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Analysis of Correlation among Zooplankton in two Near by Ponds of Jammu Region

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ABSTRACT

To analyse the existence and dominance of zooplankton, their intra and inter-specific correlations are very important to understand along with the effect of abiotic parameters. Therefore, presently two nearby located ponds lying between 32.62˚N latitude and 74.87˚E longitude have been studied. Five different groups of zooplankton have been recorded viz. Protozoa, Cladocera, Copepoda, Rotifera and Ostracoda. In total, 42 species of rotifers, 11 cladocera species, 6 copepod species, 9 protozoa species and 1 ostracod species have been recorded from both the ponds. Rotifers were found to be dominant in terms of species richness as well as abundance in pond I while high abundance and dominance of cladocera has been observed in pond II. In pond I many species of family Brachionidae have been enlisted coexisting with each other. Predatory rotifer *Asplanchna brightwelli* has been recorded having negative impact on existence of members of Brachionidae family and among abiotic factors also with temperature. From Pond II, a total 11 cladocera species showed high population density. Consecutive high density of *Phyllodiaptomus blanci* was seen with the cladocera genus *Diaphanosoma*, this may represent same positive correlation and their density has also been seen to be effected by abiotic parameters. High temperature and low transparency have favored the population growth of calanoid copepod *Phyllodiaptomus blanci*, rotifer *Hexarthra mira*, cladoceran *Moina brachiata* and ostracod *Onchocypris* species in pond II. Such distributon of zooplankton may be attributed to the interactions among abiotic and biotic parameters for the survival of various species.

Key words : *Zooplankton, Interspecific correlations, Abiotic, Biotic Interaction*

Introduction

A variety of abiotic and biotic factors are known to influence growth, abundance, distribution and species diversity of zooplankton in freshwater ecosystems. Abiotic factors including temperature, DO, pH, light etc. and biotic factors such as predation and inter and intraspecific competition results into shaping the zooplankton community structure as well as their differential assemblage (Malik and Panwar, 2015). Although many species can tolerate a wide range of environmental conditions, some species can survive only a narrow range of these environmental variables, therefore, their distribution is affected by various abiotic limitations. Similarly, biotic interactions such as food quality and quantity (Dumont, 1977) and competition among zooplankton species for limited resources influence their growth and distribution in freshwater ecosystem. Disturbances which cause imbalance in competition between species can lead to elimination of some while allowing existence of others. Likewise, predation by predators, both invertebrate as well as vertebrates like planktivorous fish can have dramatic effects on zooplankton structure (Gannon and Stemberger, 1978). Overall positive or negative correlations are found among the zooplankton species in a water body that determine their presence, absence or abundance. The study of these correlations of zooplankton groups with one another and with physico-chemical parameters shows how closely they are related to each other and dependence of survival of one species on another.

Ponds as freshwater resources are of fundamental importance to human beings. Mostly ponds are found in rural areas and human inhabitations (Rajagopal *et al.*, 2010). The increased anthropogenic activities have resulted in fast deterioration of water quality which causes direct impact on living organisms inhabiting these water bodies. Toxic substances either natural or those added by human activities can have detrimental effects on the zooplanktonic species. For overall assessment of an aquatic environment, physico-chemical and biological analysis is a prerequisite. Therefore, qualitative and quantitative study of zooplankton fauna and their relationship with abiotic and biotic factors can provide useful information about the water quality status and zooplankton community structure of these small water systems.

Hence, the present study was aimed to enlist inhabiting zooplankton and to evaluate the correlations among various zooplankton groups with the prevailing environmental conditions in two different unexplored lentic water bodies of tehsil Bishnah of Jammu region, which are located nearby each other but with different catchment areas.

Materials and Methods

Study area: For the present study, two ponds – Kanjak di Chapadi and Bhatyari pond located at 32.62ˆN latitude and 74.87ˆE longitude in tehsil Bishnah of Jammu district were selected. (Fig. 1)

Kanjak di Chapadi - is a temple pond and perennial with a concrete embankment. It is believed to be sacred and its water is used for various religious activities. It is surrounded by agricultural land. (Fig.2 (a), pond I)

Bhatyari pond is situated along roadside and surrounded by human habitation as well as agricultural land. It is a shallow pond having soft muddy embankment covered by vegetation all over the circumference. Its water is used for cattle bathing and agricultural purposes. (Fig. 2 (b), pond II)

Qualitative analysis of zooplankton

The samples were collected during morning hours between 8:00 to 11:00 am. Collection was done by filtering 50 litres of water through the plankton net made up of bolting silk no. 25 (mesh size 0.03 - 0.04 mm). The final volume of filtrate was adjusted to 20 ml and 5% formalin was added as a preservative. Samples were brought to the laboratory and examined under a compound microscope. Taxonomic identification of zooplankton species was done following Pennak (1978), Michael and Sharma (1988),

Fig. 1. Map showing location of both the study stations.

(a) Kanjak di Chapadi

(b) Bhatyari pond

Fig. 2. Figures indicating both the study sites.

Adoni (1985) and Edmondson (1992).

Physico-chemical analysis

Water samples were analysed for the abiotic parameters like water temperature, pH, DO, fCO_2, HCO_3^-, CO_3^{2-} in the field. Air and water temperature were recorded using the mercury centigrade thermometer. pH was determined using digital pH meter (Hanna). Water samples were collected from the pond surface in clean 1 litre polyethylene bottles for the analysis of other variables in the laboratory. In addition, the samples for the estimation of BOD were collected in BOD bottles and fixed immediately. The various physico-chemical parameters were analyzed by following Adoni (1985) and APHA (1985).

Results

A total of 69 zooplankton taxa represented by 42 species of rotifers (61%), 11 species of cladocera (16%), 6 species of copepods (9%), 9 species of protozoa (13%) and 1 ostracod species (1%) have been enlisted from both the study ponds (Table 1, Fig. 3)

The rotifers belonging to 13 families and 20 genera have been enlisted. The total recorded rotifer families from both the ponds are- Brachionidae, Colurellidae, Asplanchnidae, Synchaetidae, Filiniidae, Testudinellidae, Hexarthridae, Trichocercidae, Notommatidae, Euchlanidae, Mytilinidae, Lecanidae and Philodinidae.

Out of 13 families, representatives of family Brachionidae, Colurellidae, Filinidae,

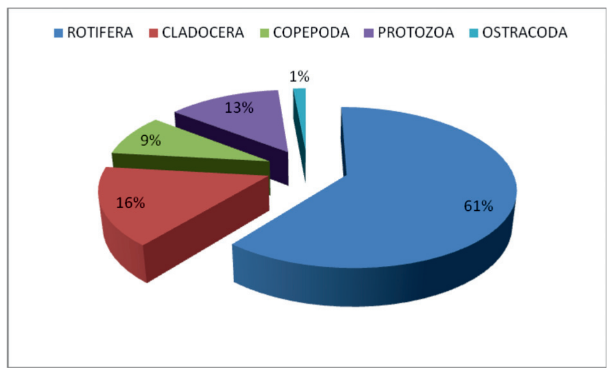

Fig. 3. Pie chart showing total percentage composition of zooplankton groups at both the study stations.

Testudinellidae, Mytilinidae and Lecanidae have been reported at both the study stations. While members of Asplanchnidae, Synchaetidae, Trichocercidae, Notommatidae and Philodinidae were found in Pond I only, and taxa belonging to Hexarthridae and Euchlanidae were enlisted only from pond II. Brachionidae with 4 genera and 14 species was dominant in pond I, and Lecanidae comprising of 2 genera and 8 species was dominant in pond II.

Cladocera belonging to 11 species and 5 families have been recorded. Family Daphnidae, Chydoridae and Macrothricidae were common in both ponds while representatives of Moinidae and Sididae were exclusively present in pond II and Chydoridae was dominant in both the ponds in terms of species diversity.

Among copepods, only cyclopoids were reported

Table 1. List of zooplankton species recorded from both the selected study stations. (+ sign: presence of species, - sign: absence of species)

S. No.		ZOOPLANKTON SPECIES	POND I	POND II
	Phylum-Rotifera			
1.	**Order- Ploima**	*Anuraeopsis fissa* (Gosse, 1851)	+	-
2.	**Family-Brachionidae**	*Anuraeopsis sp.*	+	-
3.		*B.angularis* Gosse, 1851	+	-
4.		*B.bidentata* Anderson, 1889	+	+
5.		*B.caudatus* Barrois and Daday,1894	+	-
6.		*B.falcatus* Zacharias, 1898	+	+
7.		*B.forficula* Wierzejski, 1891	+	-
8.		*B.quadridentata* Hermann, 1783	+	+
9.		*B.rubens* (Ehrenberg, 1838)	+	+
10.		*Brachionus calyciflorus* Pallas, 1766	+	+
11.		*Keratella cochlearis* Gosse, 1851	+	-
12.		*Keratella quadrata* (O.F.Muller, 1786)	+	-
13.		*Keratella tropica* (Apstein, 1907)	+	+
14.		*Platyias patulus* (O.F.Muller, 1786)	+	+
15.		*Platyias quadricornis* (Ehrenberg, 1832)	-	+
16.	**Family- Colurellidae**	*Lepadella ovalis* (O.F.Muller, 1786)	+	-
17.		*Lepadella patella* (O.F.Muller, 1773)	-	+
18.		*Colurella obtusa* (Gosse, 1886)	+	+
19.		*Colurella adriatica* (Ehrenberg, 1837)	+	-
20.	**Family-Synchaetidae**	*Polyarthra vulgaris* (Carlin, 1943)	+	-
21.	**Family-Asplanchnidae**	*Asplanchna brightwelli* (Gosse, 1850)	+	-
22.	**Family-Trichocercidae**	*Trichocerca similis* (Wierzejski, 1893)	+	-
23.		*Trichocerca pusilla* (Jennings, 1903)	+	-
24.		*Trichocerca sp.*	+	-
25.	**Family-Notommatidae**	*Cephalodella gibba (Ehrenberg, 1832)*	+	-
26.	**Family-Euchlanidae**	*Euchlanis dilatata* (Ehrenberg, 1832)	-	+
27.	**Family-Mytilinidae**	*Mytilina ventralis* (Ehrenberg, 1832)	+	+
28.	**Family-Lecanidae**	*Monostyla bulla* (Gosse, 1851)	+	+
29.		*Monostyla closterocerca* (Schmarda, 1898)	+	+
30.		*M. quadridentata* (Ehrenberg, 1832)	-	+
31.		*M. decipiens* (Murray, 1913)	-	+
32.		*Monostyla sp.*	-	+
33.		*Lecane curvicornis* (Murray, 1913)	-+	+
34.		*Lecane luna* (O.F.Muller, 1776)	+	-
35.		*L. ungulata* (Gosse, 1887)	-	+
36.		*L. leontina* (Turner, 1892)	-	+
	Order Flosculariacea			
37.	**Family-Filinidae**	*Filinia longiseta* (Ehrenberg, 1834)	+	+
38.	**Family-Testudinellidae**	*Pompholyx sp.*	+	+
39.		*Testudinella patina* (Hermann, 1783)	-	+
40.	**Family-Hexarthridae**	*Hexarthra mira* (Hudson, 1871)	-	+
	Order Bdelloidea			
41.	**Family-Philodinidae**	*Philodina sp.*	+	-
42.		*Rotaria sp.*	+	-
	Phylum - Arthropoda			
	Order - Cladocera			
1.	**Family - Daphniidae**	*Simocephalus vetulus* (Muller, 1776)	+	+
2.		*Ceriodaphnia reticulata* (Jurine, 1820)	+	+
3.		*Ceriodaphnia cornuta* (Sars, 1885)	-	+
4.	**Family Chydoridae**	*Chydorus sphaericus* (Muller, 1785)	+	+

Table 1. *Continued ...*

S. No.		ZOOPLANKTON SPECIES	POND I	POND II
5.		*Alona costata* (Sars, 1862)	+	+
6.		*Alona sp.*	-	+
7.		*Dunhevedia sp.*	-	+
8.		*Leydigia sp.*	-	+
9.	**Family Moinidae**	*Moina brachiata* (Jurine, 1820)	-	+
10.	**Family Sididae**	*Diaphanosoma sp.*	-	+
11.	**Family Macrothricidae**	*Macrothrix rosea* (Jurine, 1820)	+	+
	Sub-class- Copepoda			
	Order - Cyclopoida			
1.	**Family Cyclopidae**	*Mesocyclops leukarti* (Claus, 1857)	+	-
2.		*Mesocyclops tenuis* (Marsh, 1909)	+	-
3.		*Cyclops bicolor* (Sars)	+	+
4.		*Cyclops sp.*	+	-
5.		*Cyclops panamensis* (Marsh, 1913)	+	-
	Order Calanoida			
6.	**Family Diaptomidae**	*Phyllodiaptomus blanci*	-	+
	Phylum Protozoa	(Guerne and Richard, 1996)		
	Order- Arcellinida			
1.	**Family Arcellidae**	*Arcella megastoma* (Penard)	+	+
2.	**Family Centropyxidae**	*Centropyxis aculeate* (Ehrenberg, 1832)	+	+
3.		*Centropyxis ecornis* (Ehrenberg, 1841)	+	+
4.	**Family Difflugiidae**	*Difflugia acuminata* (Ehrenberg, 1838)	+	+
5.		*D.corona* (Wallich, 1864)	-	+
6.		*D.lebes* (Penard, 1890)	+	+
7.		*D.oblonga* (Ehrenberg, 1838)	-	+
	Order- Sessilida			
8.	**Family Vorticellidae**	*Vorticella sp.*	+	-
	Order Heterotrichida			
9.	**Family Stentoridae**	*Stentor sp.*	+	-
	Phylum Ostracoda			
	Order Podocopoda			
1.	**Family Cypridopsidae**	*Onchocypris pustulosa* (Gurney,1926)	-	+

from pond I with 5 members of the family cyclopidae while single species each of family Cyclopidae and Diaptomidae was present in pond II.

Group Protozoa has shown its presence in both the ponds with a record of seven species in each pond. Ostracods were found only in pond II with high abundance of single species *Onchocypris pustulosa*.

The hierarchy of dominance of zooplankton species in pond I was:

Rotifera (66%) > Protozoa (14%)> Cladocera (10%) = Copepoda (10%) (Fig. IV),

while the hierarchy in pond II was:

Rotifera (53%) > Cladocera (24%) > Protozoa (16%) > Copepoda (5%) > Ostracoda (2%) (Fig.V).

In terms of species richness, Rotifers dominated both the ponds.

Physico-Chemical analysis

Range of various abiotic factors for both the study stations has been shown in Table 2.

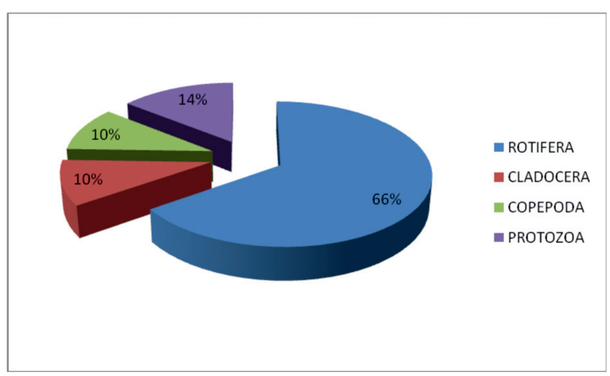

Fig. 4. Pie chart showing Percentage composition of zooplankton groups in pond I

Table 2. Range of variations in various physico-chemical parameters of both the study stations

S.No.	Physico-chemical parameter	Unit	Pond I (min.-max)	Pond II (min-max)
1.	Air temperature	(˚C)	23 - 35	22 - 34
2.	Water temperature	(˚C)	22 - 34	23.5 - 33
3.	pH		8.0 - 9.3	7.8 – 8.7
4.	DO	(mg/L)	3.2 - 9.6	1.76 – 10.24
5.	fCO2	(mg/L)	3.52-11.44	5.28 – 8.8
6.	Carbonate	(mg/L	12.0 -18.0	3.6 – 10.8
7.	Bicarbonate	(mg/L)	122-214	158.6 – 231.8
8.	Chloride	(mg/L)	19.02 - 39.04	56.06 – 82.09
9.	Calcium	(mg/L)	10.09 - 30.27	8.41 - 37
10.	Magnesium	(mg/L)	2.55 - 14	6.97 – 22.55
11.	Total Hardness	(mg/L)	42 - 108	56 - 145
12.	BOD	(mg/L)	1.28 – 4.28	0.32 – 4.64
13.	Sulphate	(mg/L)	0.0017- 0.0018	0.0017 – 0.119
14.	Phosphate	(mg/L)	0.077- 0.207	0.055 – 0.256
15.	Nitrate	(mg/L)	0.575 – 0.581	0.573 – 0.580

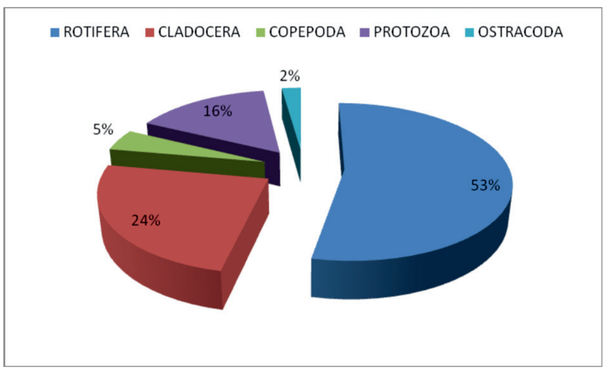

Fig. 5. Pie chart showing percentage composition of Zooplankton groups in pond II.

Discussion

Correlation among different zooplankton

In pond I, 6 species of the genera *Brachionus* have been observed co-occuring which may indicate either abundance of resources or lack of interspecific competition among these species since individuals of same genera require similar physiological conditions and food (Nandini *et al.*, 2005).

Presently, among Cladocera community, *Simocephalus vetulus* and *Ceriodaphnia reticulata* were recorded sharing same time of presence in both the ponds. Their coexistence with each other shows positive correlation between them also inferring the sharing of resources by these two cladocera species. A similar positive correlation between rotifers *Keratella tropica* and *Pompholyx* sp. and between copepod *Phyllodiaptomus blanci* and cladocera genus *Diaphanosoma* has been reported.

A negative correlation has been observed between *B. falcatus* and members of the genus *Keratella* in pond I, which may be due to the existing competition for food resources that resulted into suppression of population of one species by other.

Correlation between environmental factors and zooplankton species

A variety of physico-chemical and biological factors influence the zooplankton population dynamics. Rotifers especially, due to their permeable integument and small size have high susceptibility to environmental changes (Nogrady *et al.*, 1993). The effect of temperature on rotifers is very well known (Berzins and Pejler, 1989a). In the present study, a peak in the population density of *Asplanchna brightwelli* has been observed at high temperature (34˚C) in pond I with the complete absence of members of genus *Brachionus* from the site at pond I. At the same time, species diversity of other rotifer genera was seen to be very low. According to Ludwig (1993), rotifers can tolerate a temperature range between 15-31˚C, but different species have different tolerance levels and abundance of *A.brightwelli* at such high temperature is indicative of high temperature tolerance by this species.

A positive impact of temperature has also been noticed presently on the population growth of various zooplankton species viz. *Moina brachiata*, *Hexarthra mira*, *Phyllodiaptomus blanci* and *Onchocypris pustulosa.*

Turbidity appears to have considerable effects on zooplankton density (Sharma and Pant, 1984) it also influences aquatic biota by interfering with species interaction and resource availability (Hart, 1990). *Hexarthra mira* and *O. pustulosa* have shown a positive correlation with turbidity. Our results regarding correlation of *Hexarthra mira* with turbidity are in conformity with the findings of Shah *et al.*, (2016) and Ferdous and Muktadir, (2009).

Occurrence of *Platyias quadricornis* only in pond II along the vegetation further strengthens the findings of Bozkurt and Guven, (2009) and also of Shah *et al*., (2016) who from their findings postulated preference of vegetative zone by *P. quadricornis.*

Thus, a single factor is never operating independently in the distribution of zooplankton communities, but there are interactions among multiple ecological factors whether abiotic or biotic, which contribute to their spatial distribution, growth and abundance.

Conclusion

From the present investigation, the qualitative analysis of zooplankton from two lentic water bodies revealed the presence of a total of 69 zooplankton species belonging to five major zooplankton groups i.e. Rotifera, Cladocera, Copepoda, Protozoa and Ostracoda. It has been concluded that both the biotic as well as abiotic factors are responsible for the spatial and temporal distribution of zooplankton in any water body. Temperature is recognized as one of the major abiotic parameter that also regulates other parameters. Presently, temperature was observed to play a very prominent role in the distribution and abundance of various species like *A. brightwelli, H. mira, M. brachiata, P. blanci and O. pustulosa.* Furthermore, the role of biotic interactions in aquatic systems cannot be ignored as these are the chief drivers in structuring zooplankton community. Interestingly, both negative and positive interactions have been analysed in this study among different zooplankton groups. Similarly, presence or absence of vegetation has also contributed to differential species composition in the two water bodies as some microfaunal organisms prefer the complex habitat and shelter provided by vegetation while some others avoid it is due to the changes in physico-chemical properties of water associated with vegetative zone.

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