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A checklist of benthic macroinvertebrates of River Manuni, Himachal Pradesh

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Abstract

Himachal Pradesh is drained by five main rivers and their tributaries. River Manuni originates from the southern slopes of the Dhauladhar range and joins River Baner on the rear side of the Kangra fort to finally meet the River Beas near Haripur in district Kangra of Himachal Pradesh. The present study was undertaken to investigate the benthic macroinvertebrate communities of River Manuni during March 2009 to February 2011. Monthly samples of benthic macroinvertebrates were collected from the three designated sampling sites within an altitudinal range of 610m to 1240m asl. A total of 67 taxa were identified in River Manuni during the study period. Out of which 44 insects were identified up to generic level which belonged to 8 orders and, 12 up to family level belonging to 5 orders. Among other benthic macroinvertebrates, 8 were identified up to generic level belonging to 5 orders. In addition, earthworm, leech and crab were also recorded in Manuni water. Of the taxa recorded, 44 were common in all reaches i.e. higher (1240m), middle (770m) and lower reach (610m) of the River Manuni, whereas some taxa were restricted to specific reach only i.e., 10 taxa were limited to higher reach, 03 taxa to middle reach and 01 taxon was present only in lower reach of River Manuni.

Keywords: *Benthic macroinvertebrates, insects, crustacean, annelids, molluscs, River manuni.*

Introduction

A fundamental characteristic of river ecosystems is the unidirectional movement of water, nutrients, inorganic materials and organic matter down altitudinal gradients from headwater mountain streams to lowland streams (Suren, 1994). The stream located in the hills is called as hill stream and support wide range of flora and fauna and these in turn determines the health of major rivers systems (Johal and Rawal, 2005). Among the freshwater biota, benthos (benthonic or benthic organisms) is a collective designation for all the bottom dwelling aquatic organisms that live on or within the sediments at the bottom of water body. Among these the zoobenthos are the animals inhabiting the sediment, or living on or in other available bottom substrates. They mainly dwell at the bottom but may occasionally travel upward. Further, macroinvertebrates are defined broadly as animals with body length $\geq$ 0.5 mm which could be retained by a net of 200 µm mesh size (Dudgeon, 1999).

Stream macroinvertebrates are typical objects of community ecology and environmental monitoring studies (Rosenberg and Resh, 1993; Allan, 1995). The sensitive species inhabiting these habitats because of adverseness of environmental conditions are gradually eliminated and tolerant species establish their colonies and grow in abundance (Hellawell, 1986; Rosenberg and Resh, 1993). Most aquatic habitats with acceptable water quality and substrate conditions support diverse macroinvertebrate communities. Usually, in the hill streams, insects of principal groups Ephemeroptera, Odonata, Plecoptera, Hemiptera, Tricoptera, Coeleoptera and Diptera are among the most visible benthic animals.As such, the macroinvertebrates present several advantages compared to other groups of organisms: they are ubiquitous and diverse, exhibit different feeding habits, are sedentary and have life cycles ranging from few weeks to a few years and are of convenient size for field examination, storage and transport (Chessman, 1995; Miserendino and Pizzolon, 1999). Understandably, the macroinvertebrate

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communities have been the most commonly used tool for making an integrated assessment of water quality in rivers (Karr, 1991; Palmer et al., 1996). The Himalayan region remains comparatively lesser studied as regards to benthic macroinvertebrates. Moreover in Himachal Pradesh such study has been fewer and fragmentary, though some notable contributions have been made by Prasad (1918), Hora (1930), Dutta (1992), Farmahan (1994), Joshi (1994), Julka *et al*.(1999) and Sharma *et al*. (2006). Therefore, considering the number of rivers and streams draining Himachal Pradesh and its obvious importance, the proposed study envisaged inventorying, benthic macroinvertebrates of River Manuni, a tributary of River Beas.

Study area

Himachal Pradesh is located between $30^0$22' -$33^0$12' North Latitude and $75^0$45' -$79^0$04' East Longitude. to East, it forms India's border with Tibet, to the North lies the state of Jammu and Kashmir, Uttarakhand in the Southeast, Haryana in South and Punjab in West. There is a general increase in elevation from West to East and from South to North. The entire territory of Himachal Pradesh is mountainous with altitude varying from 350m to 7000m asl.River Manuni originates from the southern slopes of Dhauladhar range in district Kangra. Steep slopes form the upper catchment of River Manuni. It is covered by small glaciers in upper and dense forest in lower ridges. The upper catchment lies in heavy rainfall region where substantial precipitation occurs during monsoon and winter months. Manuni joins Baner (tributary of Beas) on the rear side of the historical Kangra fort at Sangam to finally meet River Beas near Haripur in district Kangra of Himachal Pradesh. The present study was undertaken during March 2009 to February 2011. For the purpose three sampling sites were selected in River Manuni within an altitude range of 610-1240m asl. (Fig.1).The sites were:

S1 (Khaniyara 1240 m asl): Located 10 km (approx.) from district headquarter, Dharamshala at an altitude of 1240m asl. The area is famous for Himachal slate mines, broken pieces of which can be seen scattered in the river. Upstream to S1 the river descends through thick forest having natural vegetation, where numerous streamlets emerge from the Dhauladhar range to form the mainstream Manuni. Khaniyara locality falls in the northern region of the study area. The litho-units exposed in the area include slates, shales, sandstones and occasional basalts. Two important thrust systems viz.; Main Central Thrust and the Main Boundary Thrust traverse this area (Dhar, 2004). Scarification and land degradation due to the haphazard mining activity of slate is conspicuously seen in this region. This area shows the presence of glacio-fluvial deposits in the upper regions. Upward to S1 i.e. Khaniyara there is sudden rise in the height of Dhauladhar having difficult terrain hence was not included in the study. Some of the important vegetational elements of the higher reaches of Dhauladhar in the Manuni watershed are *Acer caesium* (Mandar), *Aconitum heterophyllum* (Patis), *Cotoneaster microphylla* (Res), *Diplazium frondosum* (Lugru)**,** *Fagopyrum tataricum* (Fafru), *Gentiana kurroo* (Karu), *Jurinea dolomiaea* (Dhoop), *Pieris ovalifolia* (Ailan), *Quercus leucotrichophora* (Ban) and *Rhododendron arboreum* (Barah). *Cedrus deodara* is generally absent in the watershed, although few planted trees are present as low as 1250m in Khaniyara.

S2 (Bhadwal 770m asl): Located 8 km (approx.) downstream to S1 at an altitude of 770m asl, this site is surrounded by extensive agriculture fields and stream water has been directed for irrigating the crop fields. This locality falls south to Khaniyara and comprises the terrace deposits of the Manauni stream. The upper Shiwalik conglomerates and minor sandstones are encountered in this area hidden under the thick veneer of terrace deposits. Drini thrust passes in close vicinity to this area (Dhar, 2004). However the area shows gentler slope and occurrence of terrace deposits more significant owing to lesser intensity of erosional activity. Much of the natural vegetation at lower altitude (downstream Khaniyara) has been replaced by irrigated terraces locally known as 'khet'. The important crops grown in the area are wheat and rice in rotation along with maize, potatoes and pulses.

S3 (Purana Kangra 610m asl): Located 7.0 km (approx.) downstream to S2 at an altitude of 610m asl, The river further travels 1.0 km (approx.) through deep gorge to meet Baner a tributary of River Beas at Sangam. This locality as the name

signifies is the erstwhile town of Kangra. The area dominantly comprises of upper Siwalik conglomerate with intercalations of loose sand stones (Dhar, 2004). Owing to its lithological characters the area shows scanty forest cover and the signature of high erosional intensity is visible here.

Methodology

Regular monthly samples of benthic macroinvertebrates were collected following stratified random sampling (Cummins, 1962) along transects using modified Surber's square foot sampler (Welch, 1952). Benthic macroinvertebrate samples were collected during March 2009 to February 2011 at three selected sampling sites. Benthic macroinvertebrate visible to naked eye were collected. They were then transferred to small plastic bottles containing 4-5% formalin solution and taken to laboratory for analysis. Identification was carried to lowest recognizable level as far as possible with the help of keys by Burks (1953), Usinger (1956), Needham and Needham (1962), Hynes (1977), Macan (1979), Edington and Hildrew (1981), Elliott et al. (1988), Wallace et al. (1990), Dudgeon (1999) and Jessup et al. (2003).

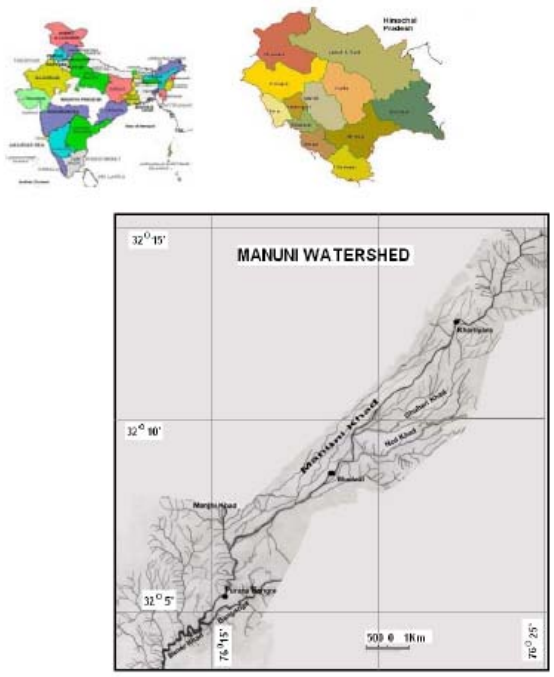

Fig.1. Location Map of Manuni Watershed

Results and Discussion

A total of 67 benthic macroinvertebrates taxa were identified in River Manuni during present study (Table 1). Of these, 44 insects were identified up to generic level which belonged to 8 orders, and 12 up to family level belonging to 5 orders. Among other benthic macroinvertebrates, 8 taxa belonging to 5 orders were identified up to generic level. These included 01genus of Platyhelminthes, 01 crustacean and 06 molluscs. Besides, crabss, earthworm and leeches were also recorded in Manuni water. Of the taxa recorded, 44 were common in all reaches i.e. higher (1240m), middle (770m) and lower reach (610m) of River Manuni.

During the present study, 60 taxa of benthic macroinvertebrates were identified from S1 followed by 56 from S2 and 48 from S3. The high number of taxa in the upper zone of study area may be due to the presence of thick riparian forest in the headwater region as the riparian zone provides food and shelter for aquatic biota **(**Bretschko and Moser, 1993**).** The middle zone (S2) is surrounded by agriculture fields, whereas the forest cover is very scanty in lower zone (S3) of Manuni. The low diversity in streams with human modified riparian land use type is attributed to change in habitat brought out by decreased detritus input, increased sedimentation and runoff (Hershey and Lamberti, 1998).Some taxa of benthic macroinvertebrates also showed restricted distribution. 10 taxa were limited to higher reach, 03 taxa were restricted to middle and 1 taxon was present only in lower reach of River Manuni. Taxa recorded only at higher reach (S1) were *Nemoura*, *Leuctra*, *Himalopsyche*, *Rhyacophila*, *Stenopsyche*, *Brachycentrus*, *Limnephilus*, *Dicranota*, *Blepharicera*, and *Gammarus*. Whereas, Crab, *Melanoides* and *Indoplanorbis* were restricted to mid reach (S2) and *Rhinocypha* to the lower reach (S3) of study area. Similar distribution of benthic macroinvertebrates has also been reported by other workers. Nemourid larvae can be quite abundant in collections from small streams draining forested catchment (Dudgeon, 1999). A thick riparian forest is present in the upper reach of Manuni, thus providing suitable habitat. *Leuctra* though basically Palaearctic genus, is also found in India and Nepal (Harper, 1977; Sivec, 1981). Similarly, *Himalopsyche* seems to be restricted to habitats where torrential flows predominate, especially at

Table1. Check list of benthic macroinvertebrates of River Manuni, Himachal Pradesh.

Phylum	Class	Order	Family	Genera
Arthropoda	Insecta	Ephemeroptera	Baetidae	*Baetiella*
				Baetis
				Platybaetis
			Heptageniidae	*Ecdyonurus*
				Epeorus
				Iron
			Leptophlebiidae	*Leptophlebia*
				Paraleptophlebia
			Ephemeridae	*Ephemera*
			Ephemerellidae	*Ephemerella*
			Caenidae	*Caenis*
		Odonata	Calopterygidae	-
			Chlorocyphidae	*Rhinocypha*
			Euphaeidae	*Euphaea*
			Coenagrionidae	*Enallagma*
			Gomphidae	-
			Macromiidae	-
			Libellulidae	-
		Plecoptera	Nemouridae	*Nemoura*
			Leuctridae	*Leuctra*
			Perlidae	-
		Hemiptera	Nepidae	*Nepa*
			Naucoridae	*Naucoris*
			Corixidae	*Micronecta*
		Megaloptera	Corydalidae	*Corydalus*
		Trichoptera	Rhyacophilidae	*Himalopsyche*
				Rhyacophila
			Glossosomatidae	*Agapetus*
			Hydroptilidae	*Hydroptila*
			Philopotamidae	*Chimarra*
			Stenopsychidae	*Stenopsyche*
			Polycentropodidae	*Polycentropus*
			Hydropsychidae	*Hydropsyche*
			Brachycentridae	*Brachycentrus*
			Limnephilidae	*Limnephilus*
			Leptoceridae	*Leptocella*
		Lepidoptera	Pyralidae	-
		Coleoptera	Dytiscidae	-
			Hydrophilidae	-
			Scirtidae	*Hydrocyphon*
			Psephenidae	*Psephenoides*
			Elmidae	-
		Diptera	Tipulidae	*Tipula*
				Antocha
				Dicranota
				Hexatoma
				Limnophila
			Blephariceridae	*Blepharicera*
			Psychodidae	*Psychoda*
			Dixidae	*Dixa*
			Simuliidae	*Simulium*
			Ceratopogonidae	-
			Chironomidae	-
			Tabanidae	*Tabanus*
			Athericidae	*Atherix*
			Dolichopodidae	-

	Crustacea	Decapoda (Crab)		-
		Amphipoda	Gammaridae	*Gammarus*
Platyhelminthes	Turbellaria	Tricladida	Planariidae	*Planaria*
Annelida	Oligochaeta (Earthworm)			-
	Hirudinea (Leech)			-
Mollusca	Gastropoda	Mesogastropoda	Thiaridae	*Melanoides*
		Basommatophora	Lymnaeidae	*Lymnaea*
			Physidae	*Physa*
			Planorbidae	*Gyraulus*
				Indoplanorbis
	Pelecypoda	Heterodonta	Sphaeriidae	*Pisidium*

high altitude, like the upstream region of the study area. The taxon has also been reported in two high mountain streams at about 1500m asl. in Nagano, Central Japan (Tsuruishi, 2006). *Rhyacophila* is wide spread and extremely speciose especially in north India (Kimmins, 1953). *Rhyacophila* larvae are probably the most restricted to conditions of high current speed (Scott, 1958). Indian *Stenopsyche* species appear to be confined to altitudes north of Tropic of Cancer (Higler, 1992). Also, *Brachycentus* has been reported from high altitude of the Himalaya (Mani, 1968) and Limnephilidae are characteristics of high altitude streams (Suren, 1994). Similarly, *Dicranota* also was reported in streams of western Nepal ranging in altitude from 850-4250m (Suren, 1994). Blephariceridsl larvae (mountain midges) have specialized morphology that is associated with living on rocks surface in swift currents at high altitude (Dudgeon, 1999). They may be found crawling on rocks in rushing water of mountain or hill streams, living directly in the water or in the perpetual spray of waterfalls (Usinger, 1956). Sehgal (1991) recorded *Gammarus* in two out of the eleven tributaries of Indus and Jehlum in northwest Himalaya (North of 32^0N). Also, it has been recorded to be confined to rather higher altitudes (Sehgal, 1983; Melkania, 1991). Ng (1988) says that crabs individual species tend to be confined to particular altitudes and hence shows longitudinal zonation along the river. The middle stretch of Manuni is surrounded by extensive agriculture fields and crabs inhabit the marginal waters. Pulmonates like planorbidae in Asian streams are less widespread and diverse than prosobranchs and tend to be most abundant in slow flowing streams (Dudgeon, 1983). *Melanoides* have been introduced widely to the regions of Tropics beyond their natural ranges (Dudgeon, 1999). Bath et al. (1999) found higher abundance of molluscs with increased water temperature and decomposed organic matter. The mean annual water temperature (20.44 ^{0}C) at S2 also seems to favour molluscs in the river. In the lower reach of Manuni the river widens and the substratum is dominated by pebbles and cobbles with isolated boulders, thus providing suitable habitat to the Chlorocyphid larvae (*Rhinocypha*) which are mainly confined to stony streams where they hide under stones or submerged wood (Dudgeon, 1999) The benthic macroinvertebrate community of River Manuni was dominated by Ephemeroptera, Trichoptera and Diptera. This observation corresponds to the study of Farmahan (1994) in Barog hill stream of Himachal Pradesh. Similar composition of benthic macroinvertebrates has also been observed by Suren (1994) and Brewin *et al*. (2000) in streams of Nepal.

The physicochemical parameters of River Manuni also varied during its course. Thus increase in mean annual- water temperature (14.34-20.50^{0}C), total dissolved solids (0.04-0.14 gl^{-1}), nitrate (0.023-0.214 mgl^{-1}) and phosphate (0.012-0.112 mgl^{-1}) in the downstream and velocity (0.64-1.12 ms^{-1}) in the upstream could also be important contributing factors along with riparian vegetation in determining diversity of benthic macroinvertebrate communities among the different reaches of river Manuni. Similarly Subramanian et al., (2005) found that, the streams with natural riparian vegetation had higher insect richness than the ones with human modified ones in Kudremukh National Park Karnataka state, India.

To conclude the macroinvertebrate communities of River Manuni showed variation in distribution from headwater to downstream region. The upstream region supported a diverse benthic fauna which decreased in the downstream with the change in riparian land use by man.

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