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Study of Zooplankton Diversity of Chhapakaiya Pond Birgunj, Nepal

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ABSTRACT- Fresh water resources are not unlimited. The highest rate of increase of the human population of Nepal and the rapid rate of industrialization have created problems of disposal of waste water products. The domestic wastes, excretory materials of both human and animals and industrial effluents are discharged into the nearly lakes, rivers, reservoirs and tanks and even in the catchment area of the above water bodies. The undesirable substances are regularly mixed into the water of the pond through surface run-off that degrades the water quality. Since, the last several years, there have been added an array of agricultural pesticides and insecticides, which are further seriously aggravating the problem of pollution both for public health and aquaculture. The detailed information on water quality and status of affected living organisms of water bodies are necessary for the implementation of any management plan. The present investigation encompasses on plankton identifying the ecological quality of Chhapakaiya pond Birgunj, Nepal. Seasonal sampling from all the sampling sites (site A, B, C, D) in winter, summer and rainy season for a period of 12 months (November 2014–October 2015) at 9:00-11: 00 AM. A total of 27 taxa from different classes of zooplankton were reported. The zooplanktons were reported to be maximized (774.4 unit/L) during summer and the minimum (539.2 unit/L) during the rainy season in Chhapakaiya pond

Key-words- Zooplankton, Biological productivity, Habitat degradation

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INTRODUCTION

Water is an essential component like other biotic components (air and soil) for the sustenance of life and to maintain an ecological process of the bio-system. The world's thirst for water is likely to become one of the most pressing resign 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 [1]. Plankton encountered in the water body reflects existed ecological characteristics and therefore, plankton organisms may be used as indicators of water quality [2]. 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.

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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 [3,4].

Zooplankton is the major trophic link in a food chain and being heterotrophic organisms it plays a key role in the cycling of organic materials in an 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 a forewarning, when pollution affects food chain [5,6]. The zooplankton communities, very sensitive to environmental modifications, are important indicators for evaluating the ecological status of these ecosystems [16]. They do not only form an integral part of the lentic community but also contribute significantly, the biological productivity of the fresh water ecosystem [7].

In the 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.

MATERIALS AND METHODS

Collection of water samples and planktons

Water samples were collected in a routine manner from all sampling stations i.e. site A, site B, site C, and site D. One liter polythene wide mouthed bottles were used for collecting water samples. A seasonal collection of water samples was 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 an assistance of local people/fishermen. Particular attention was given in the rainy periods.

The zooplanktons were 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 quantitative studies, plankton samples were collected from standard plankton net made by bolting silk No. 14 (120) and 25 (64).

Zooplankton

Zooplanktons were quantitatively estimated by filtering 100 liters of water from the surface through 40 HD silk bolting cloth having 100mesh/cm. The samples concentrated to 100 mL were preserved in 5 % buffered formalin. Before counting the samples were throughly mixed by rotating the bottle. Subs maples were taken in triplicate to 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 [9], Pennak [10], Tonapi [11], Sehgal [12], Mchael and Sharma [13], and APHA [14].

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 the help of following formula:

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

Where,

n = number of the plankton per litre of the original water

a = average number of plankton in all counts in counting unit of $1mm^3$ capacity

c = volume of the original concentration in cm^3

l = volume of the original water expressed in litre

STATISTICAL ANALYSIS

The data obtained were tabulated, graphically represented and subjected to statistical analysis using the computerized program (Graph Pad Prism 7.01). Simple means, standard deviations and Pearson's correlation have been done by the software 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 (2014-2015). The 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 the 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	Spps.	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%
	Cladocera	04	04	14.8%
Arthropoda	Copepoda	03	03	11.1%
	Ostracoda	01	01	3.7%
Total	07	23	27	100%

Winter season

The average density of zooplankton observed at four sites of the Chhapakaiya pond during winter season (2014-2015) are presented in Table 2. Maximum average density of 33.75org/L was observed for *Diffusia* sp. Among the Protozoa, *Amoeba* sp. Exhibited minimum density of 9.5org/L. Most of the species exhibited higher density on site 'A' followed by site 'C', site 'D', and site 'B'. The average density of protozoans was recorded 129.25 org/L during winter seasons.

Table 2: Density of zooplankton (org/L) at four different sites of Chhapakaiya pond Birgunj, Nepa during winter season (2014-15)

Name of species	Site-A	Site-B	Site-C	Side-D	Avg. density
Group- I Protozoa					
Amoeba sp.	16	7	10	5	9.5
Englypha sp.	19	7	15	13	13.5
Diffusia sp.	37	29	32	37	33.75
Euglena spirogyra	18	9	10	8	11.25
E. gracilis	23	6	19	17	16.25
Paramecium sp.	22	7	20	12	15.25
Vorticella companula	22	13	14	10	14.75
Epistylis anastica	24	6	18	12	15.00
Total	**191.0**	**84.0**	**138.0**	**114.0**	**129.25**
Group-II Rotifera					
Monostyla sp.	40	26	33	28	31.7
Keratella sp.	39	23	37	31	32.5
Brachionus quadridentatus	35	21	33	26	28.7
B. Patulus	32	17	29	23	25.2
B. rubens	25	21	23	22	22.7
B. caudatus	36	22	28	27	28.2
Filinia longiseta	40	16	26	17	24.7
Lecane aculiata	21	13	19	17	17.5
Polyarthra sp.	37	19	29	26	27.7
Rotaria sp.	23	13	17	15	17.0
Trichocerca similes	24	14	17	16	17.8
Total	**352.0**	**205.0**	**239.0**	**202.0**	**217.3**
Group-III Cladocera					
Alona sp.	38	19	29	26	28.0
Basmina sp.	39	24	37	33	33.2
Daphnia sp.	43	30	41	40	38.5
Moina sp.	35	27	29	28	29.7
Total	**155.0**	**100.0**	**136.0**	**127.0**	**126.5**
Group- IV Copepoda					
Cyclops sp.	38	26	35	27	31.5
Gammarus sp.	43	22	37	26	32.0
Nauplius larvae	41	22	35	26	31.0
Total	**122.0**	**70.0**	**105.0**	**79.0**	**92.5**
Group-V Ostracoda *Cypris* sp.	43	26	35	31	33.7
Total	**863.0**	**485.0**	**653.0**	**557.0**	**598.8**

Out of 11 species of Rotifera, *Keratella* sp. Exhibited a higher density of 32.5 org/L followed by *Monostyla* sp. (31.7org/L) *Brachionus quadridentatus.* (28.7org/L), *Filinia longiseta* (24.7org/L), *Rotaria* sp. (17.0 org/L), *Brachionus patulus* (28.7 org/L) and *Brachionus ruben* (27.7 org/L). The average minimum density was noted for *Rotaria* sp. (17.0org/L). The average density of rotifers observed 217.3 org/L during the winter season of the study period.

Among the four species of Cladocera, *Daphnia* sp. exhibited the higher density of 38.5 org/L whereas, the minimum density (28.0org/L) was obtained for *Alona* sp. The highest density of cladocerans was observed at the site 'A' (155.0 org/L) followed by 'B' (136.0 org/L), 'D' (127.0 org/L) and site 'B' (100.0 org/L) during winter season.

Gammarus sp. ranked first among the members of Copepoda with higher average density of 32.0 org/L, followed by *Cyclops* sp. (31.5 org/L) and *Nauplius larvae* (31.0 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 33.7 org/L during winter season.

During the winter season of the first year of the study period, the total average density of zooplankton was noted 598.8 org/L. Rotifera appeared as the dominant group with higher average density of 217.3 org/L, followed by Cladocera (126.5 org/L), Protozoa (129.25 org/L), Copepoda (92.5 org/L) and Ostracoda (33.7

org/L). Members of all five groups of zooplankton were dominated at site 'A' (863.0 org/L) and site 'C' (653.0 org/L). Comparatively lesser density was recorded in all groups at site 'B' (485.0 org/L).

Summer season

The average density of each zooplankton observed at different sites of the Chhapakaiya pond during summer season of 2014-2015 in given in Table 3. Similar trends are also observed in the case of summer season in Table 3.

Table 3: Density of zooplankton (org/L) at four sites of Chhapakaiya pond Birgunj, Nepal during summer season (2014-15)

Name of species	Site-A	Site-B	Site-C	Side-D	Avg. density
Group-I Protozoa					
Amoeba sp.	7	3	6	5	5.2
Englypha sp.	19	5	17	10	12.7
Diffusia sp.	32	13	27	26	24.5
Euglena spirogyra	16	6	10	7	9.75
E. gracilis	25	5	18	14	15.5
Paramecium sp.	19	6	18	9	13.0
Vorticella companula	28	7	20	8	15.7
Epistylis anastica	22	9	19	10	15.0
Total	**168.0**	**54.0**	**135.0**	**89.0**	**108.5**
Group-II Rotifera					
Monostyla sp.	49	34	46	39	42.0
Keratella sp.	58	25	47	36	41.5
Brachionus quadridentatus	62	36	56	42	49.0
B. Patulus	34	23	29	27	28.2
B. rubens	39	27	26	29	32.7
B. caudatus	43	26	36	31	34.0
Filinia longiseta	40	15	29	20	26.0
Lecane aculiata	29	17	25	23	23.5
Polyarthra sp.	37	22	31	30	30.0
Rotaria sp.	36	21	29	27	28.2
Trichocerca similes	38	27	30	28	30.8
Total	**465.0**	**273.0**	**394.0**	**332.0**	**366.3**
Group-III Cladocera					
Alona sp.	40	27	29	28	31.0
Basmina sp.	39	18	30	25	28.0
Daphnia sp.	49	36	48	47	45.0
Moina sp.	49	23	45	38	38.7
Total	**177.0**	**104.0**	**152.0**	**138.0**	**142.7**
Group- IV Copepoda					
Cyclops sp.	50	28	46	39	40.7
Gammarus sp.	45	24	38	31	34.5
Nauplius larvae	53	44	49	48	48.5
Total	**148.0**	**96.0**	**133.0**	**118.0**	**123.7**
Group-V Ostracoda					
Cypris sp.	40	27	37	29	33.2
Total	**998.0**	**554.0**	**851.0**	**706.0**	**774.4**

Rainy season

Zooplankton density at four sites Chhapakaiya pond observed during rainy season of 2014-2015 is represented in Table 4. Similar trends were also observed in case of rainy season in Table 4.

Table 4: Density of zooplankton (org/L) at four sites of Chhapakaiya pond Birgunj, Nepal during rainy season (2014-15)

Name of species	Site-A	Site-B	Site-C	Side-D	Avg. density
Group-I Protozoa					
Amoeba sp.	10	5	8	6	7.25
Englypha sp.	10	5	8	9	8.0
Diffusia sp.	33	21	31	29	28.5
Euglena spirogyra	20	11	13	12	14.0
E. gracilis	28	10	19	13	17.5
Paramecium sp.	16	9	13	11	12.2
Vorticella companula	25	11	18	13	16.7
Epistylis anastica	29	21	27	26	25.7
Total	**171.0**	**93.0**	**137.0**	**119.0**	**130.0**
Group-II Rotifera					
Monostyla sp.	27	21	25	23	24.0
Keratella sp.	32	27	29	28	29.0
Brachionus quadridentatus	38	23	37	29	31.7
B. Patulus	17	13	15	13	14.5
B. rubens	24	15	19	18	19.0
B. caudatus	25	9	21	14	17.2
Filinia longiseta	36	12	31	18	24.2
Lecane aculiata	20	12	18	13	15.7
Polyarthra sp.	21	13	19	14	16.7
Rotaria sp.	20	9	14	10	13.2
Trichocerca similes	22	13	18	19	18.0
Total	**282.0**	**167.0**	**246.0**	**199.0**	**223.2**
Group-III Cladocera					
Alona sp.	22	16	19	18	18.7
Basmina sp.	25	10	24	15	16.0
Daphnia sp.	25	9	24	16	18.5
Moina sp.	38	8	29	20	26.2
Total	**110.0**	**53.0**	**96.0**	**69.0**	**82.0**
Group- IV Copepoda					
Cyclops sp.	27	11	19	16	18.2
Gammarus sp.	28	14	22	20	21.0
Nauplius larvae	29	13	28	21	22.7
Total	**84.0**	**38.0**	**69.0**	**57.0**	**62.0**
Group-V Ostracoda					
Cypris sp.	47	37	43	41	42.0
Total	**694.0**	**388.0**	**591.0**	**485.0**	**539.2**

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 of the lake and the reproduction and growth of organisms [6,15]. Greenberg [16] 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 has been observed in the Chhapakaiya pond Birgunj, Nepal during present investigation. Among the 5 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 the 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 [17], Gannon and Stemberger [18] the density of rotifers as well as their diversity increases due to increase in eutrophication. Chaurasia [19] reported that the density of rotifers and their species diversity is highest in eutrophic conditions. Hutchinson [20] observed that family *Brachionidae* is of great importance in the planktonic community which is found in slight to high alkaline water. Shrivastava [21] observed the dominance of rotifers in sum-

mer. Bhowmic [22], Bilgrami and Datta Munshi [23] and Sharma [24] 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.* [25] and Unni [26] reported the domination of *Moina* sp. in Ganga and Narmada rivers respectively. Chakraborty et al., [27] reported *Alona* and *Bosmina* as the most dominant genera in the river Yamuna. Ray *et al*. [28] also observed the 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.* [29] and Unni [26] 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.* [29] observed that ostracods generally decrease with an increase in pollution.

CONCLUSION

The zooplankton communities, very sensitive to environmental modifications, are important indicators for evaluating the ecological status of the aquatic ecosystems. They do not only form an integral part of the lentic community but also contribute significantly, the biological productivity of the fresh water ecosystem. So, I hope this study will provide baseline information for making effective conservation programme of fisheries in this region for better and healthy resources as well as improve the livelihood of the fisherman of the country.

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