LIMNOLOGICAL SURVEY OF SOME FRESH WATERBODIES IN KUPWARA REGION OF KASHMIR HIMALAYA

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ABSTRACT

Some fresh waterbodies of district Kupwara in Kashmir Himalaya were studied for their limnology. The results showed that the streams were poor in nutrients compared to springs and differed markedly in their biotic set-up in terms of periphytic algae and macroinvertebrates. The species similarity coefficient was high among streams.

INTRODUCTION

Biota reflects the water quality of a waterbody and the water quality in turn reflects the ecological conditions of its catchment. The studies about the water quality and biota of waterbodies have shown a definite relationship among each other and also that even a single feature can change the community structure of a waterbody. The chemical composition of water plays a critical role in every aquatic system and the nutrient enrichment may adversely affect stream animal communities. Streams provide varied and challenging conditions for organisms that in turn adapt themselves physiologically as well as morphologically to thrive in such environments (Hynes, 1970). Bourassa & Cattaneo (1998) observed the enriched streams to have increased invertebrate biomass and altered invertebrate communities and excessive levels of algae have been shown to disturb the invertebrate community structure (Nordin, 1985; Dodds and Welch, 2000).

Situated to the extreme north-west of the Jammu and Kashmir, the aquatic habitats of the Langate and Kaehmeel Forest Divisions in district Kupwara of the State have remained untouched by the limnologists mainly because of being a highly disturbed military area and also it being far away from the capital city of Srinagar. To date there is no published information about the limnological features of the waterbodies of the remote district, though some information is available on other such waterbodies of Kashmir (Qadri *et al*., 1981; Pandit *et al*., 2001; 2002; Bhat and Pandit, 2006; Yousuf *et al*., 2006). In this backdrop it was thought worthwhile to work out the physico-chemical features of water and the structural aspects of biotic communities inhabiting nine waterbodies of the area.

STUDY AREA

District Kupwara is situated between 34° 15′ to 34° 45′ N Lat. and 74° 35′ to 74° 45′ E Long. For the present study nine waterbodies including seven streams and two springs were ecologically monitored. The Mawar nalla (Alt. 2,300 m a.s.l) and its four tributaries including Bungus (2,550 m a.s.l), Qazinag (2,500 m a.s.l), Radha (2,900 m a.s.l) and Toot-mar Gully (3,100 m a.s.l) fall in the Mawar Range of Langate Forest Division. The other two streams include Wuddar nalla (2,200 m a.s.l) falling in the Rajwar Range of Langate Forest Division and Kaehmeel nalla (2,300 m a.s.l) lying in Kaehmeel Forest Division. The two springs surveyed included a small spring, Misha Saheb nag, in Rajwar Range and a large one, Trehgam nag, in Kaehmeel Forest Division. The two springs lie in the shade of thick canopy of chinar trees. The bottom substrate of streams was dominated by boulders, cobble and gravel with extremely low organic matter, while as the spring bottom substrate contained a lot of fine sand and silt with a huge amount of decaying leaves.

MATERIAL AND METHODS

Water samples were collected on seasonal basis from autumn 2005 to summer 2006 in one litre polyethylene bottles for chemical analysis in the laboratory. Water temperature and dissolved oxygen were recorded on spot. The water samples were analyzed following CSIR (1974), APHA (1998) and Wetzel and Likens (1991). Among biological parameters macroinvertebrates and periphytic algae were assessed. Triplicate samples of macroinvertebrates were collected using a D – frame kick net of 500µm mesh size, preserved in 5% formalin and identified using standard taxonomic works of Pennak (1978), Merritt and Cummins (1996) and Engblom and Lingdell (1999). Periphytic algae were collected and preserved following Biggs and Kilroy (2000) and identified after Edmondson (1959), Cox (1996), Plaskitt (1997) and Biggs and Kilroy (2000).

RESULTS AND DISCUSSION

The water was in general alkaline as pH of more than 7.3 was recorded in all the waterbodies. While as streams depicted low conductivity values of less than 100µScm^{-1}, springs showed significantly higher values than the streams (Table 1). In contrast, springs depicted lower dissolved oxygen content and higher concentration of free carbon dioxide as compared to streams. Significant variations were also observed in PO_4^{-2} and NO_3^{-2}–N concentrations among the various waterbodies. The present study revealed the streams to have very low levels of total hardness. In general, the nutrient levels were comparatively higher in springs than the streams.

Table 1: Physico-chemical features (annual mean values) of the selected waterbodies

Parameter	Bungus nalla	Mawar nalla	Wuddar nalla	Kaehmeel nalla	Qazinag nalla	Radha nalla	Toot-mar Gully nalla	Misha Saheb nag	Trehgam nag
Water temperature (C)	8.0	8.5	11.5	10.0	8.0	8.0	7.5	15.5	14.0
pH	7.7	7.4	7.9	8.0	7.3	7.4	8.2	7.4	7.4
Conductivity (µScm^{-1})	57	70	88	59	51	45	70	310	271
D.O. (mgL^{-1})	9.8	8.6	7.8	8.2	8.5	8.0	8.5	5.2	6.4
Free CO_2 (mgL^{-1})	6.3	6.5	8.5	5.6	7.2	5.5	8.0	18	13
SiO_2 (mgL^{-1})	7.5	6.4	6.9	5.1	5.3	3.2	3.5	12.5	10.7
PO_4^{-2} (µg L^{-1})	50	80	45	40	43	30	30	75	35
NO_3^{-2}–N (µg L^{-1})	600	675	325	990	125	650	1050	630	1320
Alkalinity (mgL^{-1})	40	54	66	32	44	28	36	230	200
Total hardness (mgL^{-1})	64	80	62	40	71	40	48	236	212

In general 62 taxa of periphytic algae belonging to Bacillariophyceae (50), Cyanophyceae (6), and Chlorophyceae (6) were recorded from various waterbodies (Table 2). The higher density of periphytic algae was found in springs as compared to streams (Fig. 1). The lower density in the stream periphyton may be because of the stressful washing effect by the fast flowing water currents (Biggs and Smith, 2002). The higher density of periphytic algae in Wuddar nalla, Kaehmeel nalla and the two springs may be related to the lesser velocity of water currents and hence lower shear stress on the algal community. Uehlinger *et al.* (2003) reported the low flow, resulting in constant and relatively benign environment, in Alpine streams to be the main contributing factor

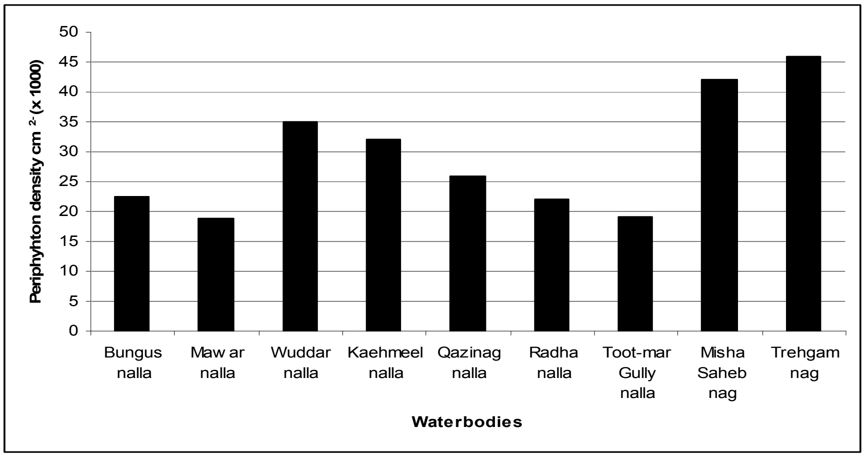

Fig. 1. Density of periphytic algae in nine different waterbodies

for dense growth of algae, mosses and an atypical invertebrate community. Further, the stable conditions in springs may have boosted the dense growth of periphyton as proposed by Albay and Aykulu (2002). All the waterbodies had a good concentration of SiO2 which may have helped the growth of diatoms as it is needed for their frustule formation (Wetzel and Likens, 1991). The shallow springs having higher density of periphyton had higher concentrations of PO_4^{-2} and NO_3^{-2} –N, which are supposed to control and boost the growth of algae (Snyder *et al.,* 2002; Dodds, 2003; Eilers, 2005).

Table 2: Species composition of periphytic algae

Class	Taxa / species
Chlorophyceae	*Closterium* sp., *Cosmarium* sp., *Mougeotia* sp., *Schizogonium* sp., *Spirogyra* sp., *Ulothrix zonata*
Bacillariophyceae	*Achnanthedium lanceolatum, A. minutissimum, Achnanthes* sp., *Amphora* sp., *Caloneis* sp., *Campylodiscus* sp., *Cavinula* sp., *Cocconeis* sp., *Cymbella* sp., *C. affinis*, *C. aspera*, *C. cistula*, *C. lanceolata*, *Diatoma* sp., *D. mesodon*, *Denticula* sp., *Encyonema* sp., *Eunotia* sp., *Fragilaria* spp., *Gomphonema angustatum*, *G. geminatum*, *G. olivaceum*, *G. truncatum*, *Gomphoneis* sp., *Gyrosigma* sp., *Hannaea* sp., *Melosira* sp., *Meridion circulare*, *Navicula* sp., *N. bryophila*, *N. cincta*, *N. cryptotenella*, *N. digitoradiata*, *N. radiosa*, *N. rhynchocephala*, *N. salinarum*, *N. veneta*, *Neidium binodis*, *Nitzschia* sp., *N. acicularis*, *N. palea*, *Pinnularia* sp., *P. major*, *Placoneis* sp., *Rhoicosphenia* sp., *Sellaphora* sp., *Surirella* sp., *S. brebissonii*, *Synedra ulna*, *Tabellaria* sp.
Cyanophyceae	*Anabaena* sp., *Calothrix* sp., *Fremyella* sp., *Lyngbya* sp., *Oscillatoria* spp. *Phormidium* sp.

Like other aquatic systems of Kashmir, insects dominated the macroinvertebrate community with respect to species diversity and density (Shah and Pandit, 2001; Rashid and Pandit, 2006) at all the study sites. A total of 27 taxa of macroinvertebrates were recorded, of which 22 taxa represented class Insecta. Crustacea, Annelida and Mollusca recorded one, two and two taxa respectively (Table 3). The dominant contributors of the macroinvertebrate community were the larvae of Diptera (Diamesinae and *Atherix* sp.), Ephemeroptera (*Baetis* spp., *Epeorus* spp. and *Ecdyonurus* sp.) and Trichoptera (*Brachycentrus* sp. and *Hydropsyche* sp.) in all the streams but the springs were dominated by dipteran larvae (*Chironomous* sp. and *Simulium* sp.), aquatic beetles, and other non-insect macroinvertebrates including *Gammarus* sp., *Lymnaea* sp. and leeches. All the non-insect species were placed in “others” category.

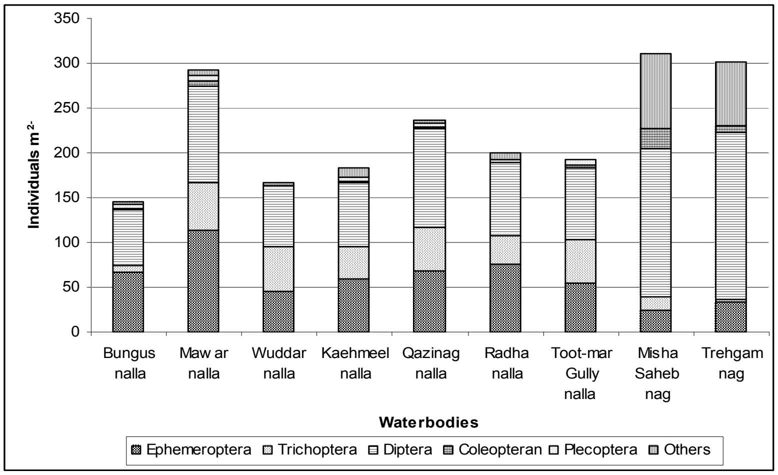

Fig. 2. Density of macroinvertebrates in nine different waterbodies

The physico-chemical features of the two springs were much different from that of the streams and so was the species diversity. It can be said that the physico-chemical environment of a waterbody is very important in determining its species diversity and density. Further, Collier (1995) holds that the differences in the dominant macroinvertebrate fauna in streams and rivers is a direct representation of the physical and chemical factors of their habitats viz., substrate type, percentage of shaded area, temperature, and current velocity. Vinson and Hawkins (2003) opined that the maximum local richness occurring at a site is related to regional richness, which seems to be constrained by both regional environmental conditions and biogeographical history. The lower density of macroinvertebrates may be because of the low discharge of the streams during most part of the year, high flushing during the late spring and early summer months, resulting in their drift, and also due to the harsh conditions that prevail in streams at such elevations. Minshall and Robinson (1998) support the above statement and believe the macroinvertebrate community to be controlled both by spatial and temporal variables at a specific site or along a river continuum.

Table 3: Species composition of macroinvertebrates

Phylum/ Class/ Order	Taxa
Arthropoda	
(a) Insecta	
(i) Diptera	*Atherix* sp., *Chironomous* sp., Diamesinae larva, *Simulium* sp., Tabanidae
(ii) Ephemeroptera	*Baetis* spp., *Caenis* sp., *Drunella* sp., *Ecdyonurus* sp., *Epeorus* sp., *Ephemerella* sp., *Rhithrogena* sp.
(iii) Trichoptera	*Brachycentrus* sp., *Glossosoma* sp., *Hydropsyche* sp., *Nectopsyche* sp., *Rhyacophila* sp.
(iv) Plecoptera	*Nemoura* sp., Perlodidae
(v) Coleoptera	*Dytiscus* sp., *Hydracanthus* sp.
(vi) Hemiptera	*Gerris* sp.
(b) Crustacea	*Gammarus* sp.
Annelida	*Erpobdella* sp., *Tubifex* sp.
Mollusca	*Corbicula* sp., *Lymnaea* sp.

Most of the streams had almost similar species composition of periphytic algae and macroinvertebrates, but the springs differed much from streams in the community structure of macroinvertebrates and also in the physico-chemical features of water. The Sorensen's similarity index showed that the waterbodies having almost similar physico-chemical environments had most of the species similar between them and hence higher values of the similarity index were observed for such waterbodies and reverse was true for the waterbodies with different physico-chemical characteristics (Table 4).

Table 4: Species Similarity between various waterbodies

	Bungus nalla	Mawar nalla	Wuddar nalla	Kaehmeel nalla	Qazinag nalla	Radha nalla	Toot-mar Gully nalla	Misha Saheb nag	Trehgam nag
Bungus nalla	1.00	0.61	0.55	0.59	0.65	0.72	0.57	0.18	0.36
Mawar nalla		1.00	0.43	0.47	0.66	0.67	0.62	0.3	0.25
Wuddar nalla			1.00	0.67	0.42	0.52	0.5	0.29	0.48
Kaehmeel nalla				1.00	0.54	0.47	0.55	0.32	0.4
Qazinag nalla					1.00	0.73	0.74	0.28	0.31
Radha nalla						1.00	0.7	0.27	0.42
Toot-mar Gully nalla							1.00	0.39	0.41
Misha Saheb nag								1.00	0.62
Trehgam nag									1.00

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