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CHECKLIST OF MACROINVERTEBRATES OF BINWA A WESTERN HIMALAYAN HILL STREAM AND THEIR ROLE AS BIOINDICATOR

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Abstract

Hydrobiological studies were made on Binwa stream in district Kangra (Himachal Pradesh). Four observation sites have been set up on the stream i.e. Kharli(S_1), Baijnath (S_2), near Near Chobin (S_3) and Triveni (S_4) and water samples were analyzed for physico-chemical and biological parameters for one year. Water temperature, water current, dissolved oxygen, turbidity, pH, phosphate and nitrate had played important role in determining the variations in planktonic and benthic fauna of the stream. Phytoplankton dominated the plankton and had more diversity at S_4. Thirty species of macroinvertebrates have been recorded from the stream and Ephemeropteran naiads were the dominant in abundance and diversity. These aquatic insect larvae (EPT) served as bioindicators of pollution. Hydrobiological studies revealed that stream have no pollution at S_1, while it is oligotrophic from S_2 to S_3 and meso- oligotrophic at S_4.

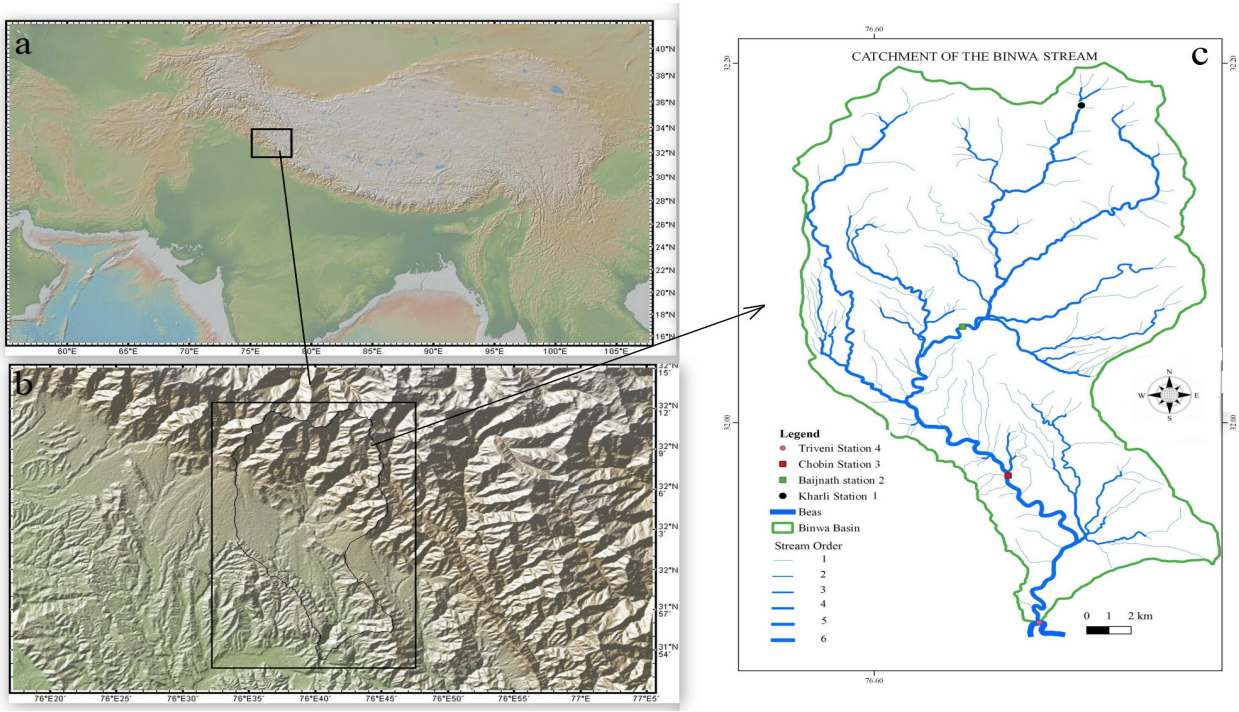
Keywords: Benthos, Binwa stream, Plankton, Diversity indices, Hill stream, Naiads.

Introduction

Binwa, a western Himalayan stream of India, plays an important role in the ecology of river Beas. It is torrential in nature and supports a vast community of the macroinvertebrates and serve as the main breeding ground for the fishes of Beas. Little information is available on the ecology of this stream. The works on hill stream ecology (Hynes, 1970; Hutchinson, 1991; Jindal and Sharma, 2011 a and Jindal *et al*., 2012) are worth mentioning. At few spots addition of sewage and mining activities affected the water quality and biodiversity of the stream. So, physico-chemical analysis of water and changes in biodiversity particularly insect larvae may be used in biomonitoring of the stream. Keeping this in view, present investigation on ecology of Binwa stream has been undertaken.

Study area

For the present investigation, water samples have been collected from Binwa, a Mid Himalayan hill stream of the Dhauladhar range, located in district Kangra (Himachal Pradesh, India). From its mouth to its head, the Binwa stream covers a distance of about 50km. However, in this relatively short distance it experiences an impressive fall of about 3100m (3678m elevation at its head and 539m at its mouth). The main habitat is comprised of runs and riffles with some pools and a substrate of boulders and cobbles. For the collection of water samples, three sites with different habitats along the length of stream have been identified i.e. at Kharli (S_1), Baijnath (S_2), near Chobin (S_3) and Triveni (confluence with Beas) (Fig. 1).



Map of study area showing observation sites

Material and Methods

Monthly water samples have been collected for one year (March-12 to Feb.-13). Physico-chemical parameters of the water were analyzed according to the standard methods (APHA, 1998). For plankton study, 100 litres of water was filtered through plankton net made up of bolting silk No. 25 (0.3 mm mesh) and fitted with a wide mouthed bottle. Plankton were preserved in 4% formaldehyde solution. Macroinvertebrates were collected in sampler net by making disturbance in the substratum of the stream and then preserved in 4% formaldehyde solution. Density of these macroinvertebrates mentioned as individual per square meter. The books consulted for the identification of the plankton and benthos were: (Ward and Whipple, 1959; Kudo, 1986; Pennak, 1989; Merritt & Cummins, 1996, Thorp and Covich, 2001 and Subramanian and Sivaramakrishnan 2007). Counting of plankton was done with the help of 'Sedgwick-Rafter counting cell (Wetzel and Likens, 1991). Species diversity was calculated using diversity indices (Shannon and Wiener,1949; Simpson, 1949).

1. Simpson's Biodiversity index

$$D = \sum n_i (n_i - 1) / N(N-1)$$

D = diversity index, N = total number of individuals of all species, *n* = number of individuals of a specific species, *i* = subscript to denote the number of different species.

2. Shannon and Wiener Diversity Index

$$H = -\sum pi \log_e pi$$

Where, H = diversity index; pi = ni/N (ni = number of individuals in species i; N = total number of individuals in the sample

3. EPT Index (Epheameroptera, Plecoptera, Trichoptera) =

$$\frac{\text{Total EPT Taxa}}{\text{Total Taxa Found}} \times 100$$

Results and Discussion

Fluctuations in physico-chemical characteristics of water at different observation sites on the stream have been given in Table 1.

Table 1: Monthly average value and range of various physico-chemical parameters of water at four stations (S_1, S_2, S_3, and S_4) on Binwa stream (Mar.2012 to Feb. 2013).

Parameter	Kharli (S_1)*		Baijnath (S_2)		near Chobin(S_3)		Triveni (S_4)	
	Mean	Range	Mean	Range	Mean	Range	Mean	Range
Water temperature (°C)	10.28	8.3-11.5	17.06	8.7-23.8	18.32	10.1-24.6	19.10	10.9-24.8
Water current (cm/sec.)	92.50	65-110	97.89	79.23-129.8	85.35	67.4-114.5	75.48	61.2-96.5
Conductivity (□S/cm)	100.50	78-115	207.67	148-265	212.92	156-270	223.42	166-287
Turbidity (NTU)	3.44	0.25-6.56	4.82	0.35-11.9	5.80	0.6-14.2	5.99	2.1-12.17
Dissolved oxygen (mg/L)	10.83	10.2-11.3	10.28	8.17-12.8	9.52	8.2-11.5	8.84	6.8-10.8
Free CO_2 (mg/L)	1.96	1.3-2.8	7.61	3.7-12.4	8.72	4.4-14.5	11.28	6.5-18.5
pH	8.12	7.96-8.21	7.82	7.5-7.98	7.87	7.5-8.2	8.31	7.9-8.57
Chloride (mg/L)	3.36	1.5-4.7	13.20	8.1-20.1	14.96	10.5-20.7	16.92	11.5-24.5
Total alkalinity (mg/L)	50.83	26-73.1	102.10	71.2-119.8	106.02	73.7-123.2	107.63	70.1-135.3
Phosphates (mg/L)	0.02	.012-.035	0.04	.01-.067	0.05	0.02-0.08	0.11	0.04-0.22
Nitrates (mg/L)	0.01	.003-.016	0.03	0.016	0.04	0.023-0.07	0.07	0.04-0.13
TDS (mg/L)	75.35	61.5-96.5	115.70	95	117.24	95.45-142.5	136.01	110.3-162.3

*For station S_1 water samples were not collected Dec.-12 to Mar.-13 due to non accessibility to the site (snow)

As the high temperature recorded at S_2 and S_3, which leads to increased water temperature then S_1 and S_2 (relatively high altitude stations) leads to increase in water temperature at S_2 and S_3. Due to high rate of evaporation at relatively high temperature, the concentration of nitrates and phosphates showed an increase, thereby showing a positive correlation with temperature and population of Dipteran. While temperature showed an inverse co-relation with pH. This was because of the fact that at higher temperature decomposition of organic matter was higher and thus more carbon dioxide was produced, which resulted in decrease of pH (Trivedy *et al.,* 1990; Bhatnagar and Garg, 1998; Jindal and Singh, 2006; Jindal and Singh, 2013).

Water current was found to be relatively higher at S_1, S_2, and S_3 then S_4. Fast water current during rainy season resulted in poor planktonic yield. It not only caused mechanical danger to the plankton but also resulted in high turbidity which led to low planktonic production (Jindal and Vashisht, 1981; Jindal and Rumana, 2000). Similarly water current plays limiting factor in case of macroinvertebrate population of the stream (Jindal and Singh, 2013)

Higher values of DO were recorded in winter (December-12 and January-13) which were due to better oxygen holding capacity of water at low temperature, as has been advocated by (Chakrabarty *et al.,* 1959; Ali, 1999; Iqbal *et al.,* 2006). The studies also revealed that any minor fluctuation in the value of DO dramatically affected the benthic population of insect larvae of the stream. Maximum values of conductivity were observed during late summer (S_2; S_3; S_4). Minimum values of conductivity were noticed during winter months (in all the stations). Comparative analysis at four experimental stations indicated relatively higher values of conductivity at S_4, due to accumulation of sewage and runoff from different human habitations at S_2 and S_3 directly or indirectly (Chopra and Rehman, 1995; Jindal and Sharma, 2011b).

Higher values of nitrate and phosphate were observed during monsoon (July-August-12). These were because of surface run off from catchment area and lesser number of phytoplankton – the consuming agency. Further, as suggested by (Gurumayum *et al.,* 2002), rain water contributed substantially towards the supply of nitrates. An inverse correlation has been observed between nitrates and DO (Ali, 1999). It may be emphasized here that the conversion of nitrogenous organic matter to nitrites and

nitrates is brought about by anaerobic bacteria which are more active in waters low in oxygen.

Aquatic biota was comprised of phytoplankton, zooplankton and benthos. Phytoplankton were comprised of members of Bacillariophyceae, Chlorophyceae, Cyanophyceae, Chrysophyceae, Euglenophyceae and Zooplankton were composed of Protozoa, Rotifera and Crustacea. Plankton were dominant at S_4 due to more pool type habitat and slightly high content of phosphate and nitrate.

Total30 species of macroinvertebrates have been collected from the stream. Among them belonging to Plecoptera (*Perla* sp., *Nemoura* sp., *Isoperla* sp.), Coleoptera (*Psephnus* sp., *Helophorus* sp., *Hydroporus* sp., *Hydaticus* sp., *Naucoris* sp.) Ephemeroptra (*Ceanis*sp., *Beatis himalayana*, *B. bifurcatus, Ecdyonurus sp., Epeorus* sp., *Ephemera consors, E. Remensa, Heptagenia* sp., *Iron suspicatus, Cinygma* sp.) and Trichoptera (*Hydropsyche* indica, Stenopsyche sp., and *Rhyacophila* sp.) have been used for calculation of EPT index, Simpson's Biodiversity index and Shannon and Wiener Diversity Index because these are intolerance for pollution. The larvae of these insects also act as bioindicators of water pollution (NCDEHNR, 1997; Mohan, 2004; Chauhan and Verma, 2016). Ephemeroptra dominated in abundance and diversity throughout the stream.

Table 2: Station wise checklist of organism recorded from Binwa stream showing their diets and feeding habits as observed during study period (Mar. 2012 to Feb. 2013)

Organism recorded	S_1* (2822 msl)	S_2 (945 msl)	S_3 (746msl)	S_4 (572msl)	Feeding habit	Diet
Perla	+	-	-	-	Pr/ Scr/ C+F	Omnivorous
Nemoura	+	+	-	-	C+G/ Shr	Detritivore/Herbivore
Euphaea	-	+	+	-	Pr	Carnivorous
Orthetrum	-	-	+	+	Pr	Carnivorous
Isoperla	-	+	-	-	Pr	Carnivorous
Culex larvae	-	-	+	+	C+G	Herbivore
Hydropsyche sp.	-	+	+	-	C+F	Omnivorous/ Detritivore
Stenopsyche	+	+	-	-	C+G	Omnivorous
Rhyacophila	-	-	+	+	Pr	Carnivorous
Hydropsyche indica	+	+	+	-	C+F	Detritivore/Herbivore
Psephnus	+	+	+	-	Scr	Detritivore/Herbivore
Hydaticus	-	+	+	+	Pr	Carnivorous
Naucoris	-	+	+	+	Pr	Carnivorous
Ceanis	-	+	+	-	C+F	Detritivore/Herbivore
Beatis himalayana	+	+	+	+	C+F	Detritivore/Herbivore
B.bifurcatus	-	+	+	-	C+F	Detritivore/Herbivore
Ecdyonurus	-	+	+	+	C+F	Detritivore/Herbivore
Epeorus	-	+	+	-	C+F	Herbivore
Ephemera consors	-	-	+	+	C+F	Detritivore
E. remensa	-	-	+	-	C+F	Detritivore
Heptagenia	-	+	+	-	Scr	Herbivore
Iron suspicatus	+	+	+	-	Scr	Herbivore
Cinygma	-	+	+	+	Scr/ C+G	Herbivore
Glossiphonia	-	-	+	+	-	-
Limex	-	+	+	+	-	Omnivorous
Hydroporus	-	+	+	+	Pr	Carnivorous
Helophorus	-	+	+	+	Pr	Carnivorous
Eristalis larvae (rat-tailed maggot)	-	-	+	+	-	-
Chironomus	-	+	+	+	-	Omnivorous
Simulium	-	-	-	+	-	-

(Predator=Pr; Collector& Gatherer=C+G; Scrapper=Scr; Collector & filter feeder=C+F; Shredder=Shr)

Table 3 : Showing different Biodiversity Indexes on all the observation sites on Binwa stream

Stations	EPT index	Simpson's Biodiversity index	Shannon and Wiener's index	Margalef Richness index	Water quality* values
S_1*	85%	0.16	2.51	1.39	Excellent
S_2	57.14%	0.04	4.3	4.247	Good
S_3	48%	0.038	4.53	5.01	Good
S_4	31.25%	0.05	3.8	3.5	Good-fair

*Values are in comparison to values provided by (NCDEHNR, 1997) for EPT index.

EPT index is very high for station S_1 (high values of DO and insignificant anthropogenic interference), species diversity is low at this point but evenly distributed. While EPT index is good in remaining three stations showing the drinkability of the stream water, high species diversity recorded at S_3, this might be due to moderate water current and DO, presence of Phosphate and nitrate and variety of habitat (run, riffle and pools).

Dipteran larvae (*Culex* larvae, *Eristalis* larvae (rat-tailed maggot) and *Chironomus* sp.) have been observed only at S_3 and S_4, while *Simulium* sp. reported only at S_4.Presence of these dipteran larvae at low DO and relatively high chloride, phosphate and nitrate show their tolerance for the organic pollution. These organisms predict the low water quality at S_3 and S_4 in comparison to S_1 and S_2 where pollution load is low.

Conclusion

Binwa stream supports the vast community of macroinvertebrates, which shows that stream is in a good health from human consumption perspective. The addition of sewage and agricultural runoff into the stream mitigated by natural purification as observed during the physic-chemical analysis of its water. Stream is breeding and feeding grounds of Beas river fishes and particularly *Tor* sp. Therefore, the stream has to be preserved and holistic management is required for conservation of its special ecological habitat.

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