Study of Benthic Macroinvertebrate Communities in Different Streams of Gulmarg Area of Kashmir Valley

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ABSTRACT

This study forms the part of the project on ecological study of Gulmarg Wildlife sanctuary carried out in year 2012. Gulmarg Wildlife sanctuary area is full of low order streams arising out of snow melting and glaciers besides some perennial streams and nallaha's. The study was carried out to investigate the benthic macroinvertebrate communities of some the freshwater streams of Gulmarg Wildlife sanctuary. The study revealed 21 taxa of benthic macroinvertebrates belonging to Phylum Arthopoda and Annelida. Phylum Arthopoda was found to be dominant with 19 species while as only two species from phylum Annelida were found to be present. Taxa belonging to mayfly group like *Epeorus* sp. which are sensitive to water quality degradation were found in all the streams. On the other hand, taxa like *Eristalis* sp., *Dytiscus* sp., *Simulium* sp., and *Glossosoma* sp. were restricted to stream I. *Tipula* sp., *Rhyacophilus* sp., *Tabanus* sp. and *Limniphilus* sp. were restricted to stream II while as *Sweltsa* sp. was restricted to stream III only. The taxonomic composition of macroinvertebrates was found to be indication of pristine conditions of the stream water as was evident from the dominance of EPT (Ephemeroptera, Plecoptera, and Trichoptera) diversity.

Key words: *Arthopoda, Annelida, Biomonitoring, Plecoptera*

INTRODUCTION

The science of biological assessment and monitoring of aquatic ecosystems have been well-developed in many parts of the world. Benthic macroinvertebrates are the most popular and commonly used group of freshwater organisms for assessing changes in water quality (Rosenberg and Resh, 1993). Their biomonitoring has certain advantages although there is need of some well-balanced monitoring programs such as quantitative sampling and community analysis. First, they are ubiquitous and thus can be affected by environmental perturbations in many different types of aquatic systems. Second, the large number of species involved offers a spectrum of responses to environmental stresses. Third, their sedentary or benthic habit allows effective spatial analyses of pollutant or disturbance effects. Fourth, they have relatively long life cycles compared to other groups of freshwater organisms, which allows elucidation of temporal changes caused by perturbations. As a result, benthic macro invertebrates act as continuous bioindicators of the water body they inhabit, enabling both temporal and spatial analyses of various degrees of aquatic environment. Biomonitoring and bioassessment of benthic macro invertebrates has emerged as a new field in countries like Europe, North America, South America and in parts of South-Africa (Barbour *et al.*, 1999; Weigel *et al.*, 2002; Vlek *et al.*, 2004; Pinto *et al.*, 2004; Böhmer *et al*., 2004; Ofenböck *et al*., 2004; Verdonschot and Moog, 2006; Hering *et al*., 2006; Ollis *et al*., 2006; Baptista *et al*., 2007; Moya *et al*., 2007) but is gaining momentum in many Asian countries (SAWAN, 2005; UNEP, 2006).

Freshwater macroinvertebrates require various physico-chemical conditions in stream water as well as specific microhabitats to survive and to build sustainable populations. Therefore the assemblage of species (number and type of benthic invertebrate taxa) reflects the overall condition of a given site.

Biological communities particularly macroinvertebrates have proved to be the most successful biological indicators of general water quality (Plafkin *et al.*, 1989; Barbour *et al*., 1999). Benthic macro invertebrates being prevalent and sensitive to environmental changes are the group of organisms most often used for assessment of fresh water quality (Resh, 1995). The distribution of aquatic macroinvertebrate species and communities is controlled by a variety of environmental factors such as habitat characteristics (Peeters and Gardeniers, 1998), water quality (Hellawell, 1986), sediment quality (Chapman and Lewis, 1976), sediment grain size (Tolkamp, 1980), contaminants (Phipps *et al*., 1995) and by biological factors such as competition and predation (Macneil *et al*., 1999).

It is only recently some work has been conducted on the general ecology of Sindh (Rashid and Pandit, 2006, 2008), Doodhganga (Hussain and Pandit, 2011) and Saeskoon streams (Bhat and Pandit, 2006) in Kashmir. There is no published work on the macroinvertebrate community on the streams in the Gulmarg catchment area. Thus, the present attempt is aimed at obtaining the baseline data and to evaluate macro invertebrate communities of the streams in terms of their distribution, diversity and density patterns.

STUDY AREA

Gulmarg Wildlife Sanctuary falls 26 Km to the South West of District Baramulla of Jammu & Kashmir and its boundaries are located within geographical coordinates of Longitude 74º.17' to 74º.79' E, Latitude 34º.55' to 34º.60' N at an altitude of about 2400-4300 asl (Fig. 1). The area of Gulmarg Wildlife Sanctuary is about 180 Km^2. Gulmarg Wildlife Sanctuary abodes rich faunal and floral bio-diversity with diverse species like Musk Deer, Common Leopard, Barking Deer, Asiatic Black Bear, Himalayan Black Bear, Indian Wolf, Snow Cock, Chakoor etc. and is one of the world's renowned tourist destination for its famous meadows, rocky cliffs, dense birch forests and a home for bird watcher. The Sanctuary is surrounded in North by Jhelum valley Forest Division of Baramulla, South by Forest Division of Poonch and Pir Panjal, East by village of Drang and Badrakoot forests of Division-Tangmarg and on the West by Forest Division Tangmarg and Baba Reshi village. The alpine and subalpine areas covered with snow and glaciers which act as water reservoirs and feed various nallaha's which provides water downstream for drinking and irrigation for Baramullah and Budgam districts

In order to study the benthic macro invertebrate community of Gulmarg Wildlife Sanctuary, three sampling points each at four different streams/nallah's namely Tangmarg, Drang, Ningal and Gulmarg were selected.

Stream I- Tangmarg

The site is located 40 km away from Srinagar, between geographical co-ordinates of 34º03'30.5''N and 74º25'29.9''E at an altitude of 2,153 m (asl). Stream bed at this site is underlined with rounded boulders along with pebbles. On the banks of Stream I rural settlements, restaurants and hotels are located.

Stream II: Drang

It lies between geographical co-ordinates of 34º02'14.9"N and 74º24'26.0"E at an altitude of 2,226 m (asl). Stream bed is underlined with a mixture of angular rock fragments, boulders and cobbles. This site is mainly surrounded by rich canopy cover of Pine and Silver fir.

Stream III: Ningal Nallah

Located 3 km away from Gulmarg, the site lies at an altitude of 2,781 m (asl) between geographical co-ordinates of 34º04'28.7"N and 74º18'48.7"E. Here stream is characterized by mixture of mud and pebbles. The area is surrounded by immediate meadow lands and rich forest cover with less human interference.

Stream IV: Gulmarg

Main Gulmarg lies between geographical co-ordinates of 34º03'31.2"N and 74º23'01.0"E and at an altitude of 2,630 m (asl). At this site the stream bed is covered with pebbles and gravel. However, this site is under human interference resulting from high tourist inflow from early spring to late summer.

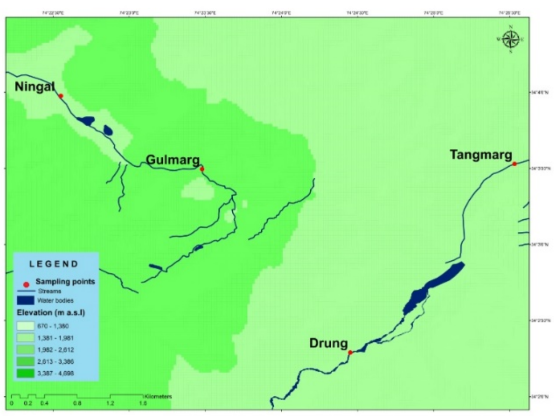

Fig.1. Map of Study area.

MATERIAL AND METHODS

For the collection of macro invertebrates composite sampling approach was opted wherein three sampling points each at four different streams/nallah's were selected. Sampling was done during the months of May, June, July, October and December 2012. For collecting the samples Rock Pick Method and D-Net (Cuffney *et al.*, 1993) sampling methods were employed. The samples were preserved in 70% ethanol. Identification and classification of preserved samples was done with the help of standard works done by APHA, 1989; McCafferty and Provonsha, 1998; Ward, 1992; Engblom and Lingdell, 1999. Shannon Weiner Diversity Index for determining diversity and Sorensen for determining the similarity was calculated.

Calculations:

Density = Number of individuals /area distributed (m^2).

Shannon Weiner Diversity Index Ĥ (1949):

$$H' = -\sum_{i=1}^{i=s}\left(\frac{ni}{N}\right)\log e\left(\frac{ni}{N}\right)$$

H'= Index of species diversity

n_i = Density of one species

N = Density of all the species

$$\log e\left(\frac{ni}{N}\right), \log_{10}\left(\frac{ni}{N}\right)$$

e = Base of natural logarithm = 2.303

$$\mathbf{S} = -\sum_{i=1}^{i=s}\left(\frac{ni}{N}\right)\log e\left(\frac{ni}{N}\right)$$

Addition of the expression for values of *i* from *i* = 1 to *i*

Sorenson's Similarity Index S (1948):

S= 2c /a + b

Where,

c = number of species common to both sites.

a = number of species at one site.

b = number of species at another site.

RESULTS AND DISCUSSION

The results obtained revealed that the benthic macroinvertebrate community exhibited good diversity in terms of species composition across the study sites. During the period of investigation 21 taxa of macro invertebrates were recorded from four streams coming under Gulmarg Wildlife Sanctuary Area (Table 1). Maximum diversity was found at stream II and minimum at stream IV. The phylum Arthropoda (with 19 species) was dominant group depicting highest relative density at all the study sites, with maximum (100%) at stream III and group Annelida (with 2 species) was least dominant group with highest density at stream I (5.97%) (Table 1). The cause for this domination can be attributed to the bottom texture of streams which was dominated by hard stones (Arimoro and Ikomi, 2008; Emere and Nasiru, 2007) as the boulders and cobbles provide a stable environment for macroinvertebrates. However within the phylum Arthropoda the greatest diversity in form and habitat was exhibited by the class Insecta. The apparent reason being the superior competitive abilities of insects, as this class represents all the functional feeding groups ranging from predators, shredders, grazers (scrapers) to filter feeders and gatherers. The phylum Annelida was represented by two species *(viz. Erpobdella octoculata* and *Lumbricus* sp.) as leeches form an important component of benthos of fresh water (Sawyer, 1986). The class crustacean (Amphipoda) was found exceptionally high above 80% at stream IV (Gulmarg) probably due to high organic load present in the stream (Table 1). It has been found that *Gammarus pulex* in channelized streams feed primarily on detritus (Nilsson, 1977).

Among the stream invertebrates, the *Epeorus* sp. was found at all the study streams. However, 10 taxa namely *Eristalis* sp. (stream I), *Dytiscus* sp. (stream I), *Tipula* sp. (stream II), *Tabanus* sp. (stream III), *Sweltsa* sp. (stream III), *Simulium* sp. (stream I), *Rhycophilus* sp. (stream II), *Limniphilus* sp. (stream II) and *Glossosoma* sp. (stream I) were found to be present only at particular streams.

The diversity during summers was found to be highest as compared to winters. The seasonal difference in the relative abundance of major taxa in high altitude streams are largely governed by temperature (Gupta and Michael, 1983). Since we know that these streams are having snow fed origin therefore, the water supply during summer is as a result of melting of ice. This water had low nutrient concentration which favored the growth of not only pollution tolerant species but also pollution sensitive species. While comparing the macro invertebrate communities of IV selected streams by means of Shannon-Weiner index it was found that there was some variation over a small range between first three streams and the stream IV showed a declined Shannon value index (Fig.1). The Sorenson similarity index value was found to be lowest (11%) between Ningal Nallah and Gulmarg streams and highest (66%) between Tangmarg and Gulmarg streams (Fig. 2).

Globally, freshwaters are experiencing declines in biodiversity at rates greater than those in terrestrial systems. Conserving biodiversity and freshwater related ecosystem services is essential to help achieve the ambitious goals of Biodiversity and the agenda for Sustainable Development, 2030. Equally, ecosystems and the freshwater services they provide will be needed. Freshwater management is key for protecting and sustaining biodiversity. At the same time healthy ecosystems play a critical role in maintaining freshwater quantity and quality, and thereby support an array of productive uses essential for economic development. In context of Gulmarg being a preferred tourist destination and the projected and perceived negative impact of tourism industry in future, it is high time that we must beforehand equally invest equally in management of freshwater ecosystems and the biodiversity they harbor and ecosystem services they offer.

Table 1. Monthly variation in the population density (ind./m^2) of the macro invertebrate community at four different sites during May to Dec 2012

Phylum	Class	Order	Family	Taxa /Species	Authority	Site	May	June	July	Oct	Dec	Mean	Total
							Spring	Summer		Autumn	Winter		
ARTHROPODA	Insecta	Diptera	Tabanidae	*Tabanus* sp.	Linnaeus, 1758	Site I	-	-	-	-	-	-	-
						Site II	-	-	-	-	-	-	-
						Site III	4	5	nr	nr	nr	1.8	9
						Site IV	-	-	-	-	-	-	-
			Tipulidae	*Hexatoma* sp.	Latreille, 1809	Site I	-	-	-	-	-	-	-
						Site II	1	nr	nr	nr	nr	0.2	1
						Site III	3	nr	nr	nr	nr	0.6	3
						Site IV	-	-	-	-	-	-	-
				Tipula sp.	Linnaeus, 1758	Site I	-	-	-	-	-	-	-
						Site II	nr	1	nr	nr	nr	0.2	1
						Site III	-	-	-	-	-	-	-
						Site IV	-	-	-	-	-	-	-
			Syrphidae	*Eristalis* sp.	Latreille, 1804	Site I	-	-	-	-	-	-	-
						Site II	-	-	-	-	-	-	-
						Site III	-	-	-	-	-	-	-
						Site IV	nr	1	1	nr	nr	0.4	2
			Simulidae	*Simulium* sp.	Latreille, 1802	Site I	2	4	6	17	15	6.4	44
						Site II	-	-	-	-	-	-	-
						Site III	-	-	-	-	-	-	-
						Site IV	-	-	-	-	-	-	-
		Trichoptera	Glossosomatide	*Glossosoma* sp.	Wallengren, 1891	Site I	nr	nr	1	nr	nr	0.2	1
						Site II	-	-	-	-	-	-	-
						Site III	-	-	-	-	-	-	-
						Site IV	-	-	-	-	-	-	-
			Hydropsychidae	*Hydropsyce* sp.	Curtis, 1835	Site I	4	3	6	nr	3	3.2	16
						Site II	-	-	-	-	-	-	-
						Site III	nr	2	nr	nr	nr	0.4	2
						Site IV	-	-	-	-	-	-	-
			Limnephilidae	*Limniphilus* sp.	Brewster, 1815	Site I	-	-	-	-	-	-	-
						Site II	2	nr	nr	nr	nr	0.4	2
						Site III	-	-	-	-	-	-	-
						Site IV	-	-	-	-	-	-	-
			Rhyacophilidae	*Rhycophilus* sp.	Stephens, 1836	Site I	-	-	-	-	-	-	-
						Site II	7	4	3	3	2	3.8	19
						Site III	-	-	-	-	-	-	-
						Site IV	-	-	-	-	-	-	-

ARTHROPODA	Insecta	Plecoptera	Capniidae	*Allocapnia* sp.	Claassen, 1928	Site I	-	-	-	-	-	-	-
						Site II	nr	8	6	9	8	6.2	31
						Site III	12	14	nr	nr	nr	5.2	26
						Site IV	-	-	-	-	-	-	-
			Chloroperlidae	*Xanthoperla* sp.	Newman, 1836	Site I	-	-	-	-	-	-	-
						Site II	8	5	6	nr	nr	3.8	19
						Site III	5	nr	nr	nr	nr	1	5
						Site IV	-	-	-	-	-	-	-
				Sweltsa sp.	Newman, 1836	Site I	-	-	-	-	-	-	-
						Site II	-	-	-	-	-	-	-
						Site III	1	nr	nr	nr	nr	0.2	1
						Site IV	-	-	-	-	-	-	-
		Ephemeroptera	Baetidae	*Alainites* sp.	Linnaeus, 1758	Site I	nr	nr	nr	6	9	3	15
						Site II	nr	6	8	nr	nr	2.8	14
						Site III	-	-	-	-	-	-	-
						Site IV	nr	nr	nr	4	2	2.6	6
				Baetis sp.	Leach, 1815	Site I	6	38	19	4	nr	13.4	67
						Site II	19	8	10	7	6	10	50
						Site III	nr	1	nr	nr	nr	0.2	1
						Site IV	nr	nr	nr	9	4	2.6	13
			Heptagenidae	*Epeorus* sp.	Eaton, 1881	Site I	nr	nr	18	9	5	6.4	32
						Site II	nr	7	4	3	6	4	20
						Site III	8	9	nr	nr	nr	3.4	17
						Site IV	nr	nr	nr	1	2	0.6	3
				Ecdyonurus sp.	Eaton,1868	Site I	nr	6	nr	nr	nr	1.2	6
						Site II	nr	10	7	9	4	6	30
						Site III	12	20	nr	nr	nr	6.4	32
						Site IV	-	-	-	-	-	-	-
		Coleoptera	Dytiscidae	*Dytiscus* sp.	Linnaeus, 1758	Site I	-	-	-	-	-	-	-
						Site II	-	-	-	-	-	-	-
						Site III	-	-	-	-	-	-	-
						Site IV	nr	nr	nr	2	nr	0.4	2
	Crustacea	Amphipoda	Gammaridae	*Gammarus pulex*	Linnaeus, 1758	Site I	3	nr	3	nr	2	2.66	8
						Site II	-	-	-	-	-	-	-
						Site III	-	-	-	-	-	-	-
						Site IV	62	39	33	24	16	34.8	174
ANNELIDA	Oligochaeta	Opisthopora	Lumbriculidae	*Lumbricus* sp.	Linnaeus, 1758	Site I	9	nr	nr	nr	nr	1.8	9
						Site II	-	-	-	-	-	-	-
						Site III	-	-	-	-	-	-	-
						Site IV	1	2	2	nr	nr	1	5
	Hirudinea	Pharyngobdellida	Erpobdellidae	*Erpobdella octoculata*	Linnaeus, 1758	Site I	3	nr	nr	nr	nr	0.6	3
						Site II	nr	nr	nr	6	nr	1.2	6
						Site III	-	-	-	-	-	-	-
						Site IV	nr	2	5	nr	nr	1.4	7

nr = Not reported in any one the sampling months at a particular site - Not found

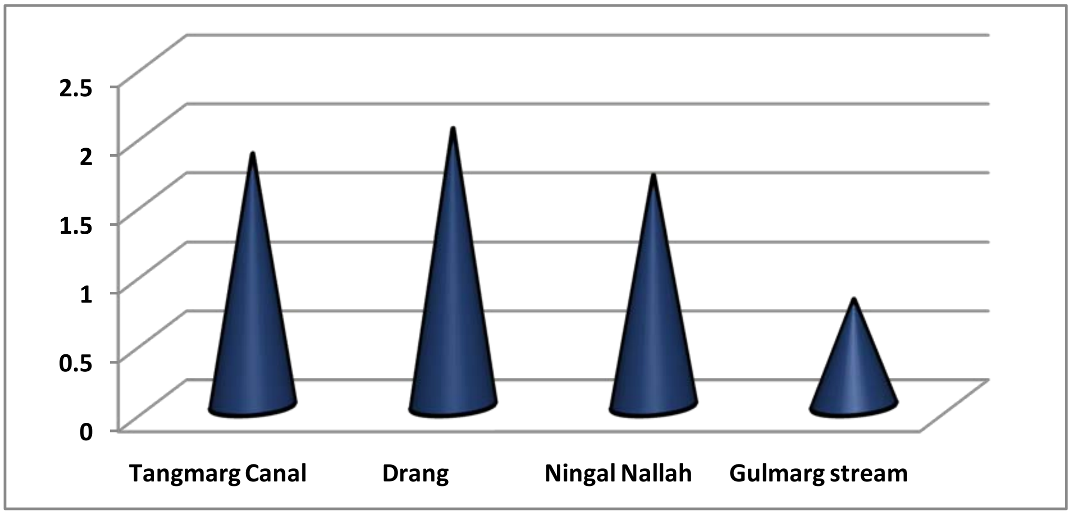

Fig.1. Graphical representation of Shannon-Weiner index of IV selected streams

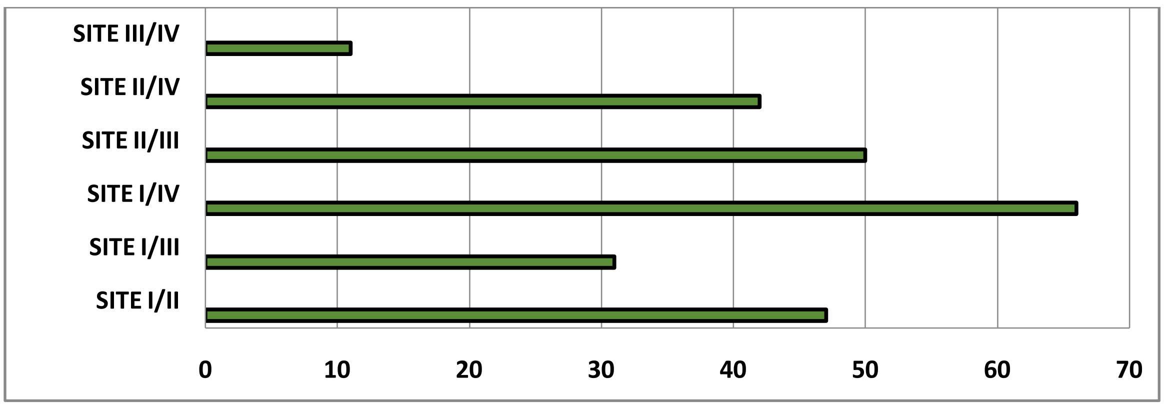

Fig.2. Graphical representation of Sorenson's Similarity Index of four streams

CONCLUSION

Habitat homogeneity in these headwater streams is responsible for domination of insects and orders like Trichoptera, Plecoptera and Ephemeroptera are indication of pristine nature of these streams. Relatively close match between the headwater streams in terms of macro invertebrates was observed as also indicated from similarity index value except Gulmarg stream which was affected by leached organic matter from catchment and is subjected to desiccation because of its intermittent nature. *Dytiscus* sp., *Gammarus pulex* sp., *Lumbricus* sp. and *Erpobdella octoculata* were some of the species found in the stream.

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