215 | 0.164 | 0.168 | 0.175 | 0.156 | 0.152 | 0.154 | 0.148 | 0.151 |
| **Shannon Wiener Index (H)** | 1.362 | 1.342 | 1.56 | 1.57 | 1.874 | 1.855 | 1.841 | 1.899 | 1.916 | 1.906 | 1.928 | 1.917 |
| **Evenness (E)** | 0.983 | 0.968 | 0.969 | 0.976 | 0.963 | 0.953 | 0.946 | 0.976 | 0.985 | 0.98 | 0.991 | 0.985 |

correlated with total hardness, phosphate, sulphate and net primary productivity ($P > 0.05$). Rotifera shows no correlation with Cladocera, Copepoda and Ostracoda. Cladocera has a significantly positive correlation with water temperature; free $CO_2$ and total hardness ($P < 0.01$) and calcium and sulphate ($P < 0.05$) and negatively correlated with dissolved oxygen, gross primary productivity and community respiration ($P > 0.05$). Cladocera also shows a significantly positive correlation with Rotifera ($P < 0.01$)

but there is no correlation between Copepoda and Ostracoda. Copepoda has a significantly positive, correlation with water temperature, pH, free $CO_2$, total alkalinity, calcium and chloride ($P < 0.01$), and negatively correlated with dissolved oxygen, gross primary productivity and community respiration ($P > 0.05$). Copepoda also shows a significantly positive correlation with Cladocera and is negatively correlated with Ostracoda. Ostracoda shows significantly positive correlation with dissolved oxygen, phosphate, net primary productivity ($P < 0.01$) and gross primary productivity ($P < 0.05$) whereas it is negatively correlated with water temperature, transparency, pH, free $CO_2$, total alkalinity, calcium and chloride ($P > 0.05$). Ostracoda is negatively correlated with Copepoda.

**Table 3: Simple correlation coefficient of meiobenthic fauna with physico-chemical parameter of Kagzipura Lake**

| P | WT | TR | PH | DO | $CO_2$ | TA | CA | TH | CL | $PO_4$ | $SO_4$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **ROT** | 0.406* | 0.500** | 0.693** | 0.041 | -0.143 | 0.625** | 0.267 | -0.622** | 0.544** | -0.610** | -0.626** |
| **CLA** | 0.671** | -0.051 | 0.360 | -0.543** | 0.757* | 0.326 | 0.560** | 0.427* | 0.553** | 0.344 | 0.493* |
| **COP** | 0.760* | 0.326 | 0.548** | -0.922** | 0.761** | 0.568** | 0.532** | -0.209 | 0.793** | -0.166 | 0.371 |
| **OST** | -0.447* | -0.478* | -0.640** | 0.547** | -0.441* | -0.834** | -0.797** | 0.379 | -0.630** | 0.563** | 0.301 |

**Table 4: Simple correlation coefficient of meiobenthic fauna with primary productivity of Kagzipura Lake**

| P | GPP | NPP | CR | ROT | CLA | COP | OST |
|---|---|---|---|---|---|---|---|
| **ROT** | 0.031 | -0.683** | 0.176 | 1.000 | | | |
| **CLA** | -0.686** | 0.255 | -0.515** | 0.151 | 1.000 | | |
| **COP** | -0.893** | 0.184 | -0.802** | 0.045 | 0.463* | 1.000 | |
| **OST** | 0.451* | 0.536** | 0.379 | -0.337 | -0.206 | -0.447* | 1.000 |

*Significant at * P < 0.05 [r = 0.396] and ** P < 0.01 [r = 0.505] and [-] = Negative correlation*
*[**P** = Parameter, **WT** = Water temperature, **TR** = Transparency, **DO** = Dissolve Oxygen, **TA** = Total Alkalinity, **CA** = Calcium, **TH** = Total Hardness, **CL** = Chloride, **$PO_4$** = Phosphate, **$SO_4$** = Sulphate, **GPP** = Gross Primary Productivity, **NPP** = Net Primary Productivity, **CR** = Community Respiration **ROT** = Rotifera, **CLA** = Cladocera, **COP** = Copepoda, **OST** = Ostracoda].*

## DISCUSSION

The seasonal fluctuations of the meiobenthic faunal population are a well-known phenomenon and the meiobenthic fauna exhibit bimodal oscillation between spring and autumn in the temperate lakes and reservoirs (Wetzel, 2001). This fluctuation is greatly influenced by variations in the temperature along with many other factors. The species composition of meiobenthic fauna is directly or indirectly influenced by a complex of ecological factors and their seasonality. Among physicochemical factors, light, pH, dissolved oxygen, temperature, salinity and other dissolved nutrients are known to influence production, composition and distribution of meiobenthic fauna.

Simpson's diversity index (also known as the species diversity index) is used to measure diversity. In ecology, it is often used to quantify the biodiversity of a habitat. It takes into account the number of species present, as well as the relative abundance of each species. The Simpson index represents the probability that two randomly selected individuals in the habitat will belong to the same species. The simplicity of Simpson's diversity index has led it to be used frequently. The Shannon index, sometimes is referred to as the Shannon Wiener Index. The advantage of this index is that it takes into account the number of species and the evenness of the species.

In the present study, the maximum Simpson's index of meiobenthic fauna was found when the Shannon wiener Index was minimal for Kagzipura Lake. The Shannon Wienner Index is more sensitive to rare species and the Simpson Index (D) puts more emphasis on the occurrence of many species. Such relationships were observed by Mukhopadhyay *et al*., (2007) in the contaminated water from Kolkata.

The Shannon Wienner Index and evenness (E) indices were high in the current study on Kagzipura reservoir. Balloch *et al*., (1976) reported that the high Shannon Wienner Index was associated with high evenness Index a three British rivers in Scotland. Such observation supports the results of the present study.

The maximum Shannon Wienner index and species richness were observed in the months of December and January in Kagzipura Lake when ambient conditions were relatively stable. Suresh *et al*., (2009) also reported that the maximum Shannon Wienner index and species richness during winter months from Tungabhadra River, at Harihar, Karnataka. Margalef (1968) recorded that the higher Shannon Wienner index for rotifers is a clear indication of a longer food chain.

Diversity indices are good indicators of pollution in the aquatic ecosystem (Mason, 1998). The Shannon Wiener index was greater than 3. It indicates that clean water values in the range of 1 to 3 are characteristics of moderately polluted conditions and values less than 1 characterize heavily polluted conditions (Mason, 1998). In the present study, the Shannon Wiener index of meiobenthic fauna observed ranges from 1.333 to 2.393 in Kagzipura Lake. The values were less than 3 throughout the study period of one year. Therefore, the water quality of Kagzipura Lake is moderately polluted. Such results were also found by Lakshmi and Khan, (2008) in a floodplain wetland of West Bengal and Mukharji *et al.*, (2010) in a lake at Ranchi.

The present study also indicates that, whenever Simpson's index of meiobenthic fauna was higher, the evenness index was longer and vice versa. Such observations reported by Walting *et al.*, (1979) in Delaware Bay and Suresh *et al*., (2009) on the Tungabhadra River at Harihar support the results on Kagzipura Lake.

The evenness index of meiobenthic fauna is minimal at the same time as species richness was also decreased in Kagzipura Lake. Evenness indices are highly sensitive to the number of individuals or species in a sample, as observed by Tendalkar and Pai, (2001) in the Andaman Sea. The values of Simpson's diversity index generally range between zero and one. The greater the value, the greater the sample diversity (Lakshmi and Khan, 2008).

In the present study, Rotifera was the dominant group, followed by the Cladocera, Copepoda and Ostracoda in Kagzipura Lake. This may be due to their special characteristics i.e., less specialized feeding, high fecundity and frequent parthenogenetic reproduction (Rocha *et al*., 1995). Recently, Suresh *et al*., (2009) also reported Rotifer dominance in Tungabhadra River, near Harihar, Karnataka, supporting the results of present study on Kagzipura Lake.

Rotifera was observed to be numerically dominant over Cladocera, Copepoda and Ostracoda in Mombatta Lake. Earlier similar findings were reported by Hujare, (2005) in Hatkanangale reservoirs in Maharashtra. It takes second position in population density in Kagzipura Lake and Nath Sagar. Pejaver and Gurav, (2008) also reported that the Rotifera occupied second position according to the order of dominance in Kalwa Lake, Thane supporting the results of present study on Kagzipura Lake.

In the present study, Brachionus was the dominant genus in Kagzipura Lake. Charjan *et al*., (2008) reported eight species of Rotifera in Ambona Lake, Yeotmal district, in which Brachionus was the dominant genus. Earlier Kudari *et al*., (2005) also reported the Brachionus dominance in ponds of Haveri district, Karnataka, supporting the results of the present study on Kagzipura Lake. Brachionus calyciflorus was the dominant species among the Rotifera. However, it was not noticed in Kagzipura Lake. According to Bath and Kaur, (1998), the Karatella tropica valga is a warm stenothermal species in Harike reservoir of Panjab. Similarly, during studies, these species have been found maximum in summer in Kagzipura Lake.

In the present study, Cladocera takes second position in species diversity, followed by Copepoda and Ostracoda, and third position in population density in the Kagzipura Lake. Pandit *et al*., (2007) reported the dominance of Cladocera at second position and third position in group density in the Pravara River near Sangamner, in Ahmednagar. The highest population density of Cladocera could be attributed to easy availability of food and favorable physico-chemical conditions such as water temperature, turbidity, transparency etc.

In the present study, the dominance of Diapanososma, Moina and Daphnia longiramis was observed. Such observations were also noticed in Rewalsar Lake, Himachal Pradesh by Chauhan, (1993). The cladoceran species like Daphnia and Moina constitute important links in limnetic as well as benthic food chains. Most of the cladocerans are filter feeders and consume microscopic algae and particulate organic matter in detritus, thereby playing an important role in recycling of matter and energy. In the present study, *Moina macrora* was the most abundant species among the Cladocera in Kagzipura reservoir. Mokhopadhya *et al*., (2007) reported the abundance of *Moina macrora* in contaminated water from Kolkata. Mahajan, (1981) has reported that cladoceran species such as Diaphanosoma and *Chydorus sphaericus* are indicators of eutrophication. Over all, the density of Cladocera in Kagzipura Lake was due to the dominance of Ceriodaphnia cornuta.

During the present study of population density, Copepoda occupied first position in Kagzipura Lake. The population diversity of Copepoda takes third position in the Kagzipura Lake. Lakshmi and Khan, (2008) reported that the Copepoda contribution to diversity was lesser than the Rotifera and Cladocera, and it dominated the meiobenthic faunal population in terms of numerical density in the floodplain in the wetland of West Bengal. Copepoda dominance is also supported by Somani and Pejawar, (2004) in Masuda Lake Thane, which is similar to the result of the present study on Kagzipura Lake. The higher population of Copepoda in winter could be due to the fertilization of leftover eggs after the monsoon breeding season, as observed by Odum, (1971).

Copepoda are the most abundant group in Kagzipura Lake. It may be due to the occurrence of Nauplii throughout the study period. Supporting observations were recorded by Sehgal, (1980) in Surinsar Lake in Jammu; Dalpatia, (1998) in some tropical ponds of Jammu and Romana, (2007) in Sarkoot Pond, District Doda. These nauplii may be abundant without any adult being present at any particular period. The second source of nauplii abundance is from eggs hatching from the sac of mature females. In the present study, the abundance of copepods appears to be due to a second cause.

Pandit *et al*., (2007) reported abundant species of Copepoda *Tropocyclops parasinus*, *Heliodiaptomus viddus*, *Paracyclops fimbriatus* and *Mesocyclops leuckarti* from Pravara river near Sangamner city, District Ahmednagar. Such abundance is indicative of nutrient availability in the Lakes (Chavhan, 2010). In the present study on Kagzipura Lake, the most abundant species of copepods noticed were *Heliodiaptomus viddus*, *Tropocyclops parasinus*, *Paracyclops fimbriatus* and *Mesocyclops leuckarti*.

Ostracods are often reflected in the shape and structure of their carapaces, making them useful palaeo-environmental indicators. They are mostly active on the surface of the sediment and as their population flourishes, the species appears in the littoral zone. In the present study, Ostracoda occupied the fourth position of meiobenthic fauna but is represented by a very low population density as compared to other groups. Majagi, (2002) observed that the Ostracods occupied fourth position as compared with other groups in Karanja reservoir Bidar, supporting the results of the present study on Kagzipura Lake. Rajshekhar *et al.*, (2010) also reported that the Ostracods occupied fourth position as compared with other groups in Khaji Kotnoor reservoir of Gulbarga District, Karnataka. In the present study, 07 species of ostracoda were recorded from Kagzipura Lake. Kudari *et al.*, (2005) reported the most abundant species of Hemicypris fossulata which contributed maximum density in Sanavalli and Battigeri reservoirs of

Haveri district, Karnataka. However, in the present study, Cypriodapsis halvetica was the most abundant species among the Ostracoda throughout the study period, which contributed to maximum density.

In the present study, Rotifera shows a significantly positive correlation between water temperature, transparency, pH, total alkalinity and chloride in Kagzipura Lake. Kudari, (2006) reported that the Rotifera population density shows a significantly positive correlation with water temperature and Cladocera and Ostracoda in Attiveri reservoir of Dharwad, Karnataka, supporting the results of the present study on Kagzipura Lake.

Cladocera shows a significantly positive correlation with water temperature, free $CO_2$, calcium, total hardness, sulphate, calcium and Rotifera in Kagzipura. From Attiveri and Balchanki reservoirs in Dharwad, Karnataka, the population density of cladocerans was reported to be positively correlated with water temperature, total alkalinity, pH and rotifers density by Kudari, (2006). Patil and Gouder, (1985) reported from Dharwad district that the copepod density negatively correlated with dissolved oxygen and phosphate. Such observations support the results of the present study in Kagzipura Lake.

Ostracoda showed a significantly positive correlation with Rotifera and Copepoda and there was no correlation between Ostracoda and Cladocera in Kagzipura Lake. According to Kudari *et al*., (2005) recorded that ostracods show a significantly positive correlation with water temperature, Rotifera, and Copepoda and no correlation with Cladocera in Attiveri reservoir of Haveri district, Karnataka. Majagi, (2002) also observed a significantly positive correlation of ostracods with dissolved oxygen, gross primary productivity and net primary productivity, Rotifera and Copepoda in the Karanja reservoir at Bidar, Karnataka. The results of the present study on the Kagzipura reservoir were in conformity with their findings. Bahura, (1997) showed a positive correlation between Ostracoda and water temperature and a negative correlation between Ostracoda and dissolved oxygen in Gajner Lake of Bikaner, Rajasthan. In the present study, Ostracoda was negatively correlated with water temperature and showed a positive correlation with dissolved oxygen in Kagzipura Lake.

## CONCLUSION

In the present study on Kagzipura Lake, the value of the Shannon-Wiener index is less than 3 throughout the study period, therefor water quality of Kagzipura lake appears to be moderately polluted. The value of Simpson’s index of diversity ranged between zero and one, showing the maximum diversity of meiobenthic fauna. The high faunal diversity is also evident from the values of the diversity index of the Shannon Wiener index and species richness. The correlation not only shows the interdependence of biotic and abiotic factors but also exhibits that such interdependence is unique to Kagzipura Lake.

## ACKOWDGEMENTS

We would like to thank our guide Professor G. K. Kulkarni, who gave us a chance to work on this particular aspect and provided valuable suggestions for the betterment of the research work. Furthermore, we want to extend special thanks towards our college as well.

## REFERENCES

**Abbasi SA (1998).** Water Quality: Sampling and Analysis. (Discovery Publishing House, New Delhi, India) 212.

**Adrian R, Wilhelm S and Gerten D (2006).** Life-history traits of lake plankton species may govern their phenological response to climate warming. *Global Change Biol*ogy, **12** 652-661

**Bahura (1997).** Abiotic parameters of a freshwater lake the Ganjer Lake (Bikaner) in the desert of India. *Journal of Aquatic Biology,* **16** (12) Pp 45- 48.

**Bakus GJ Ed. (2007).** Quantitative Biology: *Chemical Ecology*, (Academic Press, New York).

**Balloch D, Davies CE and Jones FH (1976).** Biological assessment of water quality in three British rivers the North Esk (Scotland) the level (England) and the Toff (Wales). *Water Pollution Control* (U.K.), **75** 92-114.

**Bath KS and Kaur H (1998).** Seasonal distribution and population dynamics and rotifers in Harik reservoir (Punjab-India). *Journal of Environment and Pollution,* **5** (4) 249- 252.

**Bhandarkar WR, Bandarkar SV and Markute VB (2008).** Observation on species diversity of Brachionus in Kaliskar Pond, Brahmapuri, District Chandrapur Maharashtra. *Journal of Aquatic Biology*, **23** (2) 4-7.
**Bhati DPS and Rana KS (1987).** Zooplankton in relation to abiotic components in the fort moat of Bharatpur. *Proceeding National Academic Science, India*, **57** (B) 237-242.
**Charjan AP, Malu RA and Kulkarni KM (2008).** Studies on Rotifer fauna in fresh water wetlands (Ambona lake) in Yeotmal district of Maharashtra. *Journal of Aquatic Biology,* **23** (2) 8-10.
**Chavhan RN (2010).** Limnological studies with respect to some physico-chemical and biological charecteristics of Ramsagar Lake Armori, district Gadchiroli (M.S) India. *A thesis* submitted to *Rashtrasant Tukadoji Maharaj Nagpur University*, Nagpur.
**Chauhan R (1993).** Seasonal fluctuation of zooplankton in Renuka Lake, Himachal Pradesh, *Uttar Pradesh. Journal of Zoology*, **113** (1) 17- 20.
**Dalpatia BD (1998).** Studies on ecology and population dynamics of zooplankton of some sub-tropical ponds of Jammu. *Ph.D. thesis* University of Jammu, Jammu.
**Gerten D and Adrian R (2002).** Species-specific changes in the phenology and peak abundance of freshwater copepods in response to warm summers. *Freshwater Biology*, **47** 2163-217.
**Hakenkamp CC, Morin A and Strayer DL (2002).** The functional importance of freshwater meiofauna. In: Rundle SD, Robertson AL, Schmid-Araya JM (eds). *Freshwater Meiofauna: biology and ecology. Backhuys, Leiden*, the Netherlands, 321–355.
**Hanazto and Yasuno M (1985).** Population dynamics and production of cladocerans zooplankton, in the highly eutrophic lake Kasumigaura. *Hydrobiologia,* **124** 13-22.
**Hingins RP and Thiel H (1998).** Introduction to the Study of Meiofauna. (Smithsonian Institution Press, Washington D. C) 488.
**Hujare MS (2005).** Hydrobiological studies on some freshwater reservoirs of Hatkanangle Tahsil (Maharashtra). *Ph.D. Thesis* submitted to the Shivaji University, Kolhapur.
**Hulyal SB (2005).** Studies on Limnological aspects of Almatti reservoir of Bujapur district. *Ph.D. Thesis submitted to the Karnataka University, Dharwad*.
**Hummon WD, Evans WA, Hummon MR, Doherty FG, Weinberg RH and Stanly WS (1978).** Meiofaunal abundance in sand bars of acid mine polluted, reclaimed and unpolluted streams in southeastern Ohio. In Thorp, J. H. & Gibbons, J. W., eds., Energy and Environmental Stress in Aquatic Systems, DOE Symposium Series (CONF-771114), *National Technical Information Service, Springfield*, Virginia, 188-203.
**Jeppesen EM, Søndergaard JP, Jensen KE, Havens O, Anneville L, Carvalho MF, Coveney R, Deneke MT, Dokulil B, Foy D, Gerdeaux SE, Hampton S, Hilt K, Kangur J, Köhler EHHR, Lammens TL, Lauridsen M, Manca MR, Miracle B, Moss, Peeter Nõges, Gunnar Persson, Geoff Phillips, Rob Portielje, Susana Romo, Claire L. Schelske, Dietmar Straile, Istvan Tatrai, E. Willén an Winder M (2005).** Lake responses to reduced nutrient loading- an analysis of contemporary long-term data from 35 case studies. *Freshwater Biology*, **50** (10) 1747-1771.
**Karabin A (1985).** Pelagic zooplankton (Rotatoria + Crustacea) variation in the process of Lake Eutrophication. I. Structural and quantitative features. *Ekol. Pollution,* **33**(4), 567-616.
**Kudari VA (2006).** Limnological studies of some reservoirs of Mundgod and Shiggaon Talukas. *Ph.D.Thesis submitted to the Karnataka University of Dharwad*.
**Kudari VA, Kadadevaru GG and Kanamadi RD (2005).** Zooplankton composition is some ponds of Haveri district, Karnataka. *Zoos print Journal*, **20**(12) 2094-2099.
**Lakshmi G and Khan RA (2008).** Studies on the ecology zooplankton in a floodplain wetland of west Bengal, India. *Proceeding of Taal 2007. The 12th World Lake Conference*. 67-73.
**Majagi S (2002).** Hydrobiological studies on Karanja reservoir. *Ph.D. Thesis* submitted to the Gulbarga University, Gulbarga.
**Mahajan CL (1981).** Zooplankton as indicators for assessment of water pollution, WHO workshop on biological indicators of an indices of environmental pollution. *Central Bd. Prew. Cont. poo/OSM Uni. Hyderabad*. 135-148.

**Mare MF (1942).** A study of a marine benthic community with special reference to the Microorganisms. *Journal of Marine Biology,* UK **25** 517–554.

**Margalef R (1968).** Perspectives in Ecological Theory. University of Chicago Press, Chicago Pp.112

**Matveeva LK (1991).** Planktonic rotifers as indicators of trophy. *Bjulleten' Moskovskogo Obscestva Ispytatelej Prirody / Otdel, Biology, Moskwa,* **96** 54-62 [in Russian].

**Mason CF (1998).** Biology of freshwater pollution. (Longman Scientific and Technical**,** John Wiley and Sons, Inc., New York) 351.

**Mukharji B, Nivedita M and Mukharjee D (2010).** Plankton diversity and dynamics in a polluted eutrophic lake, Ranchi. *Journal of Environmental Biology,* **31**(5) 827-839.

**Mukhopadhyay SK, Chattopadhyay B, Goswami AR and Chatterjee A (2007).** Spatial variations in zooplankton diversity in water contaminated with composite effluents. *Journal of Limnology,* **66** (2) 97-106.

**Mungikar AM (2003).** An Introduction to Biometry. (Saraswati Publication. Aurangabad). Pp. 1-63.

**Odum EP (1971).** Fundamental of Ecology 3$^{nd}$ (Ed), (W. B. Saundero, Co. Philadelphia and London) 1-574.

**Pandit SV, Vaidya VV and Joshi PP (2007).** Studies on zooplankton diversity of Pravara River, Near Sangamner city, Dist. Ahmednagar, Maharashtra. *Journal of Aquatic Biology,* **22** (2) 33-38.

**Patil CS and Gouder BVM (1985).** Ecological study of freshwater zooplankton of a subtropical pond (Karnatak State, India). *International Review of Hydrobiology,* **70** (2) 259-267.

**Pfannkuche O and Hjalmar V (1988).** Sample processing *In*: Hinggins, R. P., Thiel. H. (Eds). *Introduction to the study of Meiofauna* (Smithsonian Institution press) 488.

**Pejaver MK and Gurav M (2008).** Study of water quality of Jai and Kalwa lake Thane Maharashtra. *Journal of Aquatic Biology,* **23**(2) 44-50.

**Rajashekhar M, Vijaykumar K and Zeba Parveen (2010).** Seasonal variations of zooplankton community in freshwater reservoir Gulbarga District, Karnataka, South India. *International Journal of Systems Biology,* **2**(1) 6-11.

**Rocha O, Sendacz S and Matsumura-tundisi T (1995).** Composition, biomass and productivity of zooplankton in natural lake and reservoirs in Brazil. 1995). Pp 151- 166. *In:* J. G. Tundisi C. E. M. bicudo and T. Matsumura-Tundisi 9eds), *Limnology in Brazil.* ABC/SBL, Rio de Janeiro, 376.

**Romana A, Jyoti MK, Sawhmy N, Madiha S and Singh R (2007).** Studies on population dynamics of Cladocerans and Copepods in Sarkoot Pond, District Doda, Jammu and Kashmir. *Journal of Aquatic Biology*, **22**(2) 15-18.

**Sehgal HS (1980).** Limnology of Lake Surinsar, Jammu, with reference to zooplankton and fisheries prospects. *Ph. D. thesis, University of* Jammu, Jammu, India.

**Sharma BK and Sharma S (2001).** Biodiversity of rotifers in some tropical flood plains lakes of the Brahmaputra river basin, Assam (N.E. India). *Hydrobiologia,* **446/447** 305-313.

**Somani V and Pejawar M (2004).** Crustacean zooplankton population of the lake Masunda, Thane, Maharashtra. *Journal of Aquatic Biology,* **19**(1) 56-57.

**Straile DM, Livingstone GA, Weyhenmeyer and George DG (2003).** The response of freshwater ecosystems to climate variability associated with the North Atlantic Oscillation, 263-279. *In* J. W. Hurrell, Y. Kushnir, G. Ottersen and M. Visbeck [eds.], (The North Atlantic Oscillation. AGU Geophysical Monograph Series) 134.

**Straile DM and Geller W (1998).** The response of Daphnia to changes in trophic status and weather patterns: A case study from Lake Constance. *ICES Journal of Marine Science,* **55** 775-782.

**Strecker AL, Cobb TP and Vinebrooke RD (2004).** Effects of experimental greenhouse warming on phytoplankton and zooplankton communities in fishless alpine ponds. *Limnol. Oceanography.by the American Society of Limnology and Oceanography, Inc.* **49** 1182–1190.

**Suresh B, Manjappa S and Puttaiah ET (2009).** The content of zooplankton of the Tungabhadra river, near Hrihar, Karnataka and the saprobiological analysis of water quality. *Journal of Ecology and Natural Environment*, **1** (9) 196- 200.

**Tendalkar S and Pai IK (2001).** Statistical approaches for computing diversity of zooplankton in the Andaman Sea. *Tropical Ecology*, **42** (2) 243-250.
**Verma SR, Tyagi AK and Dalela RC (1978).** Pollution studies with reference to the biological indices. *Proceeding of Indian Academic of Science*, **87** (B) 123-131.
**Wetzel RG (2001).** Limnology; Lakes and Reservoir Ecosystem, 3rd Edition, (Academic Press. California, U. S. A.) 1006.
**Walting K, Battom G, pambroke A and Mourer D (1979).** Seasonal variations in Delaware bay Phytoplankton community structure. *Marine Biology*, **53** 207-215.