Available online at http://www.journalijdr.com

IJDR

International Journal of DEVELOPMENT RESEARCH

ISSN: 2230-9926

International Journal of Development Research
Vol. 4, Issue, 11, pp. 2431-2436, November, 2014

Full Length Research Article

A STUDY ON ZOOPLANKTON BIODIVERSITY OF KANGSABATI RESERVOIR, W. B., INDIA

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ARTICLE INFO

Article History:
Received 03rd August, 2014
Received in revised form
22nd September, 2014
Accepted 29th October, 2014
Published online 30th November, 2014

Key words:
Zooplankton biodiversity,
Trophic status,
Kangsabati Reservoir.

ABSTRACT

A study on zooplankton diversity of Kangsabati Reservoir was conducted to check the reservoir status and emerge new insights which harbors in it. Shannon-Weaver diversity index, Margalef's richness index, Pielou evenness index, Index of dominance were evaluated on zooplankton from Kangsabati Reservoir. A total of 78 species were found in this reservoir. Among these, it comprises 33 species of rotifera, 22 species of cladocera, 16 species of copepoda, 4 species of protozoa, 2 species of ostracoda, 1 species of amphipoda. The highest and lowest value of Shannon index were 3.97 and 2.85 respectively. The species richness ranged in between 9.587 to 6.380 while evenness value was 0.75 to 0.99. The index of dominance varied from 0.221 to 0.485. The species diversity was maximum in the winter month i.e. November, 2010 and minimum in summer month i.e. May, 2010. Among the rotifers, Brachionus sp., Keratella sp., Synchaeta sp., Asplanchna sp. were dominant where as Daphnia sp., Ceriodaphnia sp., Bosmina sp., Alona sp. were dominant among the cladoceran. On the contrary Naupli, paracyclops sp., Microcyclops sp. among the copepoda; Difflugia sp. and Amoeba sp. among the protozoan; Cyprinotus sp. among the ostracoda were rich in number. The occurrence of amphipod was seen in the month of summer season. The maximum diversity was observed in rotifera group in comparison to amphipoda group which was minimum.

INTRODUCTION

Plankton is the most important component of trophic structure which take parts in transfer of energy to higher trophic levels in the aquatic environment. In ecological point of view, zooplankton influence all the functional aspects of an aquatic ecosystem such as food chains, food webs, energy flow and cycling of matter (Sinha and Islam, 2007). In this connection it is to be mentioned that plankton population is very much sensitive to the environment in which they resides. Alternations among zooplankton population leads to change in the communities in terms of tolerance, abundance, diversity and dominance in their habitat. Several zooplankton species are served as bioindicators (Ahamad *et al*., 2011). Some of the noteworthy contributions on various aspects of zooplankton ecology in the reservoir have been made by Vijaykumar and Majagi, 2009; Chandan and Tiwari, 2011; Dutta, 2011; Mahor, 2011; Koli and Muley, 2012; Veerendra *et al*., 2012; Sitre, 2013; Shivashankar and Venkataramana, 2013.

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The main aim of present study were to determine the zooplankton diversity to delineate its richness, evenness, dominance, basic ecological condition during study period. Besides the present study is an effort to construct a pillar of knowledge on Kangsabati Reservoir.

MATERIALS AND METHODS

Kangsabati Reservoir is situated near Khatra town but 67 K.M. away from district town Bankura, West Bengal. The study area is located in between 22° 55'16.53" N - 23°2' 30.41"N latitude and 86° 37' 55.30" E - 86° 47' 23.35" E longitude. Three stations have been selected for sample collection covering North, South and East site of the reservoir. Zooplankton samples were collected periodically in each last week of every month from the said preselected stations from March, 2010 to February, 2011. The plankton samples were collected by filtering 100 litres of water volume through standard plankton net bolting silk no. 25 (mesh size 64 µm) and the concentrated samples were put in a glass containers where it were fixed in 5% of formalin. The qualitative analysis of zooplankton was

Table 1. Zooplankton diversity indices of Kangsabati Reservoir during study period

			Diversity indices			
Months	Taxa	Individuals /Litre	Shannon-Weaver	Evenness	Species richness	Dominance
March, 2010	39	240	3.651	0.9967	6.933	0.302
April, 2010	47	278	3.651	0.9484	8.173	0.281
May, 2010	43	500	2.851	0.7580	6.758	0.485
June,2010	46	402	3.739	0.9767	7.504	0.283
July,2010	41	220	3.711	0.9993	7.416	0.305
August, 2010	44	370	3.416	0.9027	7.271	0.357
Sept., 2010	46	358	3.814	0.9964	7.652	0.266
Oct. ,2010	46	160	3.760	0.9821	8.866	0.273
Nov., 2010	60	617	3.970	0.9698	9.183	0.247
Dec., 2010	57	344	3.669	0.9076	9.587	0.325
Janu. , 2011	47	595	3.815	0.9908	7.200	0.221
Feb., 2011	39	386	3.525	0.9622	6.380	0.269

Table 2. Total zooplankton population from March, 2010 to February, 2011

Total Zooplankton Population						
Rotifera	Copepoda	Cladocera	Protozoa	Ostracoda	Amphipod	Total
1261	1487	964	538	197	23	4470
28.21%	33.27%	21.57%	12.04%	4.40%	0.51%	100%

carried out using Sedgewick-Rafter cell method (Adoni, 1985). Zooplankton species identification was done following the key, standard literature and authenticated monographs of Edmondson, 1959; Battish, 1992; Needham & Needham, 1962; Sharma, 1998 and with the help of experts of Zoological Survey of India, Kolkata. Four indices were used to obtain the estimation of species diversity, dominance, evenness and species richness. Several statistical approaches were adopted as suggested by Shannon-Weaver index, 1963; Margalef's index, 1968; Dominance index, 1996; Pielou evenness index, 1966 applying the following formulae for the said purpose. Shannon-Weaver index ($H^{'}$) of general diversity : $H^{'} = - \sum(ni/N) \log (ni /N)$ where ni = Total number of individuals of each species here each group, N = Total number of individuals of all species here all group; Index of Dominance (C) : $C = \sum(ni / N)^2$ where ni = Total number of individuals of each species here each group, N = Total number of individuals of all species here all group; Evenness index (e) : e = H' / log S where $H^{'}$ = Shannon-Weaver Index, S = number of species; Species richness index (R) : R = S – 1 / In (n) where S = number of species and n = total number of individuals observed in the sample.

RESULTS AND DISCUSSION

Species diversity indices such as Shannon-Weaver index, species richness, evenness, dominance were studied in order to measure the status of water quality in Kangsabati Reservoir. Data obtained from the study indicates that a total of 78 zooplankton species were identified and recorded comprising 6th and 7th line – "33 species of rotifera, 16 species of copepoda, 22 species of cladocera, 4 species of protozoa and 1 species of amphipoda.Highest number of zooplankton were recorded during winter months whereas lowest during rainy season. This is due to positive correlation with P^H, dissolved oxygen which remain high in winter. Similar result was observed by Priyavada *et al*., 2012. With reference to diversity rotifera was the richest group and amphipod was the poor group.

Composition and abundance of zooplankton

Keratella sp., Brachionus sp., Synchaeta sp., Anuraeopsis sp., Asplanchna sp under rotifera were abundant. Among copepods Nauplii, Microcyclops sp., Eucyclops sp., Paracyclops sp., Diaptomus sp., were rich in number. This group are very much sensitive to alkalinity (Dutta and Patra, 2013). Daphnia sp., Ceriodaphnia sp., Bosmina sp. under cladocera; Cypris sp., Cyprinotus sp. under ostracoda; Amoeba sp., Paramecium sp. under protozoa; Hyperia sp. under amphipoda group were the dominant species. The total zooplankton population was contributed by Rotifera – 28.21 %, copepoda – 33.27 %, cladocera - 21.57 %, protozoa – 12.04 %, ostracoda – 4.40 %, amphipoda - 0.51 %. Copepods ranked first out of total population. Kurasawa, 1975 mentioned that dominance of copepods indicates oligotrophic condition of the aquatic environment.

Diversity indices

Shannon-Weaver diversity index ($H^{'}$) is important comment on the seasonal fluctuations of zooplanktons (Sibel, 2006). The $H^{'}$ index was high i.e. 3.97 in the month of winter (November, 1010) while low i.e. 2.85 in the month of summer (May, 2010). Such type of observation strengthen our finding by Ali *et al*., 2003 in Indus river, Pakistan. The higher value of Shannon- Weaver index indicated greater species diversity. The greater species diversity means longer food chain, a number of inter specific interactions which reduced oscillations and to some extent increases the stability of the community (Ludwik and Reynolds, 1998). Based on Shannon-Weaver legislation, the aquatic environment is classified as very good when $H^{'}$ is > 4, good quality 4 – 3, moderate quality 3 – 2, poor quality 2 – 1 and very poor quality < 1. Species diversity decreases when stress increases in the environment and a community dominated by a relatively few species indicates environmental stress (Plafkin *et al*., 1989). Besides, a scale of pollution regarding species diversity 3.0 – 4.5 slight, 2.0 – 3.0 light, 1.0 – 2.0 moderate and 0.0 – 1.0 heavy pollution – has been described by Staub *et al*., 1970. The Shannon index value 2.85 – 3.97 (Table - 1) obtained during study period indicates good water quality except slight shifting of values which tends to slight pollution. Zooplankton species richness was found to be high in the month of winter season i.e. 9.587 in December, 2010 and lowest in the month of February, 2011 i.e. 6.380 as compared to May, 2010 i.e. 6.758 (Table - 1). Higher species richness is characterized by longer

Table 3. Monthly abundance of zooplankton from March, 2010 to February, 2011

Sl. No.	Months → / Taxa ↓	Mar. 2010	Apr. 2010	May 2010	June 2010	July 2010	Aug. 2010	Sept. 2010	Oct. 2010	Nov. 2010	Dec. 2010	Janu. 2011	Feb. 2011
	Rotifera												
1	*Brachionus caudatus*				12	6	2			3	3		
2	*Brachionus quadridentatus*	6			6	2	2			4	12		12
3	*Brachionus havanaensis*	13			2		1			1	2		21
4	*Brachionus diversicornis*	12	4		3	2	1		1	5		18	
5	*Brachionus angularis*					1			2	1	1		
6	*Brachionus falcatus*				2					1	1		
7	*Brachionus bidentata*		2		1	2	1	16	1	2	2	17	
8	*Asplanchna reticulata*	13	3	6	4	3	1	3	1	6	4	6	
9	*Asplanchna priodonta*		10	1	1	2	3	7	1	5	9	14	15
10	*Asplanchna multiceps*		8	4	1	2	4	3		6	16		
11	*Asplanchna herricki*					1	1	2		1	3	5	19
12	*Keratella crassa*	14		3						7	3	11	
13	*Keratella quadrata*	8	4	3			1	13	1	4	8	2	13
14	*Keratella tropica*			1	14	4	4		1	7	7	2	
15	*Keratella valga tropica*	14	13	7			3	29	1	6	13	16	14
16	*Keratella cochlearis*	7								1	2	5	
17	*Keratella serrulata*							6	1	2	6	4	
18	*Synchaeta oblonga*	8	9	10	7	3	8	12	1	4	8	6	3
19	*Synchaeta grandis*	7	6	5	6	5	5	19	1	5	2	7	16
20	*Synchaeta kitina*			1	2		1	2		3	2	2	
21	*Synchaeta asymmetrica*		5	3	18	6	1	4	1	6	3	8	29
22	*Notholca labis*					4	3	5		8		14	
23	*Notolca acuminata*						5	3	1	6		3	
24	*Trichocerca cylindrical*							7	1	9	7	6	
25	*Euchlanis sp.*					2		5			8	19	
26	*Filinia terminalis*		5	2									
27	*Filinia opoliensis*		3	2									
28	*Anuraeopsis fissa*		6	5	10	5	11	15	2	20	17		
29	*Lecane sp.*				3	4			1	11	5		15
30	*Monostyla lunaris*					1		4			8	3	5
31	*Monostyla bulla*							10			3		2
32	*Polyarthra vulgaris*	5			4	3		2					
33	*Polyarthra remata*							4	1				
	Total	**107**	**78**	**53**	**96**	**58**	**58**	**171**	**19**	**134**	**155**	**168**	**164**

Table 4. Monthly abundance of zooplankton from March, 2010 to February, 2011

Sl. No.	Months → / Taxa ↓	Mar. 2010	Apr. 2010	May 2010	June 2010	July 2010	Aug. 2010	Sept. 2010	Oct. 2010	Nov. 2010	Dec. 2010	Janu. 2011	Feb. 2011
	Copepoda												
1	*Nauplii*	4	22	16	22	25	18	14	18	35	7	15	15
2	*Diaptomus denticornis*	5	6	35	13	16	9		6	24	1	13	7
3	*Diaptomus leptopus*		3		3		1					8	3
4	*Diaptomus pallidus*			25	1				2	13		10	6
5	*Diaptomus tyrelli*				12	10	2			5		7	5
6	*Tropodiaptomus australis*			28									
7	*Filipino-diaptomus sp.*			24	2			6					
8	*Pseudodiaptomus smithi*	1		22									
9	*Paracyclops fimbriatus*	5	18	43	39	14	8	8	13	52	3	18	16
10	*Diacyclops sp.*	2		45	13	10	9		12	40	2		
11	*Thermocyclops sp.*			23	6				5	34	2		
12	*Microcyclops varicans*	4	17	30	25	17	16	20	7	38	5	13	21
13	*Mesocyclops hyalinus*	2	3					3	2	18		11	18
14	*Mesocyclops leuckarti*	3	5					5	3	12		9	13
15	*Eucyclops serrulatus*		7	17	18	12	14	10	8	20	1	15	18
16	*Acanthocyclops sp.*		5	29			8						
	Total	**26**	**86**	**337**	**154**	**104**	**85**	**66**	**76**	**291**	**21**	**119**	**122**
	Protozoa												
1	*Difflugia sp.*	10	6	25	13	7	98	21	10	10	23	9	5
2	*Amoeba proteus*	17	5	11	7	11	96	35	15	34	8	8	2
3	*Paramecium sp.*							9	7	8	6	6	1
4	*Arcella sp.*							11	4				
	Total	**27**	**11**	**36**	**20**	**18**	**194**	**76**	**36**	**52**	**37**	**23**	**8**
	Ostracoda												
1	*Cypris sp.*	1		5	6	3	4		3	50			
2	*Cyprinotus sp.*	5	6	9	6	5	3	18	1		20	36	16
	Total	**6**	**6**	**14**	**12**	**8**	**7**	**18**	**4**	**50**	**20**	**36**	**16**
	Amphipoda												
1	*Hyperia macrocephala*	7	7		9								
	Total	**7**	**7**	**0**	**9**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

Table 5. Monthly abundance of zooplankton from March, 2010 to February, 2011

Sl. No.	Months → / Taxa ↓	Mar. 2010	Apr. 2010	May 2010	June 2010	July 2010	Aug. 2010	Sept. 2010	Oct. 2010	Nov. 2010	Dec. 2010	Janu. 2011	Feb. 2011
	Cladocera												
1	*Daphnia longiremis*	1	5	2	3		1	1	2	2	2	26	2
2	*Daphnia ambigua*		3	3	10	1	3	2	5	3	6	13	4
3	*Daphnia galeata*		1	2	1	3	2	1	2	4	3	20	3
4	*Daphnia retrocurva*	5	3	7			1	2	2	7	1	15	2
5	*Daphnia pulex*	1	2	4	1					3	4	18	
6	*Ceriodaphnia reticulata*	5	7	8	4	1	2	1		4	4	31	8
7	*Ceriodaphnia cornuta*	3	6	6	5	2	4	3		3	3	4	4
8	*Ceriodaphnia lacustris*	2	7	4	8		2	3		2	2	16	
9	*Simocephalus sp.*	8	5	12				4			8		4
10	*Bosmina longirostris*	4	6	3	23	4	3	1	2	5	8	17	16
11	*Bosmina fatalis*	6	5	2	14	2	1	3		4	5	15	6
12	*Eubosmina sp.*	12	8		17	5			1	8	14	40	3
13	*Moina micrura*				6		2		2	2			
14	*Pleuroxus uncinatus*	3	4						1	3	2		
15	*Pleuroxus sp.1*		2			1			1	2	1		
16	*Pleuroxus aduncus*		2			1			3	3	4		
17	*Alona affinis*	5	7		5			3	1	10	7	27	8
18	*Alona rectangula*		3		14	9		1	2	8	5	7	6
19	*Holopedium sp.*	2	2	3							5		
20	*Leptodora sp.*		3	4									
21	*Diaphanosoma sp.*	7	4				3			7	12		
22	*Chydorus sp.*	3	5			3	2	2	1	10	15		10
	Total	**67**	**90**	**60**	**111**	**32**	**26**	**27**	**25**	**90**	**111**	**249**	**76**

food chain (1999). The higher values of species diversity index suggest decreasing species richness with increasing trophic status (Vincent, 2012). In this reservoir species richness is very high throughout the year when conditions more or less stable.

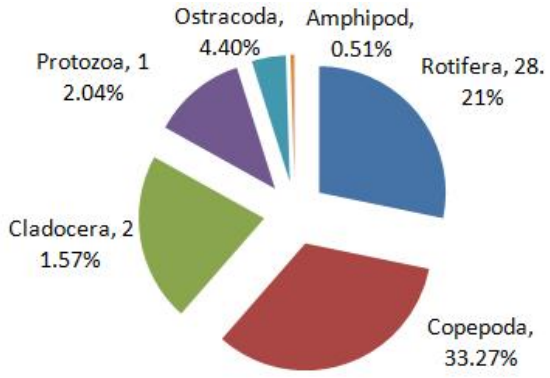

Figure 1. Percentage contribution of different group of zooplankton population

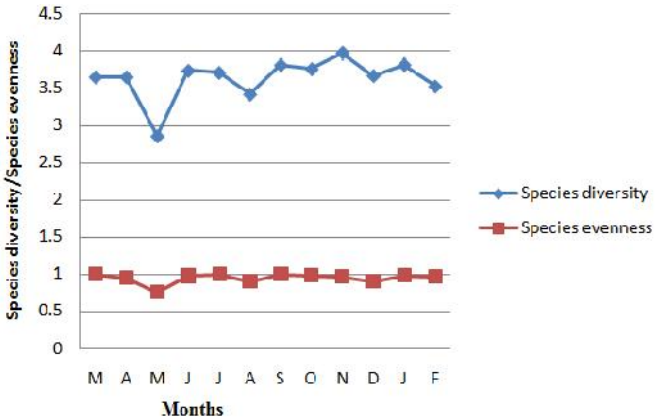

Figure 2. Monthly variation of Species diversity and Species Evenness

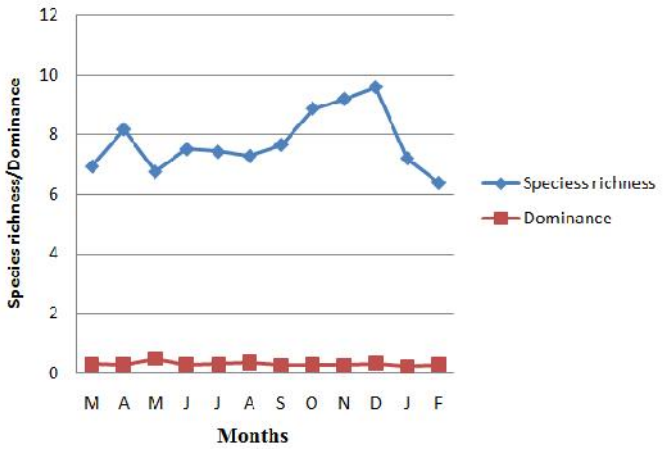

Figure 3. Monthly variation of Species richness and dominance

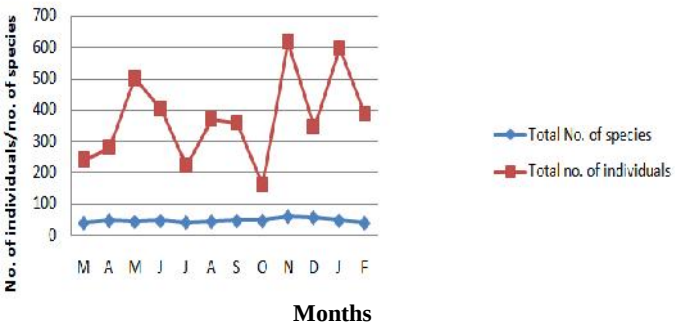

Figure 4. Monthly fluctuation of no. of species and individuals

Species evenness is a measure of the relative abundance of each species in an area. Species evenness will be decreased if the population size of different species vary. The value of evenness fluctuated between 0.75 in May, 2010 and 0.99 in July, 2010 (Table - 1). Same type of result was reported by Ramesha and Sophia, 2013 in River Seeta The value of dominance index was higher i.e. 0.485 in May, 2010 and

lower i.e. 0.221 in January, 2011. According to Whittaker, 1965 the value of dominance index is always higher where the community is dominated by a fewer number of species. It confirmed our investigation. The present study revealed that, whenever dominance index of zooplankton species was higher the evenness index was lower and vice versa. Similar finding was reported by Walting *et al*, 1979 and registered by Suresh *et al*, 2009 in Tungabhadra River. By the way, higher evenness and lower species dominance concur with the result of Sharma, 2008 in rotifer communities of the lentic ecosystem of north eastern India.

Conclusion

The study of zooplankton diversity indices clearly shows high zooplankton diversity in Kangsabati reservoir where it explores a great number of species varieties and enrich the trophic level. Consequently, the diversity indices create a signal about the good health of aquatic environment. The zooplankton species diversity of the reservoir during study period are as follows – rotifera > cladocera > copepoda > protozoa > ostracoda > Amphipod.

Recommendation – death and decay of submerged macrophytes like Hydrilla, Chara etc clog the reservoir ecosystem to a large extent which can impact the well balanced plankton community as well as diversity. So it is very much essential and urgent to manage scientifically.

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