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Studies of Zooplankton in Chhapakaiya pond Birgunj, Nepal

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Abstract

Zooplankton are the major trophic link in food chain and being heterotrophic organisms it plays a key role in cycling of organic materials in aquatic ecosystem. In present study, the population density and diversity of zooplanktons are carried out to contribute further knowledge about the planktonic population of Chhapakaiya pond Birgunj, Nepal by standard methods. In total 27 species of zooplankton belonging to three taxonomic groups were observed in the pond. Out of 27 species, 8 species belonged to Protozoa, 11 species to Rotifera and 8 species to Arthropoda. Seasonal sampling from four sampling sites (site A, B, C, D) in winter, summer and rainy season for period of 12 months (November 2015 – October 2016) at 9:00-11:00 AM. A total of 27 taxa from different classes of zooplankton were reported. The zooplanktons were reported to be maximum (788.5 unit/L) during summer and minimum (552.75 unit/L) during rainy season in Chhapakaiya pond.

Keywords: Zooplankton; Biological productivity; Habitat degradation.

Introduction

Water is an essential component like other biotic components (air and soil) for sustenance of life and to maintain ecological process of the bio-system. The world's thirst for water is likely to become one of the most pressing resource issues of the 21st Century. Biological assessment is a significant alternative for assessing the ecological quality of aquatic ecosystems since biological communities integrate the environmental effects of water chemistry of rivers and hill streams (Stevenson and Pan, 1999). Plankton encountered in the water body reflects existed ecological characteristics and therefore, plankton organisms may be used as indicators of water quality (Bhatt *et al.*, 1999; Saha *et al.*, 2000). In hill streams, a great variation in the composition of plankton occurred not only in different regions on different depths but also at different periodically time scales and seasons. The conditions that lead to maxima and minima, as well as to minor fluctuations in abundance of phytoplankton are complex in their physical, chemical and biological characteristics. A considerable amount of research work has been done in

different fresh water bodies in relation to phytoplankton (Calijuri *et al.*, 2002; Angadi *et al.*, 2005).

Zooplankton are the major trophic link in food chain and being heterotrophic organisms it plays a key role in cycling of organic materials in aquatic ecosystem. In addition, their diversity has assumed added importance during recent years due to the ability of certain species to indicate the deterioration in the quality of water caused by pollution or eutrophication. Monitoring the zooplankton as biological indicators could act as forewarning, when pollution affects food chain (Mahajan, 1981; Kapoor, 2015). The zooplankton communities, very sensitive to environmental modifications, are important indicators for evaluating the ecological status of these ecosystems (Magadza, 1994). They do not only form an integral part of the lentic community but also contribute significantly, the biological productivity of the fresh water ecosystem (Wetzel, 2001).

In present study, the population density and diversity of zooplanktons are carried out to contribute further knowledge about the planktonic population of Chhapakaiya pond Birgunj, Nepal.

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Materials and Methods

Collection of Water Samples and Planktons

Water samples were collected in a routine manner from all sampling stations. One liter polythene wide mouthed bottles were used for collecting water samples. Seasonal collection of water samples were made at intervals extending over a period of one year from the different sampling sites (site A road sites south, site B temple sites, site C resident sites and site D road and resident sites north) with assistance of local people/fishermen. Particular attention was given in rainy period.

The zooplanktons are examined were mostly in fresh water samples while some times in fixed conditions also. Pertinent extant literature was also conducted before preparing the list.

Biological Analysis

Zooplanktons were collected along with water samples. For qualitative and quantitatively studies, plankton samples were collected by standard plankton net made of bolting silk No. 14 (120) and 25 (64).

Zooplankton

Zooplanktons were quantitatively estimated by filtering 100 liters of water from the surface through t40 HD silk bolting cloth having 100mesh/cm. The samples concentrated to 100 ml were preserved in 5 percent buffered formalin. Before counting the samples were thoroughly mixed by rotating the bottle. Sub samples were taken in triplicate on Rafter cells using a volumetric pipette. The complete area of the slide was counted from the three samples to give average number per 100 liters. The systematic identification of zooplankton was done by using standard literature books like Edmondson (1961), Pennak (1978), Tonapi (1980), Sehgal (1983), Mchael and Sharma (1988) and APHA (1989).

Zooplankton study was made by collecting 100 liters of water and filtering it through a bolting silk (200 mesh per

linear inch) net and the concentrate was preserved in 5% formalin solution. Zooplankton count was made with "Sedgwick-Rafter Counting Cell" under a research binocular microscope. The qualitative analysis was done by identifying the zooplankton as per "Standard Methods". Details of zooplankton structure were clarified by according Needham and Needham. The quantity of the zooplankton was calculated with help of following formula:

$$n = \frac{ac}{l}$$

Where,

n = number of the plankton per liter of the original water.

a = average number of plankton in all counts in counting unit of 1 mm³ capacity.

c = volume of the original concentration in cm³.

l = volume of the original water expressed in litre.

Statistical Analysis

The data obtained were tabulated, graphically presented and subjected to statistical analysis using the computerized program (Graph Pad Prism 7.01) simple means, standard deviation and persons corelation have been done by softwarwe and all results were found significant (p>0.05).

Results

Seasonal sampling of zooplankton was done at four sites of the Chhapakaiya pond Birgunj, Nepal for one year (2015-2016). Average density of each species of zooplankton was determined for winter, summer and rainy seasons. In total 27 species of zooplankton belonging to three taxonomic groups were observed in the pond. Out of 27 species, 8 species belonged to Protozoa, 11 species to Rotifera and 8 species to Arthropoda (Table 1).

Table 1: Number of species in different groups of zooplanktons.

Phylum	Group	Genera	Species	Percentage of species
Protozoa	Rhizopoda	03	03	11.1%
	Mastigophora	01	02	7.4%
	Ciliata	03	03	11.1%
Rotifera	Rotifera	08	11	40.7%
Arthropoda	Cladocera	04	04	14.8%
	Copepoda	03	03	11.1%
	Ostracoda	01	01	3.7%

The average density of zooplankton observed at four sites of Chhapkaiya pond during winter season (2015-2016) are presented on Table 2. Maximum average density of 31.00 org/L was observed for *Diffusia* sp. Among the Protozoa, *Amoeba* sp. Exhibited minimum density of 8.75org/L. Most of the species exhibited higher density at site 'A' followed by site 'C', site 'D', and site 'B'. The average density of protozoans was recorded 119.25 org/L during winter seasons.

Out of 11 species of Rotifera, *Lecone aculiata* sp. exhibited higher density of 39.75 org/L, followed by *keratella* sp. (33.5 org/L) *Brachionus quadridentatus*. (32.5org/L), *rotaria sp longiseta* (31.5org/L), *filinia* sp. (28.5 org/L), *B.caudatus patulus* (28.25 org/L) and *Brachionus ruben* (25.00org/L). The average minimum density was noted for *trichocerca* similes. (15.0org/L). The average density of

rotifers observed 217.3 org/L during the winter season of study period.

Among the four species of Cladocera, *Basmina* sp. exhibited the higher density of 32.25 org/L whereas, the minimum density (23.5org/L) was obtained for *Daphnia* sp. The higher density of cladocerans was observed at site 'A' (144.0 org/L) followed by 'C' (120.0 org/L), 'D' (111.0 org/L) and site 'B' (83.0 org/L) during winter season.

Naupliularvae sp. ranked first among the members of Copepoda with higher average density of 38.75 org/L, followed by *Cyclops* sp. 28.25. org/L) and *Gammarus* sp (24.50 org/L). Most of the species of Copepoda showed higher density at site 'A' and site 'C' Ostracoda was observed by a single species, *Cypris* sp. with an average density of 28.75 org/L during winter season.

Table-2: Total density of zooplankton (org/L) at four sites of Chhapkaiya Pond, Birgunj during winter season (2015-2016).

Name of species	Site A	Site B	Site C	Site D	Avg.Density
Group –I Protozoa					
<i>Amoeba</i> sp.	13	4	10	8	8.75
<i>Englypha</i> sp.	18	9	15	11	13.25
<i>Diffusia</i> sp.	36	27	33	28	31
<i>Euglena spirogyra</i>	20	9	16	13	14.5
<i>Egracilis</i>	17	6	14	11	12
<i>Paramecium</i> sp.	15	8	14	12	12.25
<i>Vorticella companula</i>	13	10	12	11	11.5
<i>Epistylis anastica</i>	21	12	17	14	16
Total	153	85	131	108	119.25
Group-II Rotifera					
<i>Monostyla</i> sp.	30	13	29	27	24.75
<i>Keratella</i> sp.	38	25	38	33	33.5
<i>Brachionus quadridentatus</i>	37	30	32	31	32.5
<i>B.Patulus</i>	28	17	21	20	21.5
<i>B.rubens</i>	33	17	30	20	25
<i>B.Caudatus</i>	39	22	31	21	28.25
<i>Filinia longiseta</i>	37	19	30	28	28.5
<i>Lecone aculiata</i>	45	33	42	39	39.75
<i>Polyarthra</i> sp.	25	16	20	19	20
<i>Rotaria</i> sp.	39	22	37	28	31.5
<i>Trichocerca similes</i>	22	11	16	11	15
Total	373	225	326	277	300.25
Group-III Cladocera					
<i>Alona</i> sp.	30	23	28	28	27.25
<i>Basmina</i> sp.	40	21	36	32	32.25
<i>Daphnia</i> sp.	32	16	24	22	23.5
<i>Moina</i> sp.	42	23	32	29	31.5
Total	144	83	120	111	114.5
Group – IV Copepoda					
<i>Cyclops</i> sp.	37	20	30	26	28.25
<i>Gammararus</i> sp.	31	19	26	22	24.5
<i>Nauplius Larvae</i>	48	26	46	35	38.75
Total	116	65	102	83	91.5
Group – V Ostracoda					
<i>Cypris</i> sp.	36	22	29	28	28.75
Total Zooplankton	822	480	708	607	654.25

During the winter season of second year of study period, the total average density of zooplankton was noted 654.25 org/L. Rotifera appeared as the dominant group with higher average density of 300.25 org/L, followed by Protozoa (119.25 org/L), Cladocera (114.50org/L), Copepoda (91.50 org/L) and Ostracoda (28.75 org/L). Members of all five groups of zooplankton were dominated at site 'A' (822.0 org/L) and site 'C' (708.0 org/L). Comparatively lesser density was recorded for all groups at site 'B' (480.0 org/L).

Average density of each zooplankton observed at different sites of Chhapakaiya pond during summer season of 2015-2016 are given in Table 3. Similar trends are also observed in case of summer season Table 3. Total density of zooplankton (org/L) at four sites of Chhapakaiya Pond, Birgunj during rainy season (2015-2016) is shown in Table 4.

Table-3: Total density of zooplankton (org/L) at four sites of Chhapakaiya Pond, Birgunj during summer season (2015-2016).

Name of species	Site A	Site B	Site C	Site D	Avg.Density
Group –I Protozoa					
<i>Amoeba sp.</i>	18	4	16	8	11.5
<i>Englypha sp.</i>	17	8	10	8	10.75
<i>Diffusia sp.</i>	33	18	26	21	24.5
<i>Euglena spirogyra</i>	27	6	19	11	15.75
<i>Egracilis</i>	28	9	20	12	17.25
<i>Paramecium sp.</i>	18	4	17	8	11.75
<i>Vorticella companula</i>	18	5	12	9	11
<i>Epistylis anastica</i>	17	8	11	11	11.75
Total	176	62	131	88	114.25
Group-II Rotifera					
<i>Monostyla sp.</i>	45	29	43	41	39.5
<i>Keratella sp.</i>	16	42	52	49	39.75
<i>Brachionus quadridentatus</i>	57	38	53	52	50
<i>B.Patulus</i>	37	25	38	33	33.25
<i>B.rubens</i>	29	18	25	21	23.25
<i>B.Caudatus</i>	36	17	33	27	28.25
<i>Filinia longiseta</i>	39	23	33	30	31.25
<i>Lecone aculiata</i>	58	33	50	43	46
<i>Polyarthra sp.</i>	35	19	29	27	27.5
<i>Rotaria sp.</i>	41	18	38	31	32
<i>Trichocerca similes</i>	47	22	32	25	31.5
Total	440	284	426	379	382.25
Group-III Cladocera					
<i>Alona sp.</i>	39	28	37	35	34.75
<i>Basmina sp.</i>	44	26	37	33	35
<i>Daphnia sp.</i>	58	32	50	42	45.5
<i>Moina sp.</i>	35	26	30	26	29.25
Total	176	112	154	136	144.5
Group – IV Copepoda					
<i>Cyclops sp.</i>	48	33	41	40	40.5
<i>Gammarus sp.</i>	34	17	32	28	27.75
<i>Nauplius Larvae</i>	60	40	56	52	52
Total	142	90	129	120	120.25
Group – V Ostracoda					
<i>Cypris sp.</i>	35	19	29	26	27.25
Total Zooplankton	969	567	869	749	788.5

Table-4: Total density of zooplankton (org/L) at four sites of Chhapkaiya Pond, Birgunj during rainy season (2015-2016).

Name of species	Site A	Site B	Site C	Site D	Avg.Density
Group –I Protozoa					
<i>Amoeba sp.</i>	13	7	10	9	9.75
<i>Englypha sp.</i>	10	8	9	10	9.25
<i>Diffusia sp.</i>	37	28	33	32	32.5
<i>Euglena spirogyra</i>	23	12	17	13	16.25
<i>Egracilis</i>	20	11	16	14	15.25
<i>Paramecium sp.</i>	19	8	15	13	13.75
<i>Vorticella companula</i>	26	11	18	17	18
<i>Epistylis anastica</i>	30	19	26	23	24.5
Total	178	104	144	131	139.25
Group-II Rotifera					
<i>Monostyla sp.</i>	27	12	17	12	17
<i>Keratella sp.</i>	36	22	30	23	27.75
<i>Brachionus quadridentatus</i>	32	18	30	28	27
<i>B.Patulus</i>	28	17	28	26	24.75
<i>B.rubens</i>	18	10	16	11	13.75
<i>B.Caudatus</i>	21	16	19	15	17.75
<i>Filinia longiseta</i>	25	13	22	20	20
<i>Lecone aculiata</i>	34	22	30	28	28.5
<i>Polyarthra sp.</i>	18	13	17	13	15.25
<i>Rotaria sp.</i>	23	11	20	16	17.5
<i>Trichocerca similes</i>	27	9	22	16	18.5
Total	289	163	251	208	227.75
Group-III Cladocera					
<i>Alona sp.</i>	27	14	21	18	20
<i>Basmina sp.</i>	36	22	36	32	31.5
<i>Daphnia sp.</i>	35	23	30	26	28.5
<i>Moina sp.</i>	30	13	28	20	22.75
Total	128	72	115	96	102.75
Group – IV Copepoda					
<i>Cyclops sp.</i>	37	22	29	26	28.5
<i>Gammararus sp.</i>	32	22	26	23	25.75
<i>Nauplius Larvae</i>	23	12	16	15	16.5
Total	92	56	71	64	70.75
Group – V Ostracoda					
<i>Cypris sp.</i>	16	5	15	13	12.25
Total Zooplankton	703	400	596	512	552.75

Discussion

Zooplankton constitutes an important source of food for fishes and benthic macro-invertebrates. These form an integral part of the lotic community and significantly contribute to the fresh water. The most influential factors which affect zooplankton abundance are those which affecting transport of organisms from source areas to the pond and the reproduction and growth of organisms (Hynes, 1970; Kapoor, 2015). Greenberg (1964) observed that plankton density increased due to their ability to grow and reproduce and also depends upon the flow regime. A total of 27 species comprising 11 rotifers, 8 protozoans, 4 cladocerans, 3 copepods and 1 Ostracods have been

observed in the Chhapkaiya pond Birgunj, Nepal during present investigation. Among the five major groups, rotifers showed numerical superiority over the other groups of zooplankton. This group has not only shown the more number of species but also contributed maximum to the total density of zooplankton. *Brachionus quadridentatus*, *B. patulus*, *Lecane aculiata*, *Keratella sp.* and *Monostyla sp.* were contributed the main bulk of rotifers. They were found abundant during all the season.

Rotifers exhibit high turnover rates in nature. According to Adoni (1975), Gannon and Stemberger (1978) the density of rotifers as well as their diversity increases due to increase in eutrophication. Chaurasia (1996) reported that the

density of rotifers and their species diversity is highest in eutrophic conditions. Hutchinson (1967) observed that family *Brachionidae* is of great importance in planktonic community which are found in slight to high alkaline water. Shrivastava (1989) observed the dominance of rotifers in summer. Bhowmic (1968), Bilgrami and Datta Munshi (1985) and Sharma (1992) reported the increasement of zooplankton diversity during summer due to high photosynthetic activity and nutrient concentration.

Microplanktonic group Crustacean, Cladocerans and Copepods are widely distributed in Nepal. Sometimes, Ostracodes inhabit the weed flora and contribute to the planktonic collections. In the present studies 4 species of Cladocerans were investigated for their density namely *Alona* sp., *Bosmina* sp., *Daphnia* sp. and *Moina* sp. were recorded in maximum quantities in most sites of Chhapakaiya pond Birgunj, Nepal. Sreenivasan *et al.*, (1979) and Unni (1996) reported the domination of *Moina* sp. in Ganga and Narmada rivers respectively. Chakraborty *et al.*, (1959) reported *Alona* and *Bosmina* as the most dominant genera in the river Yamuna. Ray *et al.*, (1966) also observed dominance of *Alona* and *Moina* in Jamuna and Ganga. During present investigation copepods were represented by 3 species namely *Cyclops* sp., *Gammarus* sp. and Nauplius larvae. Nauplius larvae show maximum density among the member of Copepoda during most seasons. Verma *et al.* (1984) and Unni (1996) observed that *Cyclops* and *Nauplius* were sensitive to pollution and increase with an increase in nutrients. Ostracoda is represented by a single species, *Cypris* sp. and formed a minor zooplankton component. Verma *et al.* (1984) observed that ostracods generally decrease with an increase in pollution.

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