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Zooplankton interactions and their variability in some lentic and lotic water bodies of sub-tropical areas of Udhampur district of J&K, India

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ABSTRACT

Flourishing of zooplankton in any aquatic habitat is governed by numerous factors. It is not an independent process but the result of interactions among different groups of zooplankton and the impact of various abiotic factors present in any water body. The biological processes like the predation competition for niche, habitat and food are the governing factors for the developing colonies. This reveals the relation of zooplankton among themselves. The sampling was done on monthly basis and the zooplankton diversity was analysed. This resulted in 34 Genera belonging to 5 groups , Protozoa(8 Genera), Rotifera(12 Genera), Copepoda(6Genera), Cladocera(6 Genera) and Ostracoda(2 Genera). The overall dominance was shown by Rotifers and the least were Ostracods. This community structure was an overall result of all biological interactions and the abiotic factors.

Keywords: Biological interactions, Abiotic factors, niche, predation

I. INTRODUCTION

Zooplankton are the microscopic animalcules of great importance as they act as primary and secondary links in food-chain (Hutchionson, 1967). Zooplankton community is a heterogeneous assemblage of animalcules of many taxonomic groups comprising of the invertebrates including of all types of organisms like herbivores, carnivores, detritivores and even omnivorous. The growth of any zooplankton community is the direct enfluence of number of factors such as nutrients, physico-chemical parameters and more important are the biological interactions, predations and inter specific competition for space and food resources (Neves et al, 2013). But they co-exist because of difference in their niche requirements. Being sensitive to environmental changes, these zooplankton colonies are in being use in indicating the present biological status of any water body i.e. used to indicate the level of eutrophication. The present investigation deals with two lentic and one lotic station of Udhampur district in sub-tropics of J&K viz: Talpad pond (st.1), Jonu pond (st.2) and Kunullah stream (st.3).

II. MATERIALS AND METHODS:

Study area:

Station 1(Talpad pond) : This domestic pond is located at about 25 km away from the main Udhampur city in the vicinity of a village with some shops and a school nearby and the agricultural fields along the roadThe bottom is very muddy and the water on little agitation becomes turbid. The geographical position of this station on map is 32^{0}51′38″ N (latitude), 75^{0}11′40″ E (Longitude) and at an elevation of 675 m from sea level.

Station 2 (Jonu pond): It is a pond, fully embanked with cement and has a small temple nearby and the pond is surrounded by agricultural fields and some houses. It is about 28 km away from the main city. The bottom is not so muddy because of more gravel content at the base, so water remained clear in most of the seasons. The geographical position of this station on map is 32^{0}51′06″ N (latitude), 75^{0}12′19″ E (Longitude) and at an elevation of 757 m from sea level.

Station 3 (Kunullah stream): Kunullah stream is a tributary of river Tawi which originates from Kailash Kund situated in Ashapati Kailash range of Himalayas located in Bhaderwah area of Jammu and Kashmir state. Kunullah stream is formed by joining of two streams i.e Goldhi stream and Barmeen stream at Jalander Mata and flows downwards to meet river Tawi at roun-domel, district Udhampur. A stretch of 2.5 kms have been studied from Jalander Mata to Kunullah up to Ramnagar bridge. So realising the importance of zooplankton at the juncture of two streams and relation to the physico-chemical parameters and the surroundings, this unexplored stretch of stream was selected for the study. The geographical position of this station on map is 32^{0}49′13″ N (latitude), 75^{0}11′23″ E (Longitude) and at an elevation of 551 m from sea level.

Zooplankton sampling and analysis: For the present study monthly sampling was done for the qualitative analysis of zooplankton by filtering water through plankton net (made of bolting silk with mesh size 70µm). 50 liters of water was filtered through planktonic net and the filterate was collected in 100 ml plastic bottles and preserved in 5% formalin.. The identification was done using the standard books and manuals viz: Edmondson (1992), Adoni(1985), Pennack(1989). The quantitative estimation was done by using the formula: **N = A*1/L*n/V**

Where: N= Zooplankton no. per litre of water, A= Total no. of zooplanktons counted per drop,

V= Volume of a drop (ml)

L= Volume of original sample in litres.

n= Total volume of concentrated sample

Statistical analysis was also done using SPSS programme.

Analysis of physico-chemical parameters: Water samples were collected once in every month and estimated for physico-chemical parameters viz: water temperature, air temperature, pH, dissolved oxygen, free carbon-dioxide, carbonates, bicarbonates, calcium, magnesium, chloride, sulphates, nitrates, and phosphates as per standard methods of APHA.

III. RESULTS AND DISCUSSIONS

Present study was carried out for a period of one year from January 2015 to December 2015 and comparative study of 3 stations was done. A total of 34 Genera were recorded from these study stations belonging to 5 groups , Protozoa(8 Genera), Rotifera(12 Genera), Copepoda(6 Genera), Cladocera(6 Genera) and Ostracoda(2 Genera).

Protozoa: The 8 Genera of Protozoans presently recorded belong to only one Class: Sarcodina comprising of 4 Orders (Amoebae, Testacidae, Peritrichidae and Ciliophora) and 3 Families (Diffugidae, Centropyxidae and

Vorticellidae). Compairing the tables 2, 3 and 4 we can say that quantitatively Protozoans showed dominance in summers at station 2 (6.06 no./l) and 3(3.18 no./l) while at station 1 dominance was in winters (12.58 no./l). The maximum contribution at all the station was made by *Diffigia sps.* for the maximum period and the least contributing sps. were *Arcella sps., Campenella sps.* and *Euplotes sps.*. Protozoan population prefer a temperature range of 16ºC-25ºC (Kaushik and Saksena, 1995; Sawhney, 2008 and Shafiq, 2004). The difference in the dominance in summers and winters at different stations could be due to the presence of different species and their preference for food and habitat which was available at different 3 stations Comparative analysis of three study stations highlight that the maximum numbers of genera were found in the lentic as compared to the lotic station as lentic water are more stable than the lotic, thus provide better conditions for the flourishing of zooplankton colonies. This can be due to reduced current of the water (Jayabhaye, 2010).

Among the two lentic sources high number of zooplankton were recorded at station-1 as compared to station-2. This is could be due to the preference of zooplankton to grow better in soft bottom as compared to the gravel bottom. High detritus was available at station-1 which further added nutrients to the water body after decomposition. (Kehayias, 2013). Least number litre in the stream could be due to fast turbulent flow of water, wide fluctuatuations in the water discharge, poor deposits of dead organic matter at the bottom, less macrophytic vegetation in the stream (Dutta and Patra, 2013).

Rotifera: The 12 Genera of Rotifers presently recorded belong to both the Classes: Monogononta and Digononta. The Monogononta was represented by Order Ploima representing 6 Families viz: Asplanchidae, Euchlanidae, Mytilinidae, Colurellidae, Euchlanidae and Lecanidae. and the Class Digononta was represented by Order Bdelloidea representing just one Family i.e. Philonidae.). Compairing the tables 2, 3 and 4 we can say that quantitatively Rotifers showed dominance in summers at all the three stations (60.12 no. /l, 24.4no./l, 2.59 no. /l respectively). But were present throughout the study period. Rotifers presence maximum being contributed by *Platiyas patulus* and least by *Keretella cochlearis*. Similar trend of undulating presence was observed by Malhotra *et al., 1995 and* Langer *et al.,* 2007, which could be due to ability of Rotifers to adapt themselves to wide range of temperature variations. Their decreasing number could be contributed to the increased predation population of other taxas.

Cladocera: The 6 Genera of Cladocerans presently recorded belong to phylum Arthropoda, Class: Crustacea, represented by 2 Families: Chydoridae and Daphnidae. Compairing the tables 2, 3 and 4 we can say that quantitatively Cladocerans dominated station 2 and 3 in summers with 23.08 no./l and 2.64 no./l respectively while showed dominance in the approaching monsoons at station 1(18.24 no./l). Cladocera where maximum coexisting in month of March (8 species) and showed complete absence in three consecutive months (Oct, Nov, Dec) Maximum contribution to Cladoceran count was by *Alonella* sps. and minimum by *Simocephalus* sps. Cladocerans prefer clear water , optimum pH and good amount of Dissolved Oxygen. (Uttangi, 2001; *Langer et al*., 2007) that was present at station 2 and 3 while the approaching monsoons increased the water level as well the required conditions at station one as it was about to be dried in summers.

Copepoda: The 6 Genera of Copepoda presently recorded belong to Order Eucopepoda representing 2 Families viz. Cyclopida and Diapotomidae along with the Nauplius larva at all the 3 Stations. Compairing the tables 2,3, 4 we can conclude that dominance of Copepods was seen during summers at all the study stations with 28.08 no. /l, 16.04 no. /l and 3.49 no. /l respectively. Maximum number in summer months could be due to their preference to warm conditions except the month of February. (Langer *et al., 2007).* Quantitative contribution has maximum been by *Cyclops bicolor* . and minimum was by *Diapotomous* sps.

Ostracoda: The 2 Genera of Ostracods presently recorded belong to Class Crustacea representing the single order Ostracoda and represented by 2 Genera: *Stredensia* sps. and *Princypris* sps. *Stredensia* sps. was more abundant than the other at both the stations 1 and 2 while Ostracods showed total absence in the lotic station. This shows that they prefer muddy bottoms and stable conditions which were prevailing in the lentic water bodies. Also difference in the physico-chemical parameters could be the reason for their differential presence in 3 study stations parameters which influenced their growth and number.Water temperature is one of the most Abiotic predictors of Ostracod abundance and Least correlated to Dissolved oxygen (Kulkoyluoglu O *et al.,* 2007). Also supported by the findings of Mohd. A Hussain *et al.,* 2004 for surviving in high temperature. Monsoon abundance was supported by the study of Balakrishna *et al.,* 2013.

Statistical tabulation using Pearson correlation was done on the observed data. Different correlation were recorded for different stations like Protozoans showed negative result with cladocerans at station-1(Talpad pond) while positive correlation with Cladocerans and Copepods at station-2 (Jonu pond) and station-3(Kunullah stream). Similarly Cladocerans showed negative correlation with Rotifers at station-1(Talpad pond) and station-2 (Jonu pond) while positive at station- 3(Kunullah stream). Cladocerans showed positive correlation with the Copepods at all the stations with significant value at station-3(Kunullah stream). Rotifers showing positive correlation with Copepods and Ostracods at station-1(Talpad pond) and station-2(Jonu pond) while Rotifers are negatively correlated to Copepods at station-3(Kunullah stream). (Table 5, 6, 7)

Such station wise variation in the correlation among five groups presently recorded may be attributed to multifactorial reasons which govern the presence or absence of any species. Also in a food- web the preference for food depends upon various factors like quantitative abundance, qualitative abundance and various other abiotic and biotic pressures. Struggle for the niche can also be a cause, which exists at a particular time.

On the critical analysis of the various biodiversity indices it is apparent that the station -1(Talpad pond) has the highest values for Shannon-weiner diversity index, Marglef richness index and the Dominance index followed by station-2 (Jonu pond) and station-3 (Kunullah stream) (Table-8). Thus indicating that station 1 (Talpad pond) is rich in biodiversity of zooplankton than station 2(Jonu pond) and station 3 (Kunullah stream).

V. CONCLUSION

From the present investigation it can be concluded that more diversity is found in lentic than lotic sources when present even in same vicinity. Presently among two lentic sources more diversity (qualitative and quantitative) was found at station-1(Talpad pond) which is nutrionally more rich along with more zooplankton interactions. Qualitative and quantitative maxima of bioindicator species at station-1 (Talpad pond) reveals it being number one in hierarchy towards eutrophication. From the present study absence of pollution indicator species like *Asplanchna* sps., *Lecane luna, Keratella cochlearis, Mesocyclop leuckartii, Stredensia* sps., *Princypris* sps. at station-3 (Kunullah stream) highlight a better condition of this water source, water of which can be used for human consumption as compared to station-1(Talpad pond) and station-2 (Jonu pond).

Table 1: showing list of zooplankton at station 1,2, and 3

List of zooplankton	Station-1	Station-2	Station-3
PROTOZOA			
1. *Arcella sps.*	+	+	+
2. *Astramoeba sps.*	+	+	+
3. *Centropyxis aculeate*	+	+	-
4. *Campanella sps.*	+	-	-
5. *Diffugia lebes*	+	+	+
6. *Diffugia acuminate*	+	+	+
7. *Euplotes sps.*	+	+	-
8. *Paramecium Aurelia*	-	+	-
9. *Vorticella sps.*	+	+	+
ROTIFERA			
1. *Asplanchna sps.*	+	+	+
2. *Brachionus plicatilus*	+	+	-
3. *Brachionus falcatum*	+	-	-
4. *Brachionus quadridentata*	+	+	-
5. *Colurella obtusa*	+	+	+
6. *Euchlanis sps.*	+	+	-
7. *Keratella cochlearis*	+	-	-
8. *Lecane luna*	+	+	+
9. *Lepadella sps*	+	+	-
10. *Monostylla bulla*	+	+	+
11. *Mytillina sps.*	+	+	-
12. *Philodina sps.*	+	+	+
13. *Platiyas patulus*	+	+	+
14. *Trichotria sps.*	+	-	-
CLADOCERA			
1. *Alona sps.*	+	+	+
2. *Alona*	+	+	-

monocantha			
3. *Alonella sps*	+	+	-
4. *Chydorus sps.*	+	+	+
5. *Chydorus ovalis*	+	+	-
6. *Ceriodaphnia sps.*	+	+	-
7. *Daphnia longiremis*	+	-	-
8. *Daphnia similis*	+	+	+
9. *Daphnia pulex*	+	+	-
10. *Simocephalus sps.*	+	-	-
COPEPODA			
1. *Cyclop sps*	+	+	+
2. *Cyclop bicolour*	+	+	+
3. *Cyclop scutifer*	+	+	-
4. *Diaptomous sps.*	-	+	-
5. *Eucyclop agilis*	+	+	+
6. *Halicyclop sps.*	+	+	+
7. *Mesocyclop sps.*	-	+	-
8. *Mesocyclop tenius*	+	+	-
9. *Mesocycop leukarti*	+	+	-
10. *Tropocyclop prasinus*	+	+	+
11. *Nauplius larvae*	+	+	+
OSTRACODA			
1. *Princocypris sps.*	+	+	-
2. *Stredensia sps.*	+	+	-

Table 2: showing seasonal variation in the abundance of zooplankton at station 1(Talpad pond)

NO./litre	Protozoa	Cladocera	Rotifera	Copepoda	Ostracoda
Summers	7.66	1.58	60.12	28.08	8.24
Monsoons	3.14	18.24	41.81	5.95	0.82
Winters	12.58	6.32	17.56	13.34	0.40
Total	23.38	26.14	119.49	47.37	9.46
Mean	7.79	8.71	39.83	15.79	3.15
Std. deviation	4.72	8.58	21.34	11.26	9.46

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Table 3: showing seasonal variation in the abundance of zooplankton at station 2(Jonu pond)

NO./litre	Protozoa	Cladocera	Rotifera	Copepoda	Ostracoda
Summers	6.06	23.02	24.4	16.04	0.10
Monsoons	5.79	9.86	15.78	15.78	6.44
Winters	3.37	21.08	5.40	10.97	0
Total	**15.22**	**53.96**	**45.58**	**42.79**	**6.54**
Mean	5.07	17.98	15.19	14.26	2.18
Std. deviation	1.48	7.10	9.10	2.85	3.68

Table 4: showing seasonal variation in the abundance of zooplankton at station 3(Kunulllah stream)

NO./litre	Protozoa	Cladocera	Rotifera	Copepoda	Ostracoda
Summers	3.18	2.64	2.59	3.49	0
Monsoons	0.44	0.06	1.32	0.74	0
Winters	1.9	0.41	1.77	2.07	0
Total	**5.52**	**3.11**	**5.68**	**6.30**	**0**
Mean	1.84	1.03	0.89	2.1	0
Std. deviation	1.37	1.39	1.89	2.10	0

Table 5:Showing Pearson correlation among zooplankton at station-1

	Protozoa	Cladocera	Rotifera	Copepoda	Ostracoda
Protozoa	1				
Cladocera	-.106	1			
Rotifera	.132	-.461	1		
Copepoda	.161	.331	.329	1	
Ostracoda	-.003	-.230	.573	.728**	1

Table 6:Showing Pearson correlation among zooplankton at station-2

	Protozoa	Cladocera	Rotifera	Copepoda	Ostracoda
Protozoa	1				
Cladocera	.230	1			
Rotifera	-.045	-.208	1		
Copepoda	.002	.195	.388	1	
Ostracoda	-.140	-.166	.576*	.084	1

Table 7:Showing Pearson correlation among zooplankton at station-3

	Protozoa	Cladocera	Rotifera	Copepoda	Ostracoda
Protozoa	1				
Cladocera	.756**	1			
Rotifera	.118	.053	1		
Copepoda	.708**	.778**	-.050	1	
Ostracoda	.0	.0	.0	.0	0

Table 8:Showing various biodiversity indices for zooplankton at station-1, 2 and 3

	Station-1	Station-2	Station-3
Shannon-wiener diversity index	2.9	2.46	2.4
Marglef index	4.20	4.01	2.5
Dominance index	0.91	0.81	0.88

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