

## Zooplankton Diversity Indices: Assessment of an Ox-Bow Lake Ecosystem for Sustainable Management in West Bengal

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### ABSTRACT

A survey of the zooplankton communities of a water body was conducted from April 2013 to March 2014 in the Chhariganga oxbow lake located in Nakashipara block of Nadia district, India and an analysis of zooplankton with using diversity indices like Shannon-weaver and Simpson diversity index, species richness and evenness, composition trends with total abundance was also carried out to assess the water quality and aquatic health of the oxbow lake ecosystem for its sustainable management.

In this lake three major groups of zooplanktons Rotifera, Copepoda and Cladocera were identified, among the three group rotifers are dominant species in this oxbow lake.

The structure and composition trends of zooplankton in the surveyed water body may be related to both intensity of predation and limitation by environmental factors, which may include the nature of the water bodies, and food quality and quantity. In the present study low diversity values of Shannon and Simpson diversity clearly stated that the selected lake is polluted and has high anthropogenic activity especially during monsoon and this lake was found to be not suitable for aquaculture.

**Key words:** Chhariganga Oxbow Lakes, Nadia, Zooplankton, diversity index, Species richness, evenness, Shannon-Weiner Index, Simpson's index

### INTRODUCTION:

Zooplankton community is cosmopolitan in nature and they inhabit all freshwater habitats of the world. These species are not only useful as bio indicators, but are also helpful for ameliorating polluted waters. Hence qualitative and quantitative studies of zooplankton diversity are of great importance.

Studies on fresh water bodies, natural or manmade have gained much importance in recent years mainly because of their multiple uses. Several workers have attempted to study the hydro biological profile of varied water bodies with intent of assessing the quality of water. Plankton forms an important component of fish food in

aquatic environment and as such, the knowledge of their production and abundance is essential for successful management of fishery. Zooplanktons occupy a central position between the autotrophs and other heterotrophs and on an important link in food of a fresh water ecosystem.

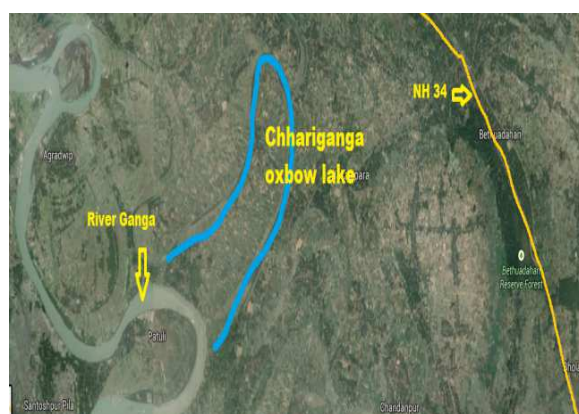
The occurrence and abundance of zooplanktons depends on its productivity. Zooplankton plays a very important role in increasing photosynthesis in some algae which pass through their nutrient rich elementary canal in viable condition. The study of zooplankton community is important as it provides ways of predicting productivity and it is one of the principle links in the food chain. They have been widely used in assessment of aquatic pollution because of their sensitivity to small changes in environment, short generation time.

In the present study, a survey of the zooplankton communities and analysis of zooplanktons with using diversity indices like Shannon-weaver and Simpson diversity index, species richness, and evenness, structure and composition trends with total abundance of different zooplankton to assess the water quality and aquatic health for sustainable management of preselected Chhariganga oxbow lake ecosystem were conducted from April 2013 to March 2014 in Nadia district, India.

## METHODOLOGY:

### STUDY AREA:

The Chhariganga oxbow lake, abandoned, fractioned and derived from the river Ganga is located in Nakashipara development block of Nadia district, West Bengal, India. It is situated at 23.5800° N latitude, 88.3500° E longitude, about 90 Km away from Kalyani University Campus, Nadia. It is a fresh water open type oxbow lake and receives water from the river Ganga during monsoon through a narrow channel at the North East corner of a loop of the river. The oxbow lake is spread over an area of 145.69 Acres with an annual average depth of 8.5 ft. It also stores rain water. The catchment area of the oxbow lake is 600 hectare.



## PLANKTON COLLECTION, PRESERVATION, IDENTIFICATION AND DENSITY ANALYSIS:

The samples of zooplankton were collected from each selected study site of this tropical oxbow lake for a period of one year (April 2013 to March 2014). Collection of zooplankton was made by filtering 50 liters of water through conical shape plankton net made of nylon blotting silk cloth of 60 $\mu$  mesh size and of reducing cone (having filtering area three times larger than the area of the mouth) with the bottle at its end. For a precise collection of zooplankton, the plankton net was towed in open water area of each site three times (horizontally, vertically and obliquely). Care was taken to avoid trapping of floating debris while towing the net. The net was lowered as close to the bottom as possible without disturbing the sediment and carefully hauled to allow the water to drip. The net was rigged with a weight to enhance vertical sinking. Three replicate samples were combined to make a composite sample. Samplings

were made between 7 to 10 AM. Immediately after the collection of the samples, the plankton was preserved with 4% formaldehyde solution and samples were kept for setting for a period of 48 hrs to quantitative estimation. In the laboratory each sample was diluted, stirred well and sub-sampled with a 5ml syringe before microscopic examination. One ml of sample was transferred to Sedge wick Rafter cell (S-R cell) and examined under the microscope at x40 magnification. Qualitative and quantitative plankton analyses were done up to the genus and planktonic organisms were numerically counted, identified and confirmed by following using various monographs, books and other published literature Ward, Henry Baldwin and Whipple, Chon (1945). Needham, G. James and Needham, R. Paul. (1972), Patil and Gouder (1982), Pace, M. L. *et. al* (1990), Battish (1992) and Ndebele M. M. R. (2012). After an accurate identification of each genus, the density of zooplankton was calculated as per the Lackey's drop method (Lackey, J. B. 1938). The species diversity was determined. Statistical analysis was done by using the following diversity index formulas:-

**Simpson's diversity index (Krebs, 1994)**

The Simpson's diversity index (D) is calculated using the following equation:

$$D = \frac{\sum_{i=1}^s n_i(n_i - 1)}{n(n - 1)}$$

D = Where 'ni' is the proportion of individuals of the i<sup>th</sup> taxon in the community. Simpson's index gives relatively little weight to the rare species and more weight to the common species. It ranges in value from 0 (low diversity) to a maximum of (1-1/s), where s is the number of taxa.

**Shannon-Wiener Index (Williams & Feltmate, 1992)**

This is a widely used method of calculating biotic diversity in aquatic and terrestrial ecosystems and is expressed as:

$$H' = \sum_{i=1}^s \frac{n_i}{n} \ln \frac{n_i}{n}$$

Where H= index of species diversity s= number of species ni= proportion of total sample belonging to the i<sup>th</sup> species. A large H value indicates greater diversity, as influenced by a greater number and/or a more equitable distribution of species.

**Taxon Evenness**

This is relative distribution of individuals among taxonomic groups within a community) and is expressed as

$$E = H / \ln(R)$$

Where E= Taxon Evenness, R is the Taxon Richness defined as total no. of distinct taxa in a population.

**RESULTS AND DISCUSSION:**

In this lake the three major groups of zooplanktons were identified. Those are Rotifera, Copepoda and Cladocera. Among the three group rotifers are dominant species in this oxbow lake. Among all the three major groups 9 species of Rotifers, 8 species of copepods and 1 species of Cladocerans were identified in this study.

Zooplankton composition during pre monsoon in Chhariganga Oxbow Lake is shown in table-1. There were two major group of zooplankton (viz. Cladocera and rotifera) abundant during pre monsoon. Single species of Cladocera *Bosmina sp* with 46.15 %, five species of rotifera *Asplanchna sp* *Anuraeopsis sp* each with 15.38 % and *Cephalodella sp*, *Platytias sp*, *Ascomorpha sp* each with 7.69 % of the total zooplankton community were found during pre monsoon.

Table-2 shows various zooplankton species Diversity indices during pre monsoon in Chhariganga Oxbow Lake. A Species Richness of 6, Evenness of 0.85, Shannon-Weiner Index of 1.53 and Simpson Index of 0.28 of different zooplankton species during pre monsoon were observed. Zooplankton Group Diversity indices during pre monsoon in Chhariganga Oxbow Lake also demonstrated values of Group Richness,

Evenness, Shannon-Weiner Index and Simpson Index 2, 1.00, 0.69 and 0.50 respectively (Table-3).

Zooplankton composition during monsoon in Chhariganga Oxbow Lake is shown in table-4. There were two major group of zooplankton (viz. Copepoda and Rotifera) dominated during monsoon. Two species of Copepoda (*Diaptomus sp* with 45.45 % and *Eucyclops sp* with 27.27 %) and three species of rotifera (*Keratella sp*, *Platyias sp* and *Ascomorpha sp* each with 9.09 %) of the total zooplankton community were found during monsoon.

Table-5 shows various zooplankton species Diversity indices during monsoon in Chhariganga Oxbow Lake. A Species Richness of 5, Evenness of 0.85, Shannon-Weiner Index of 1.37 and Simpson Index of 0.30 of different zooplankton species during monsoon were observed. Zooplankton Group Diversity indices during monsoon in Chhariganga Oxbow Lake also demonstrated values of Group Richness, Evenness, Shannon-Weiner Index and Simpson Index 2, 0.85, 0.59 and 0.60 respectively (Table-6).

Zooplankton composition during post monsoon in Chhariganga Oxbow Lake is shown in table-7. There was lone major group of zooplankton (viz. Rotifera) dominated during monsoon. Four species of rotifera (*Notholca sp*, *Monostyla sp*, *Testudinella sp* each with 20% and *Ascomorpha* with 40 %) of the total zooplankton community were found to be dominating during post monsoon.

Table-8 shows rotifer Diversity indices during post monsoon in Chhariganga Oxbow Lake. A Species Richness of 4, Evenness of 0.96, Shannon-Weiner Index of 1.33 and Simpson Index of 0.27 of rotifer group during post monsoon were observed. Among the zooplankton rotifers respond more quickly to the environmental changes and used as a change in water quality (Gannon and Stemberger 1978).

Average density of zooplankton was observed to be 520, 440 and 125 numbers per liter of lake water respectively during pre monsoon, monsoon and post monsoon in the Oxbow Lake. Variations are shown in figure-1. Figure -2 demonstrate variation in different diversity indices of zooplankton during all three seasons in the oxbow lake.

Rotiferans form a significant component of the zooplanktons. The rotiferans exhibit a very wide range of morphological variations and adaptations. Rotifers are regarded as Bioindicators of water quality. Copepods are considered as important food item for various kinds of fish, play a key role in the energy transformation at different trophic levels. As a nature of copepod they prefer Eutrophication environment to grow in high number. Their abundance during monsoon in the lake proved some kind of anthropogenic activity which aggravated Eutrophication process in the oxbow lake. It is provided that jute retting process in the lake during the monsoon rendered huge organic matter to make it eutrophic condition in the lake which might have helped the copepod group to grow in the process. From the ecological point of view Cladocerans considered to be most important components of zooplankton community. The group appears to proliferate more in ponds, lakes and reservoirs. The Cladocerans also prefer to live in clear waters. Their presence reveals that the lake water is good environmental condition and less anthropogenic activity during the pre monsoon Similar results found by Koli and Muley (2012) and Ndebele Murisa (2012).

#### CONCLUSION:

The structure and composition trends of zooplankton in the surveyed water body may be related to both intensity of predation and limitation by environmental factors, which may include the nature of the water bodies, and food quality and quantity (Gouder, B. Y. M. and K. J. Joseph. 1961). In the present study low diversity values of Shannon and Simpson diversity clearly stated that

the selected lake is polluted and has high anthropogenic activity and this lake water is not suitable for growing of fish culture especially during monsoon. So there should be some control over jute retting process and its density in the lake during the monsoon for sustainable management of this Oxbow lake.

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**Table -1: Zooplankton composition during pre monsoon in Chhariganga Oxbow lake**

Group	Genus	%
Cladocera	<i>Bosmina sp</i>	46.15
Rotifera	<i>Asplanchna sp</i>	15.38
	<i>Anuraeopsis sp</i>	15.38
	<i>Cephalodella sp</i>	7.69
	<i>Platyias sp</i>	7.69
	<i>Ascomorpha sp</i>	7.69
Total zooplankton		100

**Table-2: Zooplankton species Diversity indices during pre monsoon in Chhariganga Oxbow lake**

Species Richness:	6
Species Evenness:	0.85
Shannon-Weiner Index:	1.53
Simpson Index	0.28
Density (no.s/ lit)	520

<b>Table-3: Zooplankton Group Diversity indices during pre monsoon in Chhariganga Oxbow lake</b>		
Cladocera Rotifera	Group Richness:	2
	Group Evenness:	1.00
	Shannon-Weiner Index:	0.69
	Simpson Index	0.50

<b>Table-4 : Zooplankton composition during monsoon in Chhariganga Oxbow lake</b>		
Group	Genus	%
Copepoda- Calanoida	<i>Diaptomus sp</i>	45.45
Copepoda- cyclopoida	<i>Eucyclops sp</i>	27.27
Rotifera	<i>Keratella sp</i>	9.09
	<i>Platyias sp</i>	9.09
	<i>Ascomorpha sp</i>	9.09
Total zooplankton		100.00

<b>Table-5: Zooplankton species Diversity indices during monsoon in Chhariganga Oxbow lake</b>		
Species Richness:		5
Species Evenness:		0.85
Shannon-Weiner Index:		1.37
Simpson Index		0.30
Density (no.s/ lit)		440

<b>Table-6 : Zooplankton Group Diversity indices during monsoon in Chhariganga Oxbow lake</b>		
Copepoda Rotifera	Group Richness:	2
	Group Evenness:	0.85
	Shannon-Weiner Index:	0.59
	Simpson Index	0.60

<b>Table-7 : Zooplankton composition during post monsoon in Chhariganga Oxbow lake</b>		
Zooplankton Group	Genus	%
Rotifera	<i>Notholca sp</i>	20.00
	<i>Monostyla sp</i>	20.00
	<i>Testudinella sp</i>	20.00
	<i>Ascomorpha sp</i>	40.00
		100

**Table-8:** Zooplankton Rotifera Diversity indices during post monsoon in Chhariganga Oxbow lake

Rotifera	Species Richness:	4
	Species Evenness:	0.96
	Shannon-Weiner Index:	1.33
	Simpson Index	0.27
	Density (no.s/ lit)	125

