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RESEARCH ARTICLE

Baseline Studies on Micro Invertebrates of Head Marala, River Chenab, Punjab, Pakistan

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ABSTRACT

Received: May 22, 2014 The present study was designed to investigate the quantitative and qualitative Revised: July 17, 2014 status of micro invertebrates at Marala Barrage, River Chenab, Punjab, Accepted: July 22, 2014 Pakistan. Five potential sites were selected at Marala Baragge, River Chenab: 3 at upstream (River Tavi, Manawarwala Tavi and Upstream Chenab) and 2 at Key words: downstream (Canal Colony site and Bhalopur Site). Thirty three 33 species of Marala micro invertebrates (Zooplankton) that belong to 24 taxa and 5 phylum's were Micro Invertebrates identified from 1305 individuals collected from selected sampling sites. The Punjab numbers of individuals were 230, 339, 225, 199 and 312 were found from River Zooplannkton Tavi, Manawarwala Tavi, upstream Chenab, Canal colony side and Bhalolpur side, respectively. Twenty nine 29 species out 33 were found at River Tavi. The most abundant species was Arcella artocrae (Arcellediea) 14 (5.38% of total count). There were 26 species out of 33 species found at Manawarwala Tavi. The most abundant species Cyclocypris globosa (Cyprididae) 25 (5.67% of total count). Ninteen 19 species out 33 were found at upstream Chenab. The most abundant species were Bosmina longirostris (Bosminidae) 22 individuals (3.74% of total count). Thirty 30 species out of 33 were found at Canal colony side. The most abundant species were Osphranticum labronetcum (Centropagidae) 12 individuals (6.03% of total count). Twenty four 24 species out of 33 were found at Bhalolpur side. The most abundant species was Mesocyclops hyalinus (Cyclopidae) 24 individuals (4.91% of total count). The *Corresponding Author data of diversity indices for Zooplanktons shows that the sites River Tavi, Muhammad Farhan Khan Manawar wala Tavi and Canal Colony side were found to be highly diverse. farhankhan704@gmail.com

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INTRODUCTION

Zooplankton are one of the most important biotic components that influence all the functional aspects of an aquatic ecosystem, such as food chains, food webs, energy flow and cycling of matter (Murugan *et al.*, 1998; Dadhick and Sexena, 1999; Sinha and Islam, 2002; Park and Shin, 2007). The distribution of zooplankton depends on a complex of factors such as change of climatic conditions, physical and chemical parameters and vegetation cover (Rocha *et al.*, 1999; Neves *et al.*, 2003). Most of the species of planktonic organisms are cosmopolitan in distribution (Mukherjee, 1997).

Zooplankton and benthic macroinvertebrates support the economically important fish populations. Zooplanktons are the major mode of energy transfer between the phytoplankton and the fish, while benthic macroinvertebrates facilitate the recycling of detritus and are also a significant source of food (Howick & Wilhm, 1984).

Water quality assessment generally involves analysis of physico-chemical, biological and microbiological parameters and reflects on the abiotic and biotic status of the ecosystem (IAAB, 1998; Kulshrestha and Sharma, 2006; Mulani *et al.*, 2009 and Bouchard, 2004).

Many wetland invertebrates complete their life cycle from egg to adult in a wetland, and are therefore directly exposed to wetland conditions and stressors. In infrequently flooded, seasonal, and temporary wetlands, invertebrates will have shorter life cycles of days to weeks (Schneider and Frost 1996, Wiggins *et al.*, 1980 and Khatoon and Ali, 1975, 1976, 1977).

The Marala headworks are situated at the Chenab River near the city of Sialkot, Punjab, Pakistan. It is a massive hydro engineering project and is used to control water flow and flood control in river Chenab. Chenab is a 1,086 km (675 mi) long river which originates in the Kulu and Kangra Districts of Himachal Pradesh in India and is fed by the tributaries Chandra and Bagha as it enters Jammu & Kashmir near Kishtwar. After cutting across the Pir Panjal range, it enters the Sialkot District in Pakistan where the Marala Barrage was built across the river in 1968 with a maximum discharge of 1.1 million ft³/s (31,000 m³/s). Two major water channels originate at the Marala headworks-the Marala-Ravi Link Canal and the Upper Chenab Canal. Proposals are under consideration to build Mangla Marala Link Canal to overcome any shortage of water in future. Head Marala is also a picnic spot, wildlife sanctuary and unprotected wetland. Many people visit here and enjoy the landscape and the natural beauty.

The Chenab River is formed by the confluence of the Chandra and Bhaga rivers at Tandi located in the upper Himalayas in the Lahul and Spiti District of Himachal Pradesh, India. In its upper reaches it is also known as the Chandrabhaga. It flows through the Jammu region of Jammu and Kashmir into the plains of the Punjab, forming the boundary between the Rechna and Jech interfluves (Doabs in Persian). It is joined by the Jhelum River at Trimmu and then by the Ravi River Ahmedpur Sial It then merges with the Sutlej River near Uch Sharif, Pakistan to form the Panjnad or the 'Five Rivers', the fifth being the Beas River which joins the Satluj near Ferozepur, India. The Chenab then joins the Indus at Mithankot, Pakistan. The total length of the Chenab is approximately 960 kilometres. The waters of the Chenab are allocated to Pakistan under the terms of the Indus Waters Treaty. The study were conducted evaluated the occurrence of microinvertebrate and biodiversity at Head Marala River Chenab, Pakistan, Punjab

MATERIALS AND METHODS

Selection of sampling sites

A total of five potential sampling sites were selected at Marala Barrage on the basis of topography, surface geology, relief and human made structures. During survey, each site was marked using a GPS (Global Positioning System, Garmin) to determine the invertebrate zoology. The sampling was started early in the morning usually commencing from 5:00am to 12:00pm and after noon from 4:30 to 7:30 pm. The details of sampling sites are shown in table 1.

Sample collection

Zooplankton: Samples of zooplankton were collected from sampling sites with the help of plankton net of mesh size 60-75 μ . The collected specimens were then transferred into a tube filled with 5% formalin for their preservation. These were brought back to laboratory and then sorted into different groups. The zooplankton was identified up to species level with the stereo zoom microscope by using identification keys (Ward and Whipple, 1959; Mizuno, 1964; Mizuno and Takahashi, 1991 and Battish, 1992).

Water quality parameters: Water samples were collected to study water quality parameters like pH, dissolved oxygen contents, alkalinity, hardness, electrical conductivity, Total dissolved solids and heavy metals contents.

Alkalinity and hardness: Alkalinity and Hardness were determined by titration method as described by Golterman *et al.* (1978).

pH: pH of water samples measured using a pH meter (model LPM 1.4, PCSIR).

Dissolved oxygen: The dissolved oxygen of samples was measured by a digital DO meter (Oxi 330I, WTW). The dissolved oxygen meter was calibrated according to the manufacturer's calibration procedure before each measurement.

Electrical conductivity: Electrical conductivity was analyzed by digital EC meter (model LF 90, WTW).

Data analysis: The zooplankton data were presented as number of individuals and their relative abundance. There are several numerical indices in use that quantitatively describe the different level of diversity evenness and richness in the samples collected from different localities of an area (Simpson, 1949, Hammer *et al.*, 2001, Magurran, 2004). These commonly used diversity indices are given below along with their formulae.

- Shannon Diversity Index = $H = -\sum_{i}^{s} (p_i) (\log_e p_i)$ The *Shannon diversity index* (H) is another index that is commonly used to characterize species diversity in a community.
- Shannon index of Evenness = H / log_e (S) (a measure of biodiversity which quantifies how equal the community is numerically).
- Simpson Index of Dominance = D = ∑ n_i (n_i − 1) / N (N − 1) (Simpson's Diversity Index is a measure of diversityof dominant species. In ecology, it is often used to quantify the biodiversity of a habitat.)
- Simpson Diversity Index = 1 − D = 1 − ∑ n_i (n_i − 1) / N (N − 1) (Simpson's Diversity Index is a measure of diversity. In ecology, it is often used to quantify the biodiversity of a habitat.)
- S = Richness = number of species

The description of the symbols used in above formulae are given below

- N = the total number of individuals in the sample (N not italic is used for Hill's numbers)
- *S* = the number of species in the sample.
- n_i = the number of individuals of species *i* in the sample, $\sum n_i = N$.
- *p_i* = the proportion of individuals of species *i* in the sample, *p_i* = *n_i/N*.
- log_e = ln = natural log Diversity indices were analyzed by using PAST software.

RESULTS AND DISCUSSION

Thirty three species of micro invertebrates (Zooplankton) belonging from 24 taxa and 5 phylum's were identified from 1305 individuals from selected sampling sites (Table 2). The numbers of individuals were 230, 339, 225, 199 and 312 were found from River Tavi, Manawarwala Tavi, upstream Chenab, Canal colony side and Bhalolpur side respectively. Twenty nine species out 33 were found at River Tavi. The most abundant species was Arcella artocrae (Arcellediea) 14 (5.38% of total count) followed by Alona rectangular (Anomopoda) 13 (5.00% of total count). There are 7 species which are equal in numbers i.e. Fredericella sultana (Fredericellidae), Keratella cochlaeris (Brachionidae), Euclanis (Euchlanidae), Diaptomus castor (Diaptomidae), Cyclops varicans (Cyclopidae), Daphnia ambigua (Daphniidae) and Ceridaphnia reticulate (Daphniidae) those have 11 individuals (4.23% of total count). The Macrothrix rosae (Macrothricidae) were found lower in number viz; 01 indivdual (0.38% of total count). There were 26 species out of 33 species were found at Manawarwala Tavi. The most abundant species Cyclocypris globosa (Cyprididae) 25 (5.67% of total count) followed by Macrothrix rosae (Macrothricidae) 24 (5.44 of total count), Keratella cochlaeris (Brachionidae) 21 (4.76 of total count) and Alona rectangula 21 (4.76 of total count). There are 5 species which are equal in number at this site i.e. *Polyartha vulgaris* (Synchaetidae), Cyclops viridus (Cyclopidae), Ceriodaphnia reticulata (Daphniidae), Moinodaphnia malcavii (Daphniidae) and Chydorus poppi (Chydoridae) those have 11 individuals (2.49% of total count). The three species were found to be lower in number i.e. *Plumatella fruiticosa* (Plumatellidae), Epiphanes branchionus (Epiphanidae) and Parastenocaris lacustris (Parastenocardidae) i.e. 8 individuals (1.81% of total count). Nineteen species out 33 were found at upstream Chenab. The most abundant species were Bosmina longirostris (Bosminidae) 22 individuals (3.74% of total count) followed by Mesocyclops leuckertii (Cyclopidae) 18 individuals (3.06% of total count) and Diaptomus castor (Diaptomidae) 15 individuals (2.55% of total count). There are four species which are equal in number i.e. Fredericella sultana (Fredecellidae), Filina minuta (Trochosphaeridae), Parastenocaris lacustris (Parastenocarididae) and globosa *Cyclopcypris* (Cyprididae) those have 12 individuals (2.04% of total count). Thirty species out of 33 were found at Canal colony side. The most abundant species were Osphranticum labronetcum (Centropagidae) 12 individual (6.03 total count) followed by Difflugia lobostoma (Difflugiidae) 11 individuals (5.53% of total count). There are 3 species which are equal in numbers i.e Fredericella sultana (Fredericellidae), Keratella auadrada (Brachionidae), Epiehanes branchiobus (Epiphanidae) those have 10 individuals (5.03% of total count). The Asplancha pridonta (Asplanchnidae) and Diaptomus castor (Diaptomidae) those have 2 individuals (1.01% of total count) were found lower in numbers. Twenty four species out of 33 were found at Bhalolpur side. The most abundant species was Mesocyclops hyalinus (Cyclopidae) 24 individuals (4.91% of total count) followed by Euclanis dilate (Euclanidae) 23 individuals (4.70% of



Fig. 1: Shanon diversity index of zooplankton at Head Marala, River Chenab



Fig. 2: Simpson diversity index of zooplankton at Head Marala, River Chenab



Fig. 3: Simpson dominance index of zooplankton at Head Marala, River Chenab



Fig. 4: Species Richness of zooplankton at Head Marala, River Chenab



Fig. 5: Evenness of zooplankton at Head Marala, River Chenab

 Table 1: Location and coordinates of sampling sites at Marala

 Barrage

Sites	Locality	Coordinates				
		Ν	Е			
Site 1	River Tavi	32° 40′ 36.8″	74° 30′ 19.5″			
	(Upstream)	32° 41′ 29.0″	74° 29′ 19.7″			
Site 1	Manawarwala Tavi	32° 41′56.2″	74° 29′ 12.4″			
	(Upstream)	32° 42′06.8″	74° 28' 29.3"			
Site 3	Upstream Chenab	32° 40′ 53.5″	74° 28′ 57.6″			
	(Upstream)	32° 40′ 56.1″	74° 28′ 40.6″			
Site 4	Canal colony site	32° 40′ 16.7″	74° 27′ 53.7″			
	(Downstream)	32° 38' 08.1"	74° 27' 00.3″			
Site 5	Bhalopur site	32° 40′ 44.4″	74° 26′ 27.3″			
	(Downstream)	32° 40′ 19.3″	74° 25′ 21.3″			

total count), Diaptomus castor (Diaptomidae) 22 individual (4.50% of total count), Paulinella nidulus (Paulinellidae) 22 individuals (4.50% of total count), Philodina roseola (Philodinidae) 21 individuals (4.29% of total count), Cylops viredus (Cyclopidae) 21 individuals (4.29% of total count), Aloni rectangula (Anomopoda) 20 individual (4.09% of total count) and Cyclocypris globosa (Cyprididae) 20 individuals (4.09% of total count). There are 4 species which were equal in number i.e Centropyxis aculeta (Centropyxidae), Filina minuta (Trochosphaeridae), Mesocyclops leuckerti (Cyclopidae) and Ceridaphnia reticulate (Daphniidae) those have 11 species (2.25% of total count). The Difflugia lobostoma (Difflugidae) were found lower in numbers which have 1 individual (0.20% of total count).

The diversity indices (Shannon diversity index, Simpson diversity index, Simpson index of dominance, Species richness and Species eveness) for the zooplankton at different sites are shown in figures 1 to 5. Highest shannon's and simpson's diversity indices (3.33 and 0.96) were found at Canal colony side followed by River Tavi (3.25 and 0.96), Manawarwala Tavi (3.20 and 0.96) and Bhalolpur side (3.03 and 0.95). The lower shannon's diversity index and simpson's diversity indices was found at site upstream Chenab (2.89 and 0.95). The highest species richness was found at site of canal colony side (30) followed by River Tavi (29), Manawarwala Tavi (26)

Table 2: Distribution of Zooplankton and abundance data collected from Marala Barrage

Table 2. 1			a abundance	data conceted no	III Marala Dallage										
Phylum	Class	Order	Suborder	Family	Species	S1	RA	S2	RA	S3	RA	S4	RA	S5	RA
Protozoa	Tubulinea	Arcellinida	Arcellina	Arcellidae	Arcella artocrae	14	5.38	12	2.72	5	0.85	4	2.01	5	1.02
Protozoa	Lobosea	Arcellinida	Difflugiina	Centropyxidae	Centropyxis aculeta	3	1.15	18	4.08	10	1.70	8	4.02	11	2.25
Protozoa	Tubulinea	Arcellinida	Difflugiina	Difflugiidae	Difflugia lobostoma	6	2.31	0	0.00	0	0.00	11	5.53	1	0.20
Protozoa	Imbricatea	Euglyphida		Paulinellidae	Paulinella nidulus	12	4.62	9	2.04	11	1.87	4	2.01	22	4.50
Bryozoa	Phylactolaemata	Euglyphida		Plumatellidae	Plumatella fruiticosa	7	2.69	8	1.81	0	0.00	7	3.52	0	0.00
Bryozoa	Phylactolaemata	Plumatellida		Fredericellidae	Fredericella sultana	11	4.23	0	0.00	12	2.04	10	5.03	6	1.23
Rotifera	Monogononta	Ploima		Synchaetidae	Polyartha vulgaris	10	3.85	11	2.49	10	1.70	9	4.52	0	0.00
Rotifera	Monogononta	Flosculariaceae		Trochosphaeridae	Filina longiseta	7	2.69	0	0.00	8	1.36	5	2.51	6	1.23
Rotifera	Monogononta	Flosculariaceae		Trochosphaeridae	Filina minuta	0	0.00	10	2.27	12	2.04	7	3.52	11	2.25
Rotifera	Monogononta	Ploimida		Brachionidae	Keratella quadrata	10	3.85	10	2.27	0	0.00	10	5.03	12	2.45
Rotifera	Monogononta	Ploimida		Brachionidae	Keratella cochlaeris	11	4.23	21	4.76	0	0.00	9	4.52	6	1.23
Rotifera	Monogononta	Ploima		Asplanchnidae	Asplancha priodonta	5	1.92	13	2.95	0	0.00	2	1.01	6	1.23
Rotifera	Monogononta	Ploima		Epiphanidae	Epiphanes branchionus	5	1.92	8	1.81	11	1.87	10	5.03	0	0.00
Rotifera	Monogononta	Ploima		Euchlanidae	Euclanis dilatata	11	4.23	10	2.27	0	0.00	0	0.00	23	4.70
Rotifera	Monogononta	Flosculariaceae		Testudinellidae	Trochosphaera	0	0.00	9	2.04	0	0.00	7	3.52	0	0.00
					solstitialis										
Rotifera	Bdelloidea	Bdelloidea		Philodinidae	Philodina roseola	5	1.92	12	2.72	8	1.36	0	0.00	21	4.29
Arthropoda	Crustacaens	Copepods	Calanoida	Centropagidae	Osphranticum	0	0.00	15	3.40	0	0.00	12	6.03	0	0.00
					labronetcum										
Arthropoda	Crustacaens	Copepods	Calanoida	Diaptomidae	Diaptomus castor	11	4.23	10	2.27	15	2.55	2	1.01	22	4.50
Arthropoda	Crustacaens	Copepods	Calanoida	Diaptomidae	Diaptomus sarsi	10	3.85	12	2.72	0	0.00	5	2.51	10	2.04
Arthropoda	Crustacaens	Copepods	Cyclopoida	Cyclopidae	Cyclops viridus	7	2.69	11	2.49	0	0.00	0	0.00	21	4.29
Arthropoda	Crustacaens	Copepods	Cyclopoida	Cyclopidae	Cyclops varicans	11	4.23	0	0.00	13	2.21	6	3.02	0	0.00
Arthropoda	Crustacaens	Copepods	Cyclopoida	Cyclopidae	Mesocyclops leuckerti	9	3.46	14	3.17	18	3.06	7	3.52	11	2.25
Arthropoda	Crustacaens	Copepods	Cyclopoida	Cyclopidae	Mesocyclops hyalinus	4	1.54	15	3.40	0	0.00	6	3.02	24	4.91
Arthropoda	Crustacaens	Copepods	Harpactitoida	Parastenocarididae	Parastenocaris	5	1.92	8	1.81	12	2.04	9	4.52	8	1.64
					lacustris										
Arthropoda	Crustacaens	Copepods	Cladocera	Daphniidae	Daphnia ambigua	11	4.23	0	0.00	14	2.38	5	2.51	10	2.04
Arthropoda	Crustacaens	Copepods	Cladocera	Daphniidae	Ceridaphnia reticulata	11	4.23	11	2.49	11	1.87	4	2.01	11	2.25
Arthropoda	Crustacaens	Copepods	Cladocera	Daphniidae	Moinodaphnia	0	0.00	11	2.49	14	2.38	7	3.52	0	0.00
					malcayii										
Arthropoda	Crustacaens	Copepods	Cladocera	Daphniidae	Daphnia smilis	5	1.92	0	0.00	0	0.00	7	3.52	10	2.04
Arthropoda	Crustacaens	Copepods	Cladocera	Bosminidae	Bosmina longirostris	3	1.15	0	0.00	22	3.74	5	2.51	0	0.00
Arthropoda	Crustacaens	Copepods	Cladocera	Macrothricidae	Macrothrix rosae	1	0.38	24	5.44	0	0.00	4	2.01	15	3.07
Arthropoda	Crustacaens	Copepods	Cladocera	Chydoridae	Chydorus poppi	10	3.85	11	2.49	7	1.19	5	2.51	0	0.00
Arthropoda	Crustacaens	Copepods	Cladocera	Anomopoda	Alona rectangula	13	5.00	21	4.76	0	0.00	6	3.02	20	4.09
Arthropoda	Crustacaens/	Podocopida		Cyprididae	Cyclocypris globosa	2	0.77	25	5.67	12	2.04	6	3.02	20	4.09
-	Ostracoda	-													
Total # of S	Species					29		26		19		30		24	
Total # of I	ndividuals					230)	<u>33</u> 9	1	<u>22</u> 5		<u>19</u> 9		312	
DA Dalatix	va Abundanaa ar	ad S Sites													

RA Relative Abundance and S Sites

Species	Total # of	No of	Evenness	Shannon`s	Simpson`s			
	individuals	sites		diversity index	diversity index			
Arcella artocrae	40	5	0.92	1.47	0.75			
Centropyxis aculeta	50	5	0.92	1.49	0.75			
Difflugia lobostoma	18	3	0.75	0.82	0.51			
Paulinella nidulus	58	5	0.92	1.48	0.75			
Plumatella fruiticosa	22	3	0.99	1.09	0.67			
Fredericella sultana	39	4	0.97	1.37	0.74			
Polyartha vulgaris	39	4	0.98	1.35	0.74			
Filina longiseta	26	4	0.99	1.37	0.74			
Filina minuta	26	4	0.99	1.37	0.74			
Keratella quadrata	42	4	0.99	1.38	0.75			
Keratella cochlaeris	47	4	0.92	1.27	0.69			
Asplancha priodonta	26	4	0.86	1.19	0.65			
Epiphanes branchionus	34	4	0.97	1.35	0.73			
Euclanis dilatata	44	3	0.93	1.02	0.61			
Trochosphaera solstitialis	44	3	0.93	1.02	0.61			
Philodina roseola	46	4	0.9	1.25	0.68			
Osphranticum labronetcum	27	2	0.99	0.68	0.49			
Diaptomus castor	60	5	0.89	1.43	0.74			
Diaptomus sarsi	37	4	0.96	1.34	0.73			
Cyclops viridus	39	3	0.9	0.99	0.55			
Cyclops varicans	30	3	0.96	1.05	0.64			
Mesocyclops leuckerti	59	5	0.96	1.56	0.78			
Mesocyclops hyalinus	49	4	0.84	1.17	0.64			
Parastenocaris lacustris	42	5	0.98	1.57	0.79			
Daphnia ambigua	40	4	0.95	1.33	0.72			
Ceridaphnia reticulata	48	5	0.97	1.56	0.78			
Moinodaphnia malcavii	32	3	0.97	1.06	0.64			
Daphnia smilis	22	3	0.96	1.05	0.64			
Bosmina longirostris	30	3	0.69	0.76	0.42			
Macrothrix rosae	44	4	0.72	1	0.57			
Chydorus poppi	33	4	0.97	1.34	0.73			
Alona rectangula	60	4	0.93	1.29	0.71			
Cyclocypris globosa	65	5	0.85	1.36	0.71			

 Table 3: Total number of zooplankton individual, Species richness, Eveness, Shannon's and Simpson's diversity index calculated at

 Marala Barrage

and Bhalopur side (24). The lowest richness was found at upstream Chenab side (19). The dominance of three sites i.e. River Tavi (0.4), Manawarwala Tavi (0.4) and Canal colony side (0.4) except Bahlopur side (0.5) and upstream Chenab side (0.6). The low dominance was due to high shannon's diversity index, simpson diversity index and species richness. The data of diversity indices shows that the sites River Tavi, Manawar wala Tavi and Canal Colony side were found to be highly diverse. The diversity was found due to favourable temperature and less flowing water. Shannon's and Simpson's diversity indices for each species are shown in Table 3.

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