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Studies on Zooplankton Diversity with special reference to Similarity and Dissimilarity Index in glacial fed mountainous Goriganga River of Kumaun Himalaya, Uttarakhand, India

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Abstract

Zooplankton forms a very important link in aquatic ecosystem. They are at the second trophic level and constitute food for other invertebrates and fish. They are also used as indicator of trophic status as well as the quality of water of water bodies. The paper deals with diversity of zooplankton in glacial fed mountainous Goriganga River of Kumaun Himalaya (Uttarakhand) India. Zooplankton sampling on monthly basis were carried out for a period of two years (from July-2006 to June-2008) from three sampling stations (Station-1- Jauljibi 600 MSL; station-2- Baram 900 SML and station-3-Madhkot 1300 SML). Analysis of zooplankton samples, collected from selected stations revealed the occurance of 15 genera belonged to three groups viz. Rotifers-07 (46.66%), Protozoa-04 (26.66%) and Arthropoda-04(26.66%). The study revealed that rotifers dominated all the other two groups and it was also noticed that 04 genera of rotifers (Philodina, Branchionus, Polyarthra and Asplanchna); 02 genera of protozoa (Diffugia and Arcella) and 02 genera of arthropoda (Daphnia and Bosmina) were commonly encountered at all the sampling stations. Similarity and dissimilarity index among the recorded texa of zooplankton is also discussed in the study.

Key words: Diversity, zooplankton, similarity and dissimilarity index, glacial fed, goriganga, Kumaun Himalaya.

Introduction

Himalaya, the magnificent and awe-inspiring monument of nature, it is well known that Himalayas are full of spectacular beauty, unique snow peaks, gushing waters and diversified flora and fauna. The Kumaun region lies between latitudes, 28^0 44″ to 30^0 49″ N and longitudes 78^0 45″ to 81^0 5″ E. The peaks and valleys of Kumaun Himalaya were well known in ancient times as the abode of Gods and Goddesses and source of the Ganga River. The rivers originating from the Kumaun Himalaya are perfect for water sports with variety of flora and fauna. The Goriganga river originates from Milam glacier (3600 MSL) just north east of Nanda Devi. Zooplankton are microscopic free swimming heterogeneous assemblage of minute floating animal forms found in aquatic ecosystems, are represented by wide array of taxonomic groups *(protozoa, rotifer, cladocera, crustaceansan and copepods).* Fresh water zooplankton constitute an important component of secondary production in aquatic ecosystem that play a key role in energy transfer from primary to higher level in the ecosystem. All the secondary production in aquatic ecosystems directly and indirectly relies on zooplankton. They are located in the pelagic zone of ponds, lakes, rivers and oceans where light penetrates. The zooplankton community composition and structure is affected by eutrophication, these communities can also be used as the indicator of changing trophic status of an aquatic ecosystem. Zooplanktons have long been used as indicators of the eutrophication[1,2]. Various ecological aspects of zooplankton have been a subject of study by several workers in India during the last fifty years[3-6]. Like other biotic factors, the diversity and population dynamics of zooplankton have been studies by many workers[7-9]. The diversity and density of zooplankton is mainly controlled by availability of food as favorable water quality[10]. The zooplankton exhibit significant role in secondary production in the aquatic ecosystem, therefore a wide variety of works on plankton has been made[11-16]. Although a few recent literature on diversity of zooplankton has been consulted[17-26].The zooplankton assemblage of Goriganga river forms an important link in food chain and food web operating in an aquatic ecosystem. Therefore, a study on qualitative estimation of zooplankton fauna is the basic step to estimate quality status of an aquatic ecosystem. There is no literature at all on the diversity of zooplankton in Goriganga River. With this view in background, a study was carried out to identify zooplanktonic fauna of Goriganga River qualitatively.

Material and Methods

After the preliminary survey of Goriganga river, three sampling stations were selected figure-1, which are stretched in a river stretch of 44 kms and situated at different altitudes, station-1 Jauljibi (600MSL); station-2 Baram (900MSL) and station-3 Madhkot (1300MSL) for monthly sampling. For zooplankton collection, a fixed volume of water (50.0 ltr.) was filtered in a especially designed plankton nets made of silk bolting cloth no. 25 by scoop net and mesh cloth. The concentrate was then

preserved in 5 % formalin at the collection site. Identification was done in the Zoological laboratories, S. S. J. Campus Almora,. Identification of zooplankton was made from the texts of[27-30].

Index of similarity and dissimilarity: Similarity and dissimilarity index is used to record the similarity and dissimilarity among different taxa collected from the samples of different selected stations[31].

Similarity and dissimilarity index can be determined by the following formulae:

$$S = \frac{2C}{A+B}$$

Where S = similarity index, A = taxa in A sample, B = taxa in B sample, C = taxa common in both the samples, Dissimilarity index = 1 – S, Where S = similarity index.

Results and Discussion

In aquatic ecosystem, zooplankton play critical role as primary consumer . During the course of an extensive survey (from July, 2006 to June, 2008) encompassing the zooplankton diversity of Goriganga river at different spots, analysis of plankton samples collected at monthly intervals revealed the occurrence of 15 genera, belonging to three groups viz. 07 genera (46.66%) to *rotifera* and 04 genera (26.66%) to *protozoa* and *arthropods* each table-1. The *rotifers* were represented by *Philodina, Branchionus, Trichocera, Monostyla, Keratella, Polyarthra* and *Asplanchna*; *prtozoa* by *Centrophyxis, Volvox, Diffugia* and *Arcella* and *arthropoda* by *Daphnia, Cyclops, Bosmina* and *Ceriodaphnia*. It was also noticed in the study that 04 genera of *rotifers* (*Philodina, Branchionus, Polyarthra* and *Asplanchna*); 02 genera of *protozoa* and 02 genera *Arthropoda* (*Daphnia* and *Bosmina*) were encountered commonly at all the sampling stations table-1. Among zooplankton distribution, *rotifers* dominated all the other groups. During both years zooplankton followed the distributional pattern, *rotifers* 07 genera (46.66%) > *protozoa* and *arthropods* 04 genera (26.66%) each. Differential qualitative distributional pattern of *rotifers, protozoa* and *arthropods* at three spots was observed during the course of study. The sequence was spot-1 > spot-2 and spot-3 for *rotifers*, while for *protozoa* it was spot-2 > Spot-1 and spot-3 and for *arthropods* it was spot-1 > spot-2 and spot-3 during 2006-07 and 2007-08, respectively. The data on qualitative estimation of zooplankton are depicted in the tables 1,3,4 and 5. All the genera were found to exhibit marked seasonal and site wise fluctuations in the present study. During first year (2006-07), there were 15 genera at all the sites, spot-1 harboured maximum 14 genera (93.33%), followed by 11 genera (73.33%) at spot-2 and minimum 10 genera (66.66%) at spot-3 were identified with seasonal fluctuations. Among the 14 recorded genera of zooplankton at spot-1 during first year, maximum 07 genera (46.66%) belong to *rotifers*; 04 genera (26.66) to *arthropods* and minimum 03 genera (20.00%) to *protozoa* while at spot-2, among 11 recorded genera of zooplankton 05 genera (33.33%) belong to *rotifers*, 04 genera (26.66%) to *protozoa* and 02 genera (13.33%) to *arthropods* and at spot-3, among 10 recorded genera of zooplankton 05 genera (33.33%) belong to *rotifers*, 03 genera (20.00%) to *protozoa* and 02 genera (13.33%) to *arthropods* at spot-3 table-1. During second year (2007-08), there were 14 genera at spot-1 (07 genera represented by *rotifers*, 04 genera by *arthropods* and 03 by *protozoa*) while spot-2 harboured 13 genera (06 belong to *rotifers*, 04 genera to *protozoa* and 03 to *arthropods*) whereas spot-3 comprised of 12 genera (05 genera were identified as *rotifers*, 03 genera as *protozoa* and *arthropods* each) table-1.

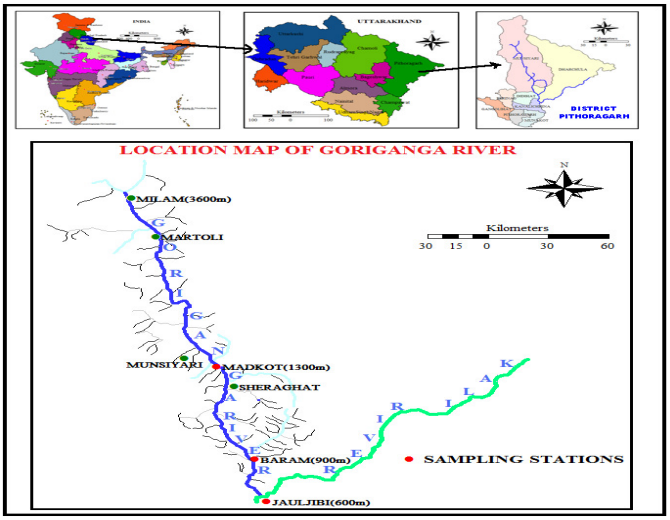

Figure-1
Location map showing the three sampling stations, Jauljibi (600 MSL), Baram (900 MSL) and Madkot (1300 MSL) in the Goriganga river of Kumaun Himalaya

Table-1
Qualitative composition of zooplankton at three spots in the Goriganga river during 2006-07 and 2007-08

	2006-2007			2007-2008		
Genera	**Jauljibi (Spot-1)**	**Baram (Spot-2)**	**Madkot (Spot-3)**	**Jauljibi (Spot-1)**	**Baram (Spot-2)**	**Madkot (Spot-3)**
Protozoa						
Centrophyxis	+	+	-	+	+	-
Volvox	-	+	+	-	+	+
Diffugia	+	+	+	+	+	+
Arcella	+	+	+	+	+	+
Rotifera						
Philodina	+	+	+	+	+	+
Branchionus	+	+	+	+	+	+
Trichocera	+	-	-	+	+	+
Monostyla	+	-	-	+	+	+
Keratella	+	+	+	+	-	-
Polyarthra	+	+	+	+	+	+
Asplanchna	+	+	+	+	+	+
Arthropoda						
Daphnia	+	+	+	+	+	+
Cyclops	+	-	-	+	+	+
Bosmina	+	+	+	+	+	+
Ceriodaphnia	+	-	-	+	-	-
Total	**14**	**11**	**10**	**14**	**13**	**12**
Annual (%)	**93.33%**	**73.33%**	**66.66%**	**93.33%**	**86.66%**	**80.00%**

It was also observed in the study that maximum diversity of zooplankton was recorded at spot-1, Jauljibi and zooplankton diversity increases with the decrease in latitude (i,e. from high altitude to low altitude). The study of second year showed almost same trend of zooplankton genera compositon, except at spot-2 and spot-3, where 13 and 12 genera were present in the study (table 1). An annual qualitative estimation of zooplankton showed that the highest taxa (93.33% and 93.33%) at Jauldibi and the lowest (66.66% and 80.00%) were available at Madkot during 2006-07 and 2007 08, respectively (table 1). Monthly qualitative composition of zooplankton diversity at three spots in the Goriganga river during 2006-07 and 2007-08 has been depicted in the tables 3, 4 and 5. During first year (2006-07), maximum (11) genera of zooplankton were recorded in the month of October followed by January and April (10), November, December and February (09), September (08), March and May (07), July (04) and minimum (03) genera were recorded in the month of August at spot-1 (Jauljibi) table-3 and figure-4; at spot-2 (Baram), the maximum (10) genera were recorded in the month of October followed by November and February (09), December and January (08), September and March (07), April and May (06), July (03) and minimum (02) genera were recorded in the months of August and June table-4 and figure-4, whereas at spot-3 (Madkot), the maximum (08) genera were recorded in the month of December followed by November and January (07), October, March and April (06), February (05), September and May (04), July (03) and minimum (02) genera were recorded in the months of August and June table-5 and figure-4. During second year, (2007-08), the maximum (11) genera were recorded in the month of January followed by October, November and February (10), December (09), September and May (08), March and April (07), August (05) and mimimum (04) genera were recorded in the month of June at spot-1 (Jauljibi) table-3 and figure-5; at spot-2 (Baram), the maximum (10) genera were recorded in the months of November and January followed by October, December and March (08), February, April and May (07), September (05) and minimum (03) genera were recorded in the months of August and May table-4 and figure-5, whereas at spot-3 (Madkot), the maximum (09) genera were recorded in the month November followed by October, Decmber and January (07), February, April and May (05), September and March (04) and minimum (03) genera were recorded in the months of August and June in the present study Table-5 and figure-5.

The similarity index was also applied which indicated that Goriganga river was slightly rich in *rotifers* diversity than the other two groups. On the basis of similarity index it was concluded that maximum similarity was among the *taxa* of *protozoa* (s = 0.58) followed by *rotifers* (s = 0.54) and minimum (s = 0.5) were noticed among the *taxa* of *arthropods* during first year (2006-07) table-2, while during the second year (2007-08), maximum similarity was again among *protozoa* (s = 0.6) followed by *arthropods* (s = 0.6) and minimum similarity was recorded among the texa of *rotifers* (s = 0.54) table-2, figures-2 and 3.

Table-2
Similarity and dissimilarity index of zooplankton in Goriganga river during 2006-07 and 2007-08

Zooplankton	Similarity index		Dissimilarity Index	
	2006-07	2007-08	2006-07	2007-08
Rotifers	0.54	0.54	0.46	0.46
Protozoa	0.58	0.63	0.42	o.37
Arthropoda	0.5	0.6	0.5	0.4

Table-3
Monthly qualitative composition of zooplankton at spot-1 (Jauljibi) in the Groriganga river during 2006-07 and 2007-08

Order/Genera	Monthly qualitative composition of zooplankton at spot-1 (Jauljibi) in the Groriganga river during 2006-07 and 2007-08.																							
	July		Aug		Sept		Oct		Nov		Dec		Jan		Feb		March		Apr		May		Jun	
Protozoa	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II
Centrophyxis	-	-	-	+	+	-	+	+	+	+	-	+	-	+	-	+	+	-	-	-	-	-	-	-
Volvox	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Diffugia	+	-	+	+	+	-	-	-	-	-	+	-	+	-	+	+	-	+	+	+	+	+	-	+
Arcella	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	-	+	-	+	+	-	-
Rotifera																								
Philodina	-	-	-	-	-	-	+	+	+	-	+	-	+	-	-	-	-	+	+	+	-	+	+	-
Branchionus	+	-	-	+	+	-	+	+	-	+	-	+	-	+	-	+	-	+	+	+	+	+	-	-
Trichocera	-	-	-	+	-	+	-	-	-	-	-	-	+	-	-	-	-	+	-	-	+	-	-	-
Monostyla	-	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	-	+	+	-	-	-	+
Keratella	-	-	-	-	-	+	+	+	+	+	+	+	-	+	+	+	+	+	+	-	-	+	-	-
Polyarthra	-	-	-	-	+	-	+	+	+	-	-	+	+	+	-	+	-	-	-	-	-	-	-	-
Asplanchna	-	-	+	+	+	+	+	-	+	+	+	+	+	+	+	+	+	-	+	-	+	-	-	-
Arthropoda																								
Daphnia	-	-	-	+	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Cyclops	+	-	-	-	-	+	+	+	-	+	+	-	+	+	+	-	+	+	+	+	-	+	-	+
Bosmina	+	-	+	-	+	+	+	+	+	+	+	-	-	+	+	+	-	-	+	+	+	+	+	-
Ceriodaphnia	-	-	-	-	+	-	-	-	-	+	-	+	+	+	+	-	-	-	-	-	-	-	-	-
Total	04	0	03	05	08	08	11	10	09	10	09	09	10	11	09	10	07	07	10	07	07	08	03	04
{I = during first year-2006-07; II = during second year-2007-08; + = present and - = absent}																								

Table-4
Monthly qualitative composition of Zooplankton at spot-2 (Baram) in the Groriganga river during 2006-07 and 2007-08

Order/Genera	Monthly qualitative composition of Zooplankton at spot-2 (Baram) in the Groriganga river during 2006-07 and 2007-08.																							
	July		Aug		Sept		Oct		Nov		Dec		Jan		Feb		March		Apr		May		Jun	
Protozoa	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II
Centrophyxis	+	-	+	+	+	+	-	+	+	-	-	-	-	-	-	-	-	+	-	+	-	+	+	+
Volvox	-	-	-	-	-	-	+	-	-	-	+	-	+	-	+	-	-	-	+	-	-	-	-	-
Diffugia	-	-	-	-	+	-	+	+	+	+	+	+	+	+	+	+	+	-	+	-	+	+	-	-
Arcella	-	-	-	-	-	-	+	-	+	+	+	+	-	+	+	+	+	+	+	+	+	-	-	-
Rotifera																								
Philodina	-	-	-	-	-	-	+	-	-	+	+	-	+	+	-	+	-	+	-	+	-	+	+	+
Branchionus	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	-	+	+	+	+	+	+	-	-
Trichocera	-	-	-	-	-	+	-	-	-	-	-	-	-	+	-	-	-	+	-	-	-	-	-	-
Monostyla	-	-	-	-	-	-	-	+	-	+	-	-	-	+	-	+	-	-	-	-	-	-	-	-
Keratella	+	-	-	--	+	-	+	-	+	-	-	-	+	-	+	-	+	-	+	-	+	-	-	-
Polyarthra	-	-	-	-	-	-	+	+	+	+	-	+	-	-	+	-	-	+	-	+	-	-	-	-
Asplanchna	-	-	-	-	+	-	+	+	+	+	+	+	+	+	+	+	+	-	-	-	+	+	-	-
Arthropoda																								
Daphnia	-	-	-	-	+	-	+	-	+	+	+	+	+	+	+	-	+	+	-	+	-	+	-	+
Cyclops	-	-	-	-	-	+	-	+	-	+	-	+	-	+	-	+	-	-	-	-	-	-	-	-
Bosmina	+	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	-
Ceriodaphnia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	03	0	02	03	07	05	10	08	09	10	08	08	08	10	09	07	07	08	06	07	06	07	02	03
{I = during first year-2006-07; II = during second year-2007-08; + = present and - = absent}																								

Table-5
Monthly qualitative composition of Zooplankton at spot-3 (Madkot) in the Groriganga river during 2006-07 and 2007-08

Order/Genera	Monthly qualitative composition of Zooplankton at spot-3 (Madkot) in the Groriganga river during 2006-07 and 2007-08																							
	July		Aug		Sept		Oct		Nov		Dec		Jan		Feb		March		Apr		May		Jun	
Protozoa	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II
Centrophyxis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Volvox	+	-	+	+	+	+	-	-	-	-	+	-	-	+	-	+	-	-	-	-	-	-	-	-
Diffugia	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	-	+	-	+	-	-	-	-	+
Arcella	-	-	-	-	-	-	+	-	+	+	+	+	+	-	-	-	+	+	+	+	+	+	-	-
Rotifera																								
Philodina	-	-	-	-	-	-	-	+	+	+	+	-	-	-	+	-	-	-	-	+	-	+	-	+
Branchionus	-	-	-	-	+	+	+	+	+	-	+	+	+	+	+	+	+	+	+	-	+	-	-	-
Trichocera	-	-	-	-	-	-	-	-	-	+	-	+	-	+	-	-	-	-	-	-	-	-	-	-
Monostyla	-	-	-	-	-	-	-	-	-	+	-	+	-	+	-	-	-	-	-	-	-	+	-	-
Keratella	-	-	-	-	-	-	-	-	+	-	+	-	+	-	-	-	+	-	+	-	+	-	-	-
Polyarthra	-	-	-	+	-	-	-		-	+	-	-	+	-	-	-	-	-	-	-	-	-	-	-
Asplanchna	-	-	-		-	+	+	+	+	+	+	+	-	+	+	+	+	+	+	-	-	-	-	-
Arthropoda																								
Daphnia	+	-	+	+	+	+	+	+	-	-	-	-	+	+	+	-	-	+	+	+	+	+	+	+
Cyclops	-	-	-	-	-	-	-	+	-	+	-	-	-	+	-	+	-	-	-	+	-	-	-	-
Bosmina	+	-	-	-	+	-	+	+	+	+	+	+	+	-	-	+	+	-	-	+	-	+	+	-
Ceriodaphnia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	03	0	02	03	04	04	06	07	07	09	08	07	07	07	05	05	06	04	06	05	04	05	02	03
{I = during first year-2006-07; II = during second year-2007-08; + = present and - = absent}																								

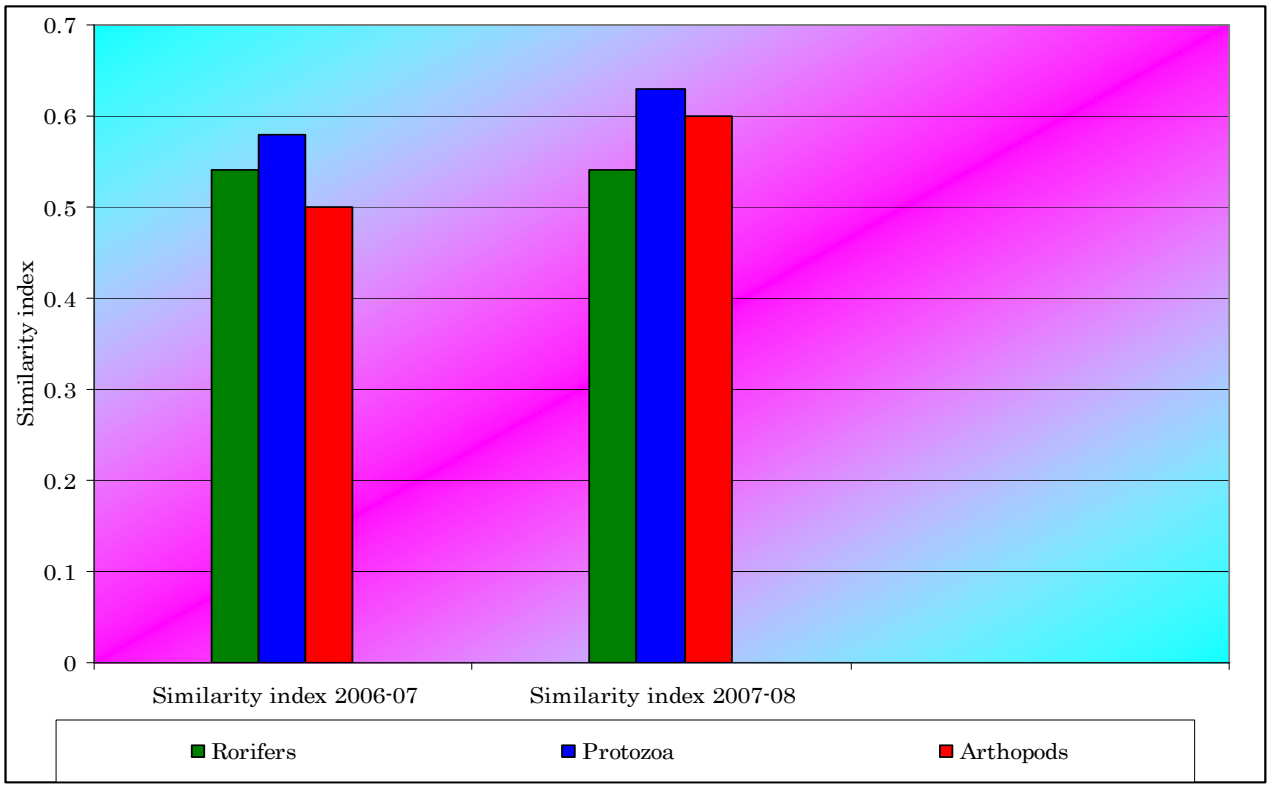

Figure-2
Similarity index among different groups of zooplankton (*rotifers, protozoa and arthropods)* in the Goriganga river during 2006-07 and 2007-08

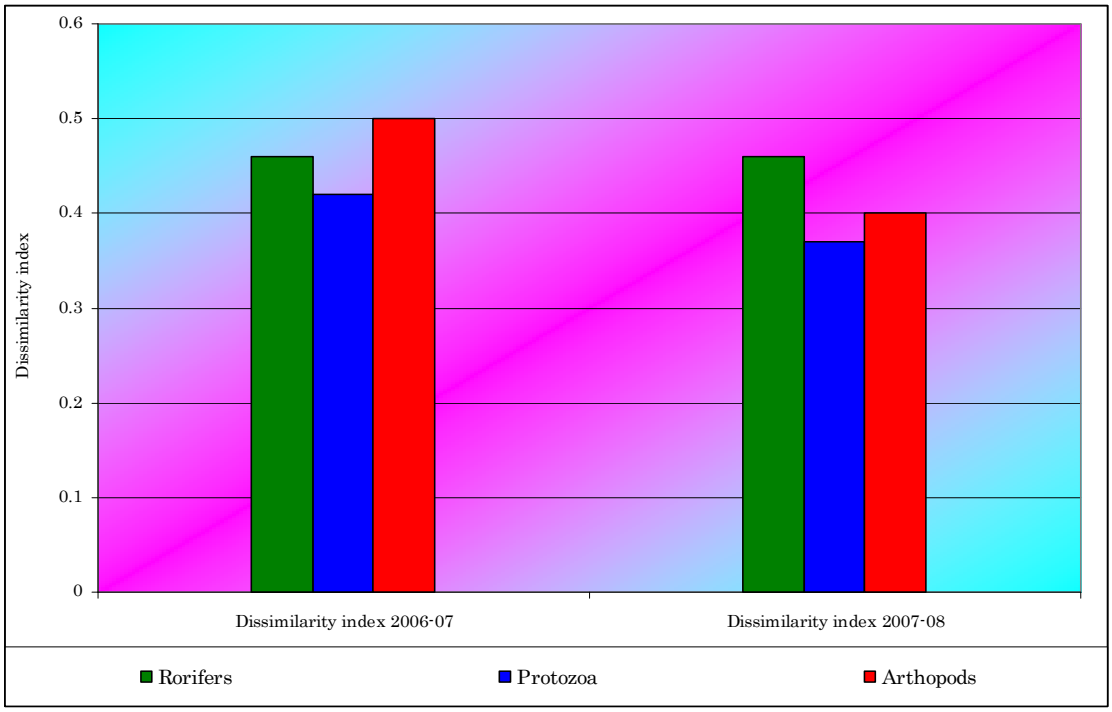

Figure-3
Dissimilarity index among different groups of zooplankton (*rotifers, protozoa and arthropods*) in the Goriganga river during 2006-07 and 2007-08

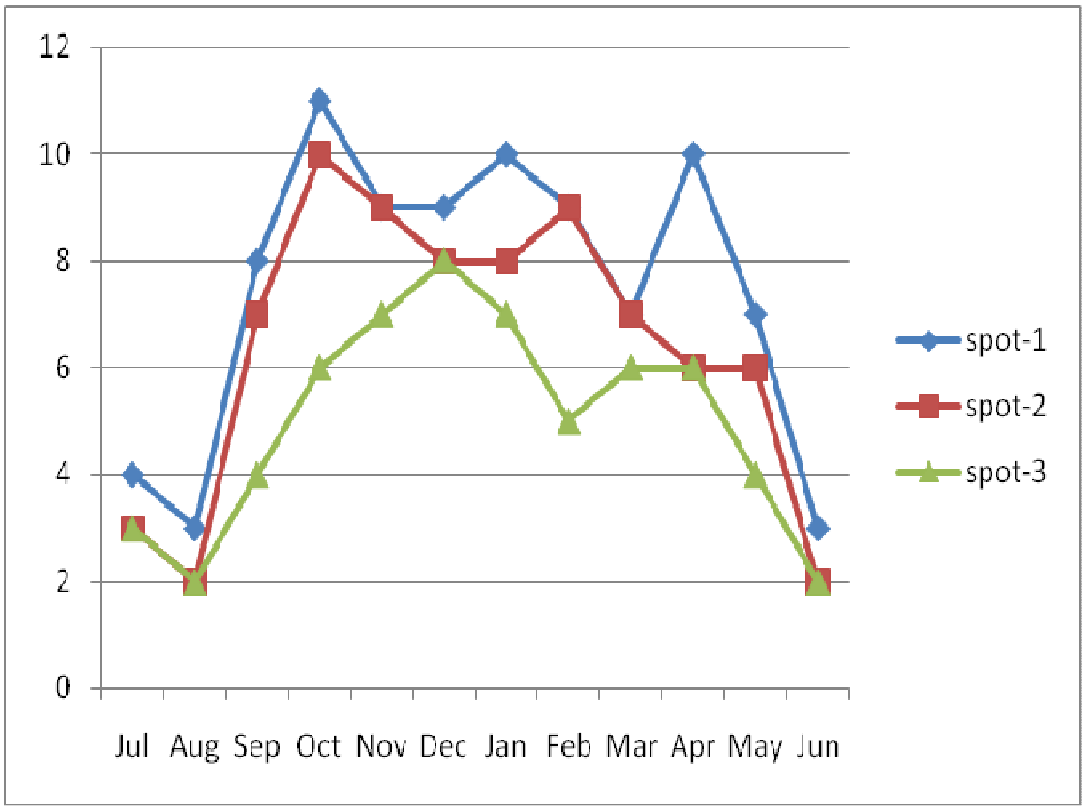

Figure-4
Monthly variations of zooplankton diversity at three selected stations dur ing the year 2006-07

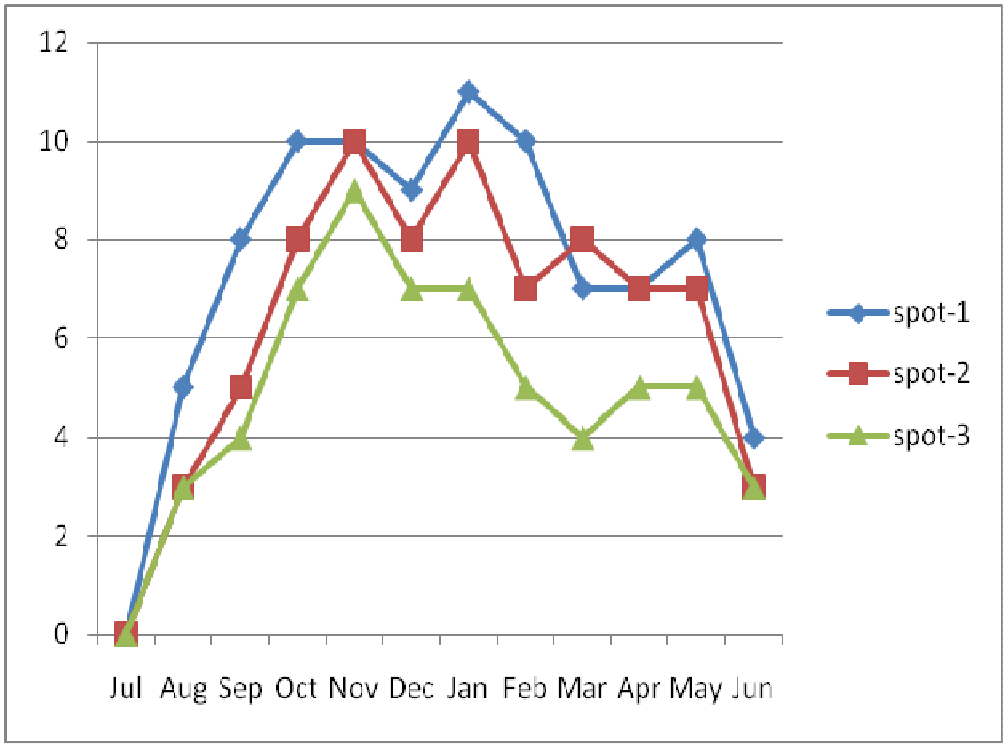

Figure-5
Monthly variations of zooplankton diversity at three selected stations during the year 2007-08

Conclusion

The present study would give preliminary knowledge on the diversity of zooplankton and reasons for variations at different sampling stations. In the present investigation the composition of zooplankton species during July, 2006 to June, 2008 it was *rotifera* 46.66%, *protozoa* and *arthopoda* 26.66% each. Among all the species of zooplankton rotifer is dominating. In the present study, it was concluded that diversity of zooplankton increases with the decrease in latitude (i.e. from high altitude to low altitude) and maximum similarity were observed among the texa of of *protozoa* during both years.

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