

Physicochemical Profile and Benthos of River Giri Up and Downstream Giri Barrage in Renuka, Sirmour (Himachal Pradesh)



Zoology

KEYWORDS : Benthos, density, river, physicochemical.

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ABSTRACT

Himachal Pradesh is drained by various rivers. Himachal Pradesh provides water to both the Indus and Ganges basins. The drainage systems of the region are the Chandra Bhaga or the Chenab, the Ravi, the Beas, the Sutlej and the Yamuna. The Yamuna has its origin in Yamunotri in Uttarkashi district, Uttarakhand. Its total catchment area in Himachal Pradesh is 2,320 km². Its tributaries are the Tons, the Giri and the Bata. Giri river is a perennial river of Sirmour district of Himachal Pradesh state. Present attempt has made to study the physicochemical parameters, qualitative and quantitative base of benthos of River Giri up and downstream Giri Barrage in Renuka, Sirmour, H.P.

The average water temperature ranged from 7.75±0.96°C (minimum) to 17.00±1.830C (maximum) The mean variation of dissolved oxygen was observed 7.25±0.96 mg l⁻¹ (minimum) and 12.00±1.63 mg l⁻¹. Moreover, a total of 12 genera of benthos were collected and identified which includes 9 families, 5 orders and 1 class, respectively. The benthos community was formed by Trichoptera, Ephemeroptera, Diptera, Coleoptera and Hemiptera.

INTRODUCTION

River plays a prime part in moulding the earth's physical and ethnic aspects through their distinctive hydrologic attribute as well as framing ethnic aspects. Rivers are very distinctive and priceless resources supporting a range of biotic wealth. Fast flowing rivers and waterfalls are widely used as sources of energy, via watermills and hydroelectric plants. Huge loads of waste water from industries, domestic sewage and agricultural practices find their way into rivers, resulting in large scale deterioration of water quality. The growing problem of degradation of our river ecosystem has necessitated the monitoring of water quality of various rivers all over the country to evaluate their production capacity, utility potential and to plan restorative measures. (Datar and Vashista 1992, Das and Sinha 1993)

The creation of a reservoir from damming a river has multiple social and economic impacts on individuals living near the dam project. Resettlement and loss of land from reservoir inundation is the most prominent impact from dam construction. Environmental impacts of dams and consequent reduction in access or availability of fish and other riverine resources may negatively impact human livelihoods as well. Reservoir fisheries may be poor substitutes for river fisheries as a result of lower productivity (Marmula, 2001 and Baran et al., 2007)

Himachal Pradesh is drained by various rivers. Himachal Pradesh provides water to both the Indus and Ganges basins. The drainage systems of the region are the Chandra Bhaga or the Chenab, the Ravi, the Beas, the Sutlej and the Yamuna. These rivers are perennial and are fed by snow and rainfall. The Yamuna has its origin in Yamunotri in Uttarkashi district, Uttarakhand. Its total catchment area in Himachal Pradesh is 2,320 km². Its tributaries are the Tons, the Giri and the Bata. Giri river is a perennial river of Sirmour district of Himachal Pradesh state.

Lot of studies has been conducted in India and abroad on the environmental effect of dams and impoundments (Egborge, 1979; Ward and Stanford, 1983; Collier *et al.*, 1998; Sreenivasan, 2000) Brooker (1981) studied the impact of impoundments on the downstream fisheries and general ecology of rivers. Baxter (1977) and Rosenberg *et al.* (1995, 1997) give a good overview on the environmental effects of dams and impoundments.

Owing to the variables, evaluation of water quality and productivity of impoundments of various levels (small/medium/large reservoir) has been studied for different sets of ecological families of reservoir by number of workers in India (Govind, 1963; Sreenivasan, 1965, 2000; Mishra and Yadav, 1978; Annon, 1982.; Sharma, 1987; Adholia *et al.*, 1990; Kumar, 1990; Sugunan, 1991, 1995; Singh *et al.*, 1993; Unni, 1993; Dixitulu, 1999; Thomas and Azis, 2000, Sukumaran and Das, 2001; Das, 2002; Sinclair, 2003) The Himalayan mountain system is drained by many small and large rivers. However studies on the benthic insects of Himalaya fluvial system (Badola and Singh 1981; Dutta and Malhotra, 1986; Nautiyal 1986; Sharma, 1986; Negi and Singh, 1990; Sunder, 1997; Julka et al., 1999, Sharma et al., 2011; Sharma and Dhanze, 2012; Sharma and Dhanze, 2013; Chauhan, et al., 2013) have remained fragmentary. The present study was carried out up and down stream to Giri Barrage to achieve the water quality and benthic status of the river.



Photo 1. Ariel view of river Giri showing

METHODOLOGY

Sampling for the limnological study of river Giri, was conducted at four (4) designated sampling sites (Photo 1). Monthly sampling for collecting data on various physicochemical and biological parameters was undertaken during December 2013 to May 2014.

Monthly sampling was carried out to collect data on the selected physicochemical parameters and benthic community of river. Physicochemical parameters were studied following standard methods outlined in Welch (1952), Trivedy and Goel (1986) and APHA (1995) Benthos was collected by using the Surber's square foot sampler. The collected samples were preserved in 5% formalin solution. The number of individual in 1 sq. feet was converted into sq. meter by multiplying with a factor of 10.765, because $1 \text{ m}^2 = 10.765 \text{ feet}^2$. Quantitative estimation was based on numerical counting *i.e.* units per meter square (Ind. m^{-2}) Qualitative analysis was made with the help of Ward and Whipple (1959), Needham and Needham (1962), Hynes (1970), Macan (1979) and Tonapi (1980)

Density = Total number of individuals/Total number of samples studied

The monthly data collected on the BENTHOS density was subjected to further analysis by applying the following ecological indices like; Shannon-Wiener species diversity index (Shannon and Wiener, 1963), Margalef (richness) index, Evenness index

RESULT AND DISCUSSION

The average temperature was minimum $9.00 \pm 0.82^\circ\text{C}$ (December) and maximum $23.75 \pm 1.89^\circ\text{C}$ (May). Changes in the river temperature are closely related to seasonal trends in mean monthly air temperature. Daily fluctuations occur more often in small streams, especially unshaded, due to day-night changes in the air temperature and absorption of the solar radiation during the day (Allan, 1995). Rada and Puljas (2008) found minimum water temperature in winter (8.6°C) and maximum in summer (28°C) in river Karst jadro. Agarwal and Rajwar (2010) in Tehri Dam reservoir found temperature minimum temperature in June and maximum during January.

The dissolved Oxygen mean variation was observed $7.25 \pm 0.96 \text{ mg l}^{-1}$ (minimum) in March and $12.00 \pm 1.63 \text{ mg l}^{-1}$ (maximum) in January (Table 1). Hassan *et al.*, (2008) observed high values of dissolved oxygen in winter and spring seasons, with lowest values in summer and autumn seasons. Agarwal and Thapliyal (2005) observed minimum dissolved oxygen during summer and maximum during winter during the pre-impoundment hydro biological study of Bhilangana river from Tehri reservoir area.

The average variation of free CO_2 fluctuates from $1.71 \pm 0.49 \text{ mg l}^{-1}$ (February) to $2.04 \pm 0.38 \text{ mg l}^{-1}$ (April) Bhalla and Sekhon (2010) observed minimum free CO_2 in winter while maximum during summer season in Godavari river. Similar observation were observed by Chakraborty and Asthana (1989), Mehta (1999) and Khanna and Bhutiani (2003) The average total alkalinity ranges from $17.50 \pm 6.45 \text{ mg l}^{-1}$ (March) to $36.25 \pm 4.79 \text{ mg l}^{-1}$ (February) According to Moyle (1946), water bodies having total alkalinity above 50 mg l^{-1} can be considered productive and the present findings showed low productivity of the selected river. Pahwa and Mehrotra (1996) and Zafar and Sultana (2008) high alkalinity during summer and low during monsoon season in river Ganga. Ayoade *et al.*, (2009) also recorded higher alkalinity in winter and lower in monsoon.

The pH varied from 7.20 ± 0.51 (December) to 8.05 ± 0.44 in March. Ayoade *et al.*, (2009) observed higher pH values in winter season in Bhilangana and Bhagirathi river. Tassaduqe *et al.*, (2003) observed minimum water temperature in summer while maximum during winter in Indus river in Pakistan. In Tungbhadra River in Karnataka higher values of pH were recorded in winter and lower pH values during the monsoon season (Suresh, *et al.*, 2011)

The average water current ranges from 1.20 ± 0.54 (April) to 1.35 ± 0.47 (February) (Table 1). Water velocity and the associated physical forces collectively represent the most important environmental factor that indirectly affects aquatic insects. Biologists have long believed that water as a medium, and current as a force, strongly determine ecological distribution and shape, as well as anatomical and behavioural adaptations (Allan, 1995) Khanna and Badola (1994) reported that the water current velocity varied from $0.35\text{-}2.1 \text{ msec}^{-1}$ in the Ganga at Chandighat (Haridwar). Gusain (1994) reported that water current velocity ranged from $0.5\text{-}3.7 \text{ msec}^{-1}$ in the Bhilangana. Singh and Gupta (2010) recorded minimum water current during summer while maximum during monsoon.

A total of 12 genera were collected and identified from the Giri river during the present study period. Benthos of Giri river includes 9 families, 5 order and 1 class, respectively (Table 2) The total density of benthos of Giri river ranged from 21.53 Ind m^{-2} at site S3 during the month of March and April to $290.66 \text{ Ind m}^{-2}$ at site S4 during the month of March. The Trichoptera has largest contribution followed by Ephemeroptera, Diptera, Coleoptera, Hemiptera. The order wise density of benthos were present in table 3.

In general, diversity and abundance of benthic invertebrates increase with median particle size, and some evidence suggests that diversity declines with stones at or above the size of cobbles (Allan, 1995). But larger substratum also tends to have larger abundance and variety of aquatic insects than a small type of substratum (Resh and Rasenberg, 1984; Minshall, 1984; Resh *et al.*, 1995) Fine sediment concentrations are usually higher downstream as rivers become wider and flow more slowly (Resh *et al.*, 1995).

In term of percentage composition, Ephemeroptera had the maximum contribution while the minimum contribution of Miscellenous in Giri river during the study period. The percentage composition of various groups at different sampling site has been given in fig no 1 to 4. In Giri river the percentage of different order of benthos varies at different sites. However, the order Ephemeroptera has largest contribution in terms of percentage during the spresent study period. Ephemeroptera are used as indicators of environmental conditions (Olomukoro, 1996) they tend to live mostly in unpolluted lakes, ponds, stream and rivers where they contribute substantially to secondary production. Ephemeroptera are restricted to cool, clean stream and rivers with high dissolved oxygen content (Olomukora and Ezemonye, 2007) Bodola and Singh (1981) reported that the Beatis, Caenis, Ephemerella were the most common form found throughout the year in river Alaknanda. Kishore *et al.*(1998) reported the Ephemeroptera taxa *viz.*, Heptagenia, Beatis other Bastidae and Rhithrogene were found to be common throughout the period in acquit abundance barring January when it was replaced by Siphonuridae in river Ganga between Rishikesh and Haridwar (Nautiyal *et al.*, 1997)

The dominant Tricoptera in river Giri was Glossosoma, Letocella, Ageptus. In river Alaknanda Tricoptera is the second largest order and common sps. found were Limnephilus, Leptocella Rhyacophila, Neophylax (Badola, 2009). The tricoptera caddisflies were found to be potential bio indicator for the clean eco-

system since they could be found at the clean upstream of the Langat river (Azrine *et al.*, 2005).

The Hemiptera (true bug) is a widespread and specious order (Muller, 1982), belonging to the infraclass Neoptera, in the division Exopterygota; their wings develop externally and can be folded over the dorsum. Only about 10% of all species of Hemiptera are associated with aquatic environments and these are representatives of 15 families of the Heteroptera (Williams and Feltmate, 1992). Badola (2009) in river Alaknanda also reported Gerris and Mesovelis sometimes in the river. Hemiptera is represented by Gerris and Mesovelis by Rak *et al.*(2011) in three river in Malaysia. In river Giri Hemiptera is represented by only Gerris.

Ejikeme *et al.* (2007) observed that majority of coleopteran were collected during the dry season (October-April) when the river level was drastically reduced and the insect concentrated in small ponds that were formed along the river course during residing flood. Badola (2009) also reported *Psephenus* adult and larvae in River Alaknanda and Nayar.

In River Ganga, Alaknanda, Saung and Nayar, respectively the benthic diversity was recorded to be 0-1.28, 0-2.88, 0-1.66 and 0-2.06 (Nautiyal, *et al.*, 1997). The peak was recorded during

the winter in glacier-fed river the Ganga and Alaknanda. Here, in river Giri Shannon wiener diversity index ranged in between 0.918 (May) to 3.086 (January) (Table 4). The minimum Value of Shannon- wiener index was always observed at site S3 (Barrage site) as compared to other sites. The water of river Giri falls under the category of polluted to clean water. Relative species abundance in a community is another factor that affects diversity (Whittaker, 1965; Hurlbert, 1971) It is measured with a standardized index of species abundance (evenness or equitability) that is typically on a scale ranging from near 0, which indicates low evenness or high single-species dominance, to 1, which indicates equal abundance of all species or maximum evenness (Routledge, 1980; Alatalo, 1981) The benthos species richness was recorded between 2.427(March) at S4 and 11.542 (March & April) at site S4 & S3 during the study. The evenness index of benthos varied between 0.290 (May) at S3 and 0.974 (January) at S4 (Table 4). The evenness index applied to the present study indicated that individual of the benthic community was not evenly distributed.

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Table 1. Monthly average variation in physicochemical parameters of river Giri during the study (Mean ± SD).

Parameters/Months	December	January	February	March	April	May
	Mean±SD	Mean±SD	Mean±SD	Mean±SD	Mean±SD	Mean±SD
Air temperature (°C)	9.50±1.29	9.00±0.82	11.00±0.82	22.25±1.71	23.50±1.29	23.75±1.89
Water Temperature (°C)	8.00±0.82	7.75±0.96	10.50±0.58	16.75±0.96	16.00±1.41	17.00±1.83
Dissolved oxygen (mg l ⁻¹)	11.00±1.15	12.00±1.63	9.25±0.96	7.25±0.96	7.45±0.66	7.80±1.14
Carbon dioxide (mg l ⁻¹)	1.76±0.31	1.82±0.55	1.71±0.49	1.93±0.58	2.04±0.38	1.98±0.40
Alkalinity (mg l ⁻¹)	21.25±2.50	25.00±4.08	36.25±4.79	17.50±6.45	21.25±6.29	27.50±6.45
Transparency (cm)	38.25±3.50	37.50±5.57	40.00±4.08	40.00±4.08	39.00±3.37	40.00±4.08
TDS (mg l ⁻¹)	120.73±33.02	180.35±7.16	103.10±68.09	74.00±12.96	104.63±25.85	101.10±19.08
Salinity	0.25±0.13	0.33±0.17	0.18±0.10	0.35±0.10	0.18±0.10	0.24±0.09
pH	7.20±0.51	7.38±0.78	7.60±1.28	8.05±0.44	7.83±0.56	7.35±1.07
Water current (m sec ⁻¹)	1.25±0.50	1.30±0.48	1.35±0.47	1.25±0.53	1.20±0.54	1.25±0.50

Table 2. Checklist of benthos recorded from river Giri during the study period.

Phylum	Class	Order	Family	Genera	
Arthropoda	Insecta	Coleoptera	Psephenidae	<i>Psephenus</i>	
			Diptera	Simuliidae	<i>Simulium</i>
				Chironomidae	<i>Chironomus</i>
		Ephemeroptera	Heptageniidae	<i>Heptagenia</i>	
				<i>Cinygma</i>	
			<i>Baetis</i>		
			Ephemerellidae	<i>Ephemerella</i>	
		Trichoptera	Philopotamidae	<i>Philopotamus</i>	
			Glossosomatidae	<i>Glossosoma</i>	
			<i>Agapetus</i>		
Hemiptera	Leptoceridae	<i>Leptocella</i>			
	Gerridae	<i>Gerris</i>			

Table 3. Order -wise density of benthos of Giri river at site S1, S2, S3 and S4 during the study period (in Ind m-2).

Order	December				January				February				March				April				May			
	S1	S2	S3	S4	S1	S2	S3	S4	S1	S2	S3	S4	S1	S2	S3	S4	S1	S2	S3	S4	S1	S2	S3	S4
Ephemeroptera	118.42	43.06	0.00	64.59	75.36	118.42	21.53	86.12	75.36	53.83	10.77	118.42	75.36	75.36	0.00	183.01	53.83	53.83	0.00	107.65	43.06	107.65	0.00	86.12
Diptera	21.53	64.59	10.77	21.53	32.30	43.06	10.77	32.30	32.30	53.83	21.53	21.53	21.53	10.77	43.06	21.53	21.53	10.77	64.59	0.00	32.30	0.00	43.06	
Trichoptera	32.30	43.06	21.53	43.06	53.83	53.83	32.30	53.83	21.53	53.83	21.53	64.59	10.77	43.06	10.77	21.53	43.06	64.59	0.00	64.59	53.83	64.59	21.53	75.36

	December				January				February				March				April				May			
Coleoptera	21.53	10.77	0.00	32.30	21.53	0.00	0.00	21.53	21.53	10.77	0.00	53.83	10.77	10.77	0.00	43.06	21.53	53.83	0.00	10.77	10.77	0.00	0.00	0.00
Hemiptera	0.00	10.77	21.53	0.00	0.00	0.00	10.77	0.00	0.00	10.77	32.30	0.00	0.00	0.00	0.00	0.00	10.77	0.00	10.77	0.00	0.00	0.00	10.77	0.00
Miscellaneous	10.77	0.00	10.77	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.77	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.77	0.00	0.00
Total Density	204.54	172.24	64.59	161.48	183.01	215.30	75.36	193.77	150.71	183.01	86.12	269.13	118.42	150.71	21.53	290.66	150.71	193.77	21.53	247.60	107.65	215.30	32.30	204.54

Table 4. Diversity index (H'), Richness (d') and Evenness (e) of benthos of Giri river at site S1, S2, S3 and S4 during the study period.

Months	Sites	H'	d'	e
December	S1	2.985	2.717	0.942
	S2	3.078	2.885	0.971
	S3	1.918	4.465	0.605
	S4	2.657	2.954	0.838
January	S1	2.851	2.824	0.899
	S2	2.984	2.670	0.941
	S3	2.807	4.111	0.886
	S4	3.086	2.768	0.974
February	S1	2.896	3.031	0.914
	S2	2.845	2.824	0.898
	S3	2.156	3.847	0.680
	S4	2.995	2.485	0.945
March	S1	2.845	3.336	0.898
	S2	2.985	3.031	0.942
	S3	1.000	11.542	0.315
	S4	2.788	2.427	0.879
April	S1	2.753	3.031	0.869
	S2	2.594	2.768	0.818
	S3	1.000	11.542	0.315
	S4	2.997	2.551	0.945
May	S1	2.922	3.474	0.922
	S2	2.971	2.670	0.937
	S3	0.918	7.282	0.290
	S4	2.800	2.717	0.883

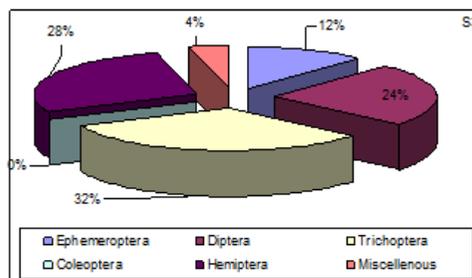


Fig 3. Percentage contribution of benthos of Giri river at site S3.

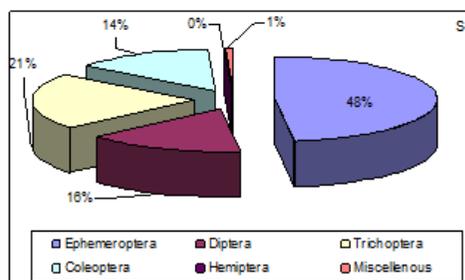


Fig 4. Percentage contribution of benthos of Giri river at site S4.

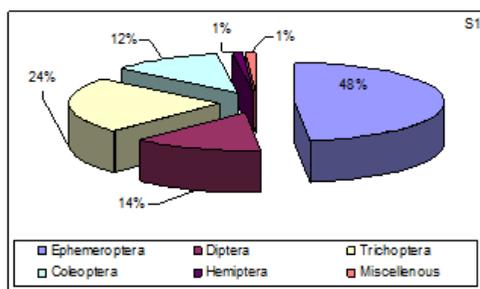


Fig 1. Percentage contribution of benthos of Giri river at site S1.

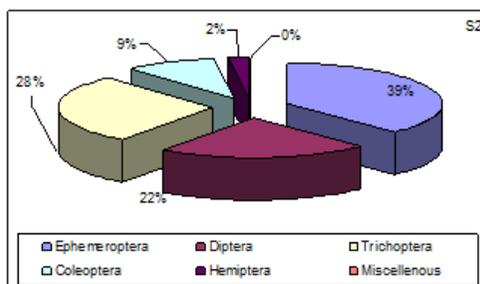


Fig 2. Percentage contribution of benthos of Giri river at site S2.

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