Influence of Substrate on the Fate of Macrozoobenthos in Saeskoon Water Quality, a Small Tributary of Vishav Stream

Sami Ullah Bhat and Ashok K. Pandit

Aquatic Ecology Laboratoty, Centre of Research for Development, University of Kashmir, Srinagar 190006, J & K, India

ABSTRACT

The paper presents an overview of possible role of substrate in relation to species diversity and abundance of macrozoobenthos in the stream. Among the various types of substrates, gravel was found to support more genera (13) as against sand harbouring the lowest (5). Further the highest number of individuals were recorded at silt + mud substrate (960) and lowest at cobble substrate (180). The benthos was comprised of 16 genera belonging to Annelida (3), Amphipoda (1), Mollusca (2), Trichoptera (3), Diptera (6) and Ephemeroptera (1). The water of the stream was slightly alkaline (7.58 - 8.60). The overall increasing trend of the values of alkalinity, hardness, temperature, depth and conductivity were registered in the months of June and July with slight variations. The ions like sodium, potassium, sulphate and iron were found to be in low concentrations as against NO_3 - N and total phosphorous being registered in higher concentration.

Keywords: Macrozoobenthos, substrate, Vishav, stream

INTRODUCTION

The Saeskoon stream rises near the Parigam village of Kulgam Tehsil of Anantnag district and flows near about 30 km before discharging into Vishav near Arvani village, being one of the major tributary of river Jhelum. The Vishav originates from the glacial lake Kounsarnag falling in the Pir Panjal range of the Himalaya. The majority of the benthic organisms are intimately associated with substrate wholly or during at least a portion of their lives. It is, therefore, not surprising that substrate type is major detriment of the distribution and abundance of macrozoobenthos especially aquatic insects (Minshall, 1984). The substrate provides habitat, space, food directly or a surface where food concentrates and protection from predators (Ward, 1992). The substrate of lotic waters is largely structured by unidirectional flow of water interacting with basin geology and allocthonous organic inputs

(Bilby and Likens, 1980; Rust, 1982; Leopold *et al.*, 1984). Organic inputs of terrestrial origin has vital role in lotic systems than in lentic systems and is especially important to the ecology of insects in small streams.

The substrate composition of running waters bears a close relationship to the current velocity and to the flow regime in general sense (Dudgeon, 1982). The habitat complexity and substrate stability, further, seem to be important factors in determining the distribution of macrozoobenthos and especially aquatic insects. Only a few studies (Engblom and Lingdel, 1999; Mahdi *et al.*, 2005) have been carried out to explore the benthic fauna of streams of Kashmir valley. Taking the above fact into consideration an attempt has been made to explore the benthic fauna of the Saeskoon stream.

MATERIAL AND METHODS

The samples for water analysis were collected near Kokergund village in the middle of the stream so far as the length of the stream is concerned. The water samples were taken on monthly basis from May to October, 2005. Temperature and current velocity was recorded on spot while other parameters were carried out in the laboratory in accordance with Golterman and Clymo (1969), APHA (1998) and Wetzel and Likens (2000).

For macrozoobenthos, five different habitats were identified and sampled in the stream on the basis of substrate composition (Cobble, Pebble, Gravel, Sand and Silt + mud). The quantitative and qualitative samples for macrozoobenthos were collected from five different substrates with Surber type sampler (1937) and Ekman dredge (c.f., Kajak, 1971) depending on the type of substrate to be sampled. The organisms were sorted out and the material wherever needed was sieved through sieve mesh size 500 µm and preserved in 4% formalin and 70% alcohol depending upon the type of organisms to be preserved. The soft bodied organisms like Ephemeroptera were preserved in 70% alcohol while the shelled organisms like molluscs in 4% formalin.

The classification of mineral substrate by particle size was done according to the Wentworth scale (1960). Identification of specimens was done with the help of standard taxonomical works (Edmondson, 1959; Borror *et al.*, 1976; Pennak, 1978; Ward, 1992; Engblom and Lingdell, 1999).

RESULTS AND DISCUSSION

The substrate in areas with current velocities ranging from 15-30 cm per second seemed to be largely clay and silt, with 10-25 cm per second sand predominates, 30-70 cm per second gravel predominates, 45- 65 cm per second pebble predominates and at 60 -70 cm per second cobbles were found in higher percentage in substrate composition (Minckly, 1963). Particles finer than sand were not normally found a major component of stream bed. However, during low flow, a temporary film of silt and clay together with organic detritus mainly of plant leaves appeared with reduced water currents in lower reaches of the stream.

The data on the various physico-chemical parameters of the stream are presented in Table 1. The influence of normal ranges of chemical variables on aquatic organisms is often difficult to discern, especially under field conditions. However, from the research it appears that many species of aquatic insects are capable of tolerating relatively wide natural ranges of many chemical variables. The water temperature of the stream fluctuated from 14 to 18 °C and conductivity 125 to 195µS/cm. With respect to life, as a whole, temperature is presumably the most important single environmental entity. The stream under investigation is not influenced by ground water hence there occurs a close relationship between water and air temperatures. Substrate type and degree of exposure to direct sunlight play major role in determining temperature regimes of streams (Geijskes, 1942). The other factors that influenced stream temperature include warming and cooling effect from tributaries entering into the stream, season, precipitation, snow melting etc. The pH of water ranged from 7.88 to 8.60 thus indicative of slightly alkaline nature.

Table 1. Physico chemical characteristics of water of Saeskoon stream

Parameters	Months					
	May	June	July	August	September	October
Air temperature (°C)	21	23	26	22	27	24
Water temperature (°C)	14	15	16	18	17	14
Depth (cm)	35	35	32	24	20	18
DO (mg/l)	5.6	5.6	5.6	5.6	5.8	5.4
Chloride (mg/l)	10	20	39	19	25	14
Total alkalinity (mg/l)	72	68	140	44	52	55
Total hardness (mg/l)	90	50	100	72	100	90
Calcium hardness (mg/l)	63	37	73	63	73	65
Magnesiumhardness (mg/l)	27	13	27	09	27	20
Conductivity (µS/cm)	134	183	187	125	195	180
pH	8.60	7.58	8.36	7.85	8.44	8.32
NH_3-N (µg/l)	25	100	80	58	45	42
NO_2-N (µg/l)	02	03	02	traces	02	03
NO_3-N (µg/l)	80	200	1800	3000	1800	200
Ortho - phosphate (µg/l)	48	40	75	52	85	45
Total phosphorous (µg/l)	100	2420	1680	1740	1880	540
Iron (µg/l)	180	600	200	180	170	165
Sulpahte (mg/l)	6.0	3.0	2.0	2.0	3.0	4.0
Sodium (mg/l)	8	14	18.5	12	7.2	7.8
Potassium (mg/l)	4.5	7.0	5.0	4.0	2.0	2.5

The values of hardness exhibited considerable variation from 50 to100 mg/l, indicating thereby the hard water nature of the stream. Calcium and magnesium accounted for most of the hardness with minor contribution from chlorides and sulphates. This is attributed to the streams situated on insoluble bedrock to the hard waters of calcareous aquatic habitats located in lime stone regions. Since some aquatic animals occur over a wide range of water hardness, others are largely limited to hard (Calciphiles) or soft waters (Calciphobed), although underlying causal mechanism for such preference are poorly understood (Maccan, 1961). Molluscs and to some extent crustaceans contain a preponderance of species with high physiological demand for calcium which accounts for their restriction to waters with a certain amount of hardness. However, aquatic insects appear indifferent to normal ranges of water hardness (Maccan, 1974). That is why non-insect invertebrates are often numerically dominant in the benthos of calcareous waters, as is true for present study, whereas insect invertebrates tend to predominate in soft water habitats. However, Neel (1973) reported molluscs, may flies, beetles and dipterans to be better developed in the hard water alkaline streams.

Dissolved oxygen, an environmental variable of considerable importance to the aquatic organisms, was found to be in fairly good amount. The numerical surge of *Baetis* sp. and *Stenopsychae* sp. in oxygen rich waters suggests their physiological need for oxygen. The values for NO_3-N (3000 µg/l) and total phosphorous (1880µg/l) were significantly high due to the agricultural run-off from the catchment, comprising mainly the agricultural land, where the fertilizers like urea and DAP are being applied intensively .

The taxonomical survey of the stream benthos revealed a total of 16 taxa of macrozoobenthos belonging to three major groups, viz. Arthopoda, Mollusca and Annelida. The highest biannual average number of individuals/m^2 were found in silt + mud substrate (1153) and lowest in cobble substrate (198). However, maximum number of 13 taxa was recorded in gravel substrate against a minimum of 5 in sand substrate. *Chironomus* sp., *Gammarus pulex, Erpobdella* sp. and *Radix ovata* were the most dominant taxa in terms of their occurrence and abundance.

Table 2. Abundance and species diversities of macrozoobenthos found in five different habitats characterized mainly by their substrates in Saeskoon stream. (Values are biannual averages)

Habitat	Velocity Range (cm/s)	Particle diameter (mm)	Number of genera	Number of individuals/m^2
Cobble	60-70	64-256	8	198
Pebble	45-65	16-64	10	564
Gravel	30-70	2-16	15	660
Sand	10-25	0.125-2	5	516
Silt + mud	15-30	< 0.063	6	1152

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Table 3. Species diversity and abundance of macrozoobenthos in five different habitats (values are biannual averages)

S. No.	Order/Taxa/ Class	Cobble No. of Ind./m^2	Pebble No. of Ind./m^2	Gravel No. of Ind./m^2	Sand No. of Ind./m^2	Silt+Mud No. of Ind./m^2
A.	Diptera					
1	*Atherix* sp.	--	28	12	--	--
2	*Chaoborus* sp.	45	--	5	--	--
3	*Chironomus* sp.	--	135	30	380	715
4	*Simulium* sp.	6	--	15	--	--
5	*Tabanus* sp.	--	8	12	--	--
6	*Tipula* sp.	--	6	30	--	--
B.	Trichoptera					
1	*Rhycophila obscura*	10	--	--	--	--
2	*Rhycophila* sp.	--	5	--	--	--
3	*Stenopsyche* sp.	5	--	--	--	--
C.	Ephemeroptera					
1	*Baetis rhodani*	30	116	180	--	--
D.	Annelida					
1	*Limnodrilus* sp.	--	28	6	--	50
2	*Tubifex* sp.	--	--	40	--	100
3	*Erpobdella* sp.	12	60	120	15	16
E.	Amphipoda					
1	*Gammarus pulex*	70	160	180	65	266
F.	Mollusca					
1	*Radix ovata*	--	18	12	35	5
2	*Corbicula* sp.	20	--	18	20	--

Though few benthic organisms were restricted to a specific biotope, yet most of the benthic species occurred a wide range of substrates and thus occupying varied ecological niches. The close association of a particular species within a given substrate may further reflect specific preferences of organisms for current, shelter, respiratory needs or food habits rather than directly indicating an affinity for a specific bottom type as a whole. The study further revealed that certain species of Trichoptera were found in association with stony substrates of certain definite size (cobble and pebble) and are thus categorized as substrate specific organisms (lithophilous). In general, gravel and pebble substrates almost seem to be more favourable for the growth of association of various taxa as compared to substrates like sand and silt + mud where only certain species like *Chironomus* sp. and *Gammarus pulex* flourished because such organisms prefer substrates rich in microbe-organic detritus complex. Sand, as a substrate, proved to be a poor one especially for macro invertebrates because of its instability, tight packing of particles which reduces the trapping of detritus, thus limiting the availability of oxygen.

In general, it seems that diversity of benthic invertebrates is particle size dependent, increasing in median particle size and decreasing with incidence of stones and cobbles. Further the amount of detritus trapped within the cervices seems very important for enhancing the growth and abundance of benthic organisms.

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