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Benthos composition of a hill stream in Western Himalayas

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Abstract

Among the macro-invertebrates of Sheerkhad stream, the nymphs of mayflies emerged as the dominant group (40-67%) reaching their highest population during summer months, whereas the larvae of caddis flies (33·65%) dominated the winter crops of the aquatic insects, showing their aptitude to the cold-water temperatures. The periphytic communities were constituted by diatoms (77·68%), green and filamentous algae (12·73%) and blue-green algae (9·39%) with the highest densities during spring months when stream water was slightly warmer with increased length of day light. Due to the detrimental effect of flood the densities of benthic organisms were found to be low during the monsoon months.

Key words: Benthos, macro-invertebrates, hill streams.

1. Introduction

The lotic environment in temperate regions has attracted a number of researchers to enumerate the eco-biological status of the fluvial resources[1-6]. In India, however, very scanty information is available on the riverine ecology, especially of the upland waters of Himalayas[7-10]. The present communication, apart from giving detailed qualitative and quantitative estimations of the benthic communities of a spring-fed stream, the Sheerkhad, a tributary of R. Sutlej in Western Himalaya, also describes the physico-chemical parameters of the stream.

2. Study site

Sheerkhad stream originates from Talangra and Chayarun areas in Sarkaghat region of Himachal Pradesh, at an elevation of approximately 933 m (Fig. 1). The stream after draining the southern slopes of Himalayan foothills flows from north to south before joining Gobindsagar reservoir (R. Sutlej system) near Jeorghat at an elevation of 500 m. About 16-km stretch in the downstream of Sheerkhad is influxed by the

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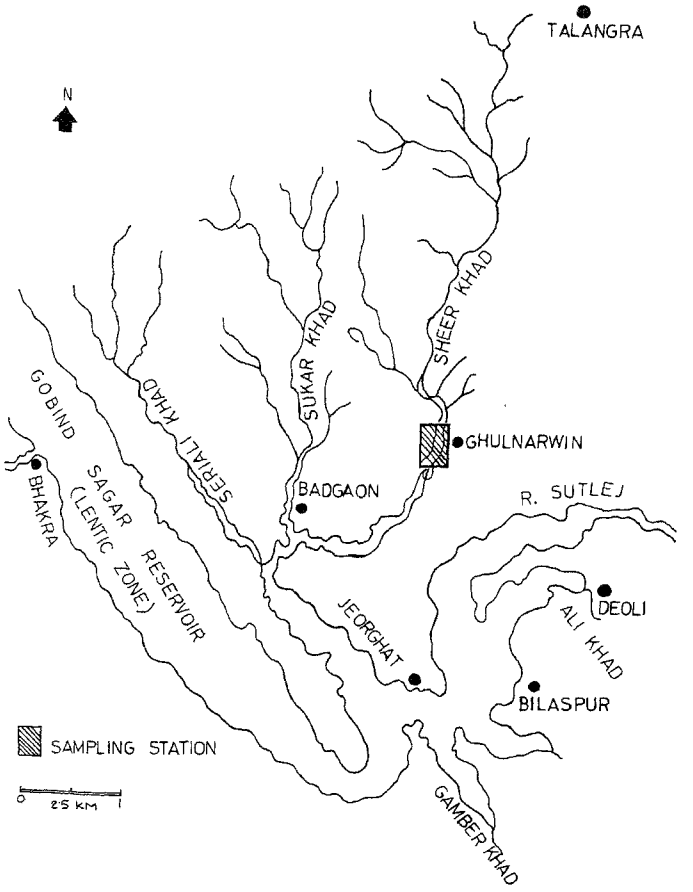

FIG. 1. Sketch map of Sheerkhad stream showing the sampling areas.

reservoir for a large part of the year. Though a number of perennial and seasonal tributaries join the stream at different places throughout its 70-km-long stretch, only Sukar and Seriali khads drain considerable water into it.

The total catchment area of the stream forming about 1627 km^2 is covered with the forest of *Pines, Acacia* and *Zyzypus* in the upper reaches and shrubs and thorny bushes in the lower. Though the course of the stream is through shruby pastures and rocky contours, agricultural and grazing fields are also traversed by it. There are a number of small-to-medium-sized shallow and deep pools, falls and rapids throughout its course, with variations in the width of the stream. The floods, however, bring about drastic changes in the nature of the stream by replacing the substrata together with alternation of the rapids and pools.

3. Material and methods

For the present study, the periphyton sample collection from the non-living objects in the stream was made as per the methods of Edmondson and Winberg[11] and Vollenweider[12]. The periphytic organisms from natural substrata (smooth surface stones) were scrapped with the help of a sharp-edged knife and the material was brushed and collected in a glass tube for qualitative and quantitative estimations in the laboratory.

A surber sampler was used for collecting the bottom macro-invertebrates of the stream. The material collected was fixed in 5% formaline and brought to the laboratory for analysis. The samples were collected during April, 1983 to March, 1985 from a fixed station selected in the middle stretch of the stream near Ghumarwin in Bilaspur district of Himachal Pradesh. Water quality parameters like transparency, temperature, pH, dissolved oxygen, free carbon dioxide, total alkalinity, calcium, magnesium and silicates were estimated as per APHA[13] and Golterman *et al* [14].

4. Observations and discussion

4.1. *Physico-chemical factors*

During the large part of the year the substrata of the stream consisting mainly of stones, pebbles, gravel and sand was found to be covered by mucilagenous algal mats except during monsoon months when it was completely washed off by floods or replaced by new deposits. The current velocity of the stream varied greatly in the rapids, falls and pools. It ranged from 0·12 to 0·23 m/sec during the lean period and 2·38 to 2·68 m/sec during the monsoon. Similarly, the average depth of the stream also varied from 0·18 m in the lean period to 0·62 m in the monsoon due to the incursion of the flood water. The water of the stream was clear during the large part of the year with the exception of monsoon months (July-September) when sudden drop in transparency (0·2 m) was noted with water turning muddy brownish. The water temperature during the study period ranged between 12·5 and 31·5°C, the lowest being in January and the highest in June (Table I).

Table I
Monthly average values of the physico-chemical factors of Sheerkhad during 1983-85

Month	*Water temp. (°C)*	*pH unuts*	*Dissolved oxygen (ppm)*	*Free carbon dioxide (ppm)*	*Total alkalinity (ppm)*	*Calcium (ppm)*	*Magnesium (ppm)*	*Silicates (ppm)*
January	12·75	8·2	11·38	2·0	126·0.	31·8	7·2	3·5
February	14·25	8·2	11·06	3·0	123·0	30·6	6·9	3·7
March	16·0	8·1	9·98	Nil	111·8	28·5	6·6	3·5
April	22·5	8·1	8·50	2·0	114·9	28·2	6·9	3·5
May	27·0	8·0	8·32	2·5	109·0	27·2	6·9	3·9
June	30·25	7·8	7·28	4·5	98·0	26·1	6·55	4·5
July	28·5	7·7	7·92	4·0	91·0	24·5	5·4	5·1
August	27·5	7·8	8·36	3·0	88·0	24·5	4·6	5·5
September	27·75	7·7	8·36	3·5	92·0	25·1	5·2	4·7
October	29·25	7·8	8·24	3·5	96·0	26·8	5·8	4·3
November	18·0	7·9	9·68	4·0	100·0	28·0	6·7	3·7
December	14·75	8·1	10·10	2·0	110·0	30·1	7·0	3·3

Among the chemical parameters of the stream water, the concentration of the dissolved oxygen was quite high, ranging from 7·04 ppm in June to 11·40 ppm in January, in contrast to ample free carbon dioxide (2·0-5·0 ppm) during the summer months. Though no definite trend was depicted in the pH fluctuations (7·6-8·3), total alkalinity values were maximum (128·0 ppm) in January and minimum (86·0 ppm) in August. A second maxima for this parameter was also recorded during the month of April. Calcium and magnesium contents, ranging from 24·0 to 32·0 ppm and from 4·2 to 7·4, respectively, were also found to follow a similar trend (alkalinity being high during winter and spring months). The silica content in the stream was maximum (5·2 ppm) in December.

4.2. *Periphyton*

For the present study, the periphyton samples were collected from the stones at the bottom considering them as the best source for algal growth in the hill streams. In Sheerkhad, the periphytic community is constituted by 41 genera of three major groups of algae, the Bacillariophyceae, the chlorophyceae and the cyanophyceae (Table II). The occurrence of zoo organisms, mostly contributed by fresh-water nematodes, in the total periphytic populations was negligible (0·2%). The average periphyton population was 25040 units/cm^2, the maximum being 48500 units/cm^2 in March, 1985, and the maximum densities of epilithic algae were observed in the spring months (Fig. 2) with slight rise in water temperature and increased day length. Similar observations were also made by Round[2-3], Moss and Round[4], Moore[5] and Eloranta[6] in some European streams. They have concluded that increased day-light length with appropriate solar radiation is probably the most important factor initiating rapid algal growth during the spring methods.

Table II
Periphytic forms recorded from Sheerkhad during 1983-85

Bacillariophyceae	*Chlorophyceae*	*Cyanophyceae*
Navicula radiosa	*Cladophora glomorata*	*Amphithrix janthina*
Melosira ambigua	*Cylindrocapsa sp.*	*Oscillatoria proteus*
Fragilaria capucina	*Chaetophora incrassata*	*Phormidium sp.*
Gomphonema acuminatum	*Cosmarium minimum*	*Anacystis sp.*
Nitzschia acicularis	*Closterium pronum*	*Anabaena oscilleriodei*
Diatoma elongatum	*Ankistrodesmus convolutus*	*Scytonema sp.*
Asterionella sp.	*Hydrodictyon sp.*	*Spirulina sp.*
Tabellaria fenestrata	*Microspora amoena*	
Synedra ulna	*Mougeotia sp.*	
Gyrosigma kutzingi	*Pithophora sp.*	
Opephora sp.	*Rhizoclonium sp.*	
Rhoicosphenia sp.	*Scenedesmus obliques*	
Meridion circulare	*Spirogyra varians*	
Cocconeis placentula	*Uronema elongatum*	
Amphora bitumida	*Ulothrix zonata*	
Cyclotella stelligera	*Zygnema insigne*	
Cymbella prostrata		
Stauroneis sp.		

Whiteford and Schumacher[15] opined that diatoms grow best at low temperatures and medium-to-high day-light length. In Sheerkhad also, the population of the diatoms contributing 77·68% to the total flora was the highest (37340 units/cm^2 in February, 1984) during spring months when the average water temperature was comparatively low (14·5°C) with slightly increased duration of day light. The predominant forms of diatoms recorded during two years of study were *Navicula radiosa* (19·09%) and *Fragilaria capucina* (14·45%) with highest densities during February and March, respectively. *Cymbella prostrata* (14·94%) was maximum during January in the first year and during November in the subsequent year (Fig. 2).

The green and filamentous algae (Chlorophyceae) contributed 12·73% of the epilithic crop during the two years of study with the maximum densities being 6100 units/cm^2 in February during the first year and 7040 units/cm^2 in November during the second year. Among the 16 taxa of Chlorophyceae (Table II), *Cladophora glomerata* appeared as dominant form with maximum densities of 4920 units/cm^2 in October during 1983-84 and 5800 units/cm^2 in November during 1984-86. The predominance of this algae in total periphytic group was noticed during August to November in both the years of study (Fig. 2).

The contribution of blue-green algae in the total algal crop was 9·39% with maximum densities of 3780 units/cm^2 in April during the first year and 7780 units/cm^2 in March during the second. Among the taxa recorded under this group, *Amphithrix* spp. was the only predominant form with maximum population in March and April in both the years (Fig. 2), at slightly higher temperatures (14·5-24·0°C).

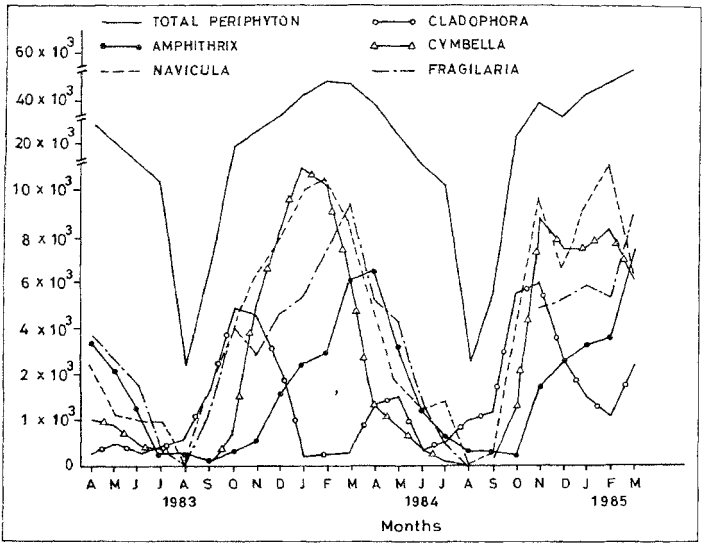

FIG. 2. Seasonal fluctuations of the total periphyton along with predominant forms in Sheerkhad stream.

4.3. *Macro-invertebrates*

The aquatic insects, contributing 99·14% to the macro-invertebrate population in Sheerkhad stream during 1983-85, were represented by Ephemeroptera (40·67%), Trichoptera (33·65%), Plecoptera (10·11%), Coleoptera (7·77%), Diptera (5·03%), Odonata (1·01%) and Hemiptera (1·00%) in the order of their abundance (Tables III and IV). The remaining 0·76% included molluscan shells, oligochaetes, nematodes and planarians, and crab fry in negligible densities.

The highest densities of benthic animals were recorded during summer months with maximum populations of Ephemeroptera (149 no./m^2 in May, 1984) which corroborates with the findings of Hemsworth and Brooker[16]. The winter crop of the macro-invertebrates was found to be dominated by the larvae of caddis flies (Table IV) that, according to Ross[17], were characteristically the inhabitants of cold-water streams. In Sheerkhad, the maximum density of larvae of caddis flies, 96 no./m^2, was recorded in February, 1985. The maximum occurrence of the nymphs of stone

Table III
Macro-invertebrates recorded from Sheerkhad during 1983-85

ODONATA	PLECOPTERA	COLEOPTERA	DIPTERA
Agrion	*Perla*	*Psephenus*	*Blepharocera*
Cordulegaster	*Chloroperla*	*Helmis*	*Atherix*
Gomphus	*Isoperla*	*Gyrinus*	*Antocha*
	Nemoura	*Dytiscus*	*Chironomus*
		Haliplus	*Simulium*
		Elodes	*Tendipes*
		Ptilodactylus	*Tabanus*
		Hydrophilus	*Ephydra*
			Psychoda
EPHEMEROPTERA	**HEMIPTERA**	**TRICHOPTERA**	**NEUROPTERA**
Heptagenia	*Cornixa*	*Hydropsyche*	*Sailis*
Ephemerella	*Gerris*	*Brachicentrus*	
Ecdyonurus		*Chimarra*	
Caenis		*Mystacids*	
Baetis	**MOLLUSCA**	*Rhyacophila*	**MISCELLANEOUS**
Iron	*Lymnaea*	*Philopotamus*	Plannarians
Siphlonurus	*Pisidium*	*Lepidostoma*	Oligochaetes
Rhithrogena		*Setodes*	Crab fry
Brachycircus			Nematodes

flies, the third biggest group of aquatic insects in the stream, was also recorded during the winter months (Table V). The average density of fly larvae and aquatic beetles in Sheerkhad was 5 and 8 no./m^2, respectively, without any significant variation throughout the study period.

It has been observed that the stone-inhabitating fauna in Sheerkhad stream has much similarity to that of the forms recorded from other parts of the Himalayas[7-10]. The dominance of the aquatic insects in all the samples of benthos of Sheerkhad stream was conspicuous.

In Sheerkhad, the floods not only reduced the periphyton densities to 2380 and 2560 units/cm^2 during August in both the years of study, but also resulted in complete wash-off of the macro-invertebrates to an average 2-6 no./m^2. The detrimental effect of the current on stream biota has also been reported in Harkiwi[1], Nayar[9], Towy[18] and Provo[19] rivers.

5. Conclusions

The present observations revealed that the occurrence and distribution of the benthic animals in this hill stream varied from season to season. No direct relationship could

Table IV
Average population density and per cent composition of various groups of macro-invertebrates of Sheerkhad stream recorded during 1983-85

Months	*Total benthic populations*	*Odonata*		*Coleoptera*		*Ephemeroptera*		*Trichoptera*		*Diptera*		*Plecoptera*		*Miscellaneous*	
	no./m²	*no./m²*	%	*no./m²*	%	*no./m²*	%	*no./m²*	%	*no./m²*	%	*no./m²*	%	*no./m²*	%
January	130	–	–	12	9·23	26	20·0	61	46·92	10	7·6	20	15·38	1	0·76
February	160	1	0·62	7	4·37	39	24·37	82	51·25	11	6·87	18	11·25	2	1·25
March	128	1	0·78	4	3·12	51	39·84	37	28·90	6	4·68	27	21·09	2	1·56
April	167	2	1·19	20	11·47	87	52·09	45	26·94	8	4·79	3	1·79	2	1·79
May	210	2	0·95	27	12·85	111	52·85	47	22·38	10	4·76	7	3·34	6	2·85
June	147	1	0·68	19	12·92	74	50·34	30	20·40	12	8·16	9	6·12	2	1·36
July	7	–	–	1	14·28	2	28·57	2	28·57	–	–	2	28·57	–	–
August	2	–	–	–	–	–	–	1	50·0	–	–	1	50·0	–	–
September	18	1	5·56	1	5·56	7	38·88	3	16·66	2	11·11	4	22·22	–	–
October	91	1	1·09	3	3·30	35	38·46	40	43·95	3	3·29	8	8·80	1	1·09
November	64	1	1·56	2	3·12	25	39·06	13	20·31	4	6·25	17	26·56	2	3·12
December	67	1	1·49	3	4·47	29	43·28	22	32·84	4	5·97	6	8·97	2	2·99

be established between the macro-invertebrate populations, periphyton and physico-chemical features. Besides the nature of the stream, its gradient, substrata, fast current and water temperature appear to play an influential role in determining the abundance and occurrence of various benthic forms.

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