Ecology of Benthic Entomofauna in Buniyar Stream, Kashmir

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ABSTRACT

Ecology of benthic entomofauna of Buniyar stream, an important left bank tributary of the Jhelum River in Uri region of Kashmir, was studied during 2002-2003. The water was alkaline with very low nutrient content. Ephemeroptera, Trichoptera and Diptera were the main contributors of the benthic community in the stream. The highest density was recorded during winter and the lowest during summer. The influence of physico-chemical parameters on the seasonal changes in the population density of entomofauna were assessed statistically by coefficient of correlation, Margalef's index of species richness, evenness and Shannon wiener diversity index. The group showed negative correlation with water temperature, velocity, CO_2, inorganic nitrogen and total phosphorus and positive correlation with DO.

Key words: Buniyar stream, limnology, entomofauna

INTRODUCTION

The vastness of the aquatic habitats of the valley strongly reflects the richness of fishery resources and potential for their development for the benefit of people. However, over the years these habitats have been receiving large quantities of untreated sewage and other pollutants from their catchment, which has resulted in deterioration of many of these resources of the region. Aquatic insects form an important component of the benthos of running waters and play a significant role in the cycling of organic material in aquatic food chains. The species diversity of the benthos has been shown to be influenced by the changes in the habitat. Conversely the occurrence and abundance of the aquatic entomofauna can provide an insight into the pollution level of the habitat in which they are present. Our knowledge regarding the ecology of aquatic insects in Kashmir Himalaya is very limited (Kumar and Bhagat, 1977; Bhat and Yousuf, 2002, 2004 and Mahdi *et al.*, 2005). As such a detailed limnological study of the Buniyar Nalla, a left bank tributary of the Jhelum in Uri Tehsil of Kashmir was undertaken during the tenure of a G. B. Pant Institute of Himalayan Ecology and Development (GBPIHED) sponsored research Project on the Fisheries of the

River Jhelum System in Kashmir. The present report is based on a part of the data collected during this project and discusses the ecology of the benthic entomofauna of the stream.

MATERIAL AND METHODS

The Buniyar Nalla, also called the Hapath Khai Nalla, is an important left bank tributary of the Jhelum River, joining the latter below Buniyar village in Uri, downstream of the Uri Barrage. It is formed by the confluence of two glacial/snow fed streams, namely Hapath Khai and Dothalian, at Gagarhil in the Gazan forest. Along its course it receives a number of tributaries and becomes a sizeable watercourse from Kurali onwards, especially after receiving Banali stream. Its main tributaries include Darakujan, Banali and Barnet streams on its right bank and Lajri, Silasap and Malnagali streams on the left bank. The catchment of Buniyar Nalla is about 141.46 km^2. Owing to the underlying lithology and the gradient of the area, the Nalla is a fast flowing stream with fluctuating discharge with high sediment yield, especially during wet period in early spring.

The data used for the present communication were procured from November 2002 to October 2003 on monthly basis from three sampling sites in a one km stretch of the stream ahead of its confluence with the Jhelum. Water samples were collected between 10.00 and 15.00 hr in one litre polyethylene bottles. Temperature, Transparency, DO, pH and Conductivity of water were analyzed on the spot. Dissolved oxygen was measured directly with the help of digital oxygen probe. However, for comparisons samples were also analyzed as per Winkler's method. Various physico-chemical parameters were analyzed as per the methods given in Welch (1948), CSIR (1974), Mackereth *et al.* (1978) and APHA (1995). A Serber type sampler (Downing and Rigler, 1984) was used to collect the macrozoobenthos. Identification of taxa was done with the help of taxonomical works of Edmondson (1959), Pennak (1978) and Engblom and Lingdell (1999). Later on population density of each taxon was determined. The diversity indices used included (i.) Species diversity index (Shannon Wiener, 1963), (ii) Margalef's community diversity index (Margalef, 1957) and (iii) Equitability or Evenness index (Shannon Wiener, 1963).

RESULTS

Physico-chemical Features of Water

The mean monthly values of physico-chemical parameters are presented in Table 1. The minimum water temperature of 4°C was recorded in February, while the maximum of 11°C in May. The velocity of water showed the highest value of 170 cm/sec in December, while the minimum of 85cm/sec was recorded in May. The conductivity of water fluctuated between 97µs in April and 147µs in July. The pH of water was always on alkaline side, fluctuating between 8.00 in June and 8.6 in December. Dissolved oxygen concentration was generally high, with maximum value of 12.7mg/l in October and the minimum of 8.5 mg/l in May. Total hardness ranged from 60mg/l in March to 90mg/l in December and February.

Calcium and magnesium hardness followed a similar trend and the maximum values were recorded in February in case of Ca (32 mg/l) and in October in case of Mg (8mg/l, while the minimum values were recorded in July (17 mg/l) and January (4 mg/l) for the two respectively. CO_2 content recorded the minimum value of 2 mg/l in December and the maximum of 8mg/l in April and June. The nitrate nitrogen fluctuated between 20µg/l in February and 150µg/l in January, while the ammonical nitrogen recorded minimum concentration of 21µg/l in September and the maximum of 35 µg/l in April and May. The total phosphorus varied from 40 µg/l in November to 65 µg/l in January.

Benthic Entomofauna

The aquatic insect community in the stream was represented by 11 taxa, belonging to Ephemeroptera, Trichoptera and Diptera (Table 2). The mean population of the group varied from 135 ind./m^2 in September to 302 ind./m^2 in January, the annual mean density being 206ind/m^2. Ephemeroptera was the most dominant group in the stream, contributing more than 40% of the benthic entomofauna. Its density ranged from 66 ind./m^2 in September to 122 ind./m^2 in January. The group was represented by *Baetiella* larva, *Ecdyonurs* sp., *Potamanthelus* sp. and *Drunella* sp., recording mean annual density of 55 ind/m^2, 33 ind. /m^2, 5 ind. /m^2 and 5 ind. /m^2 respectively. *Baetiella* sp. was the most dominant taxon, having its density range of 36 ind./m^2 (June and September)-65 ind./m^2 (January). Trichoptera was the second dominant group and recorded an annual mean population of 98 ind. /m^2 with a range of 42 ind./m^2 in September to 101 ind./m^2 in February. The group was represented by *Rhycophila Orscura* sp., *Stenopsychae* sp. and *Nectopsychae* sp., recording mean annual density of 45 ind./m^2, 10 ind./m^2, 9 ind./m^2 and 4 ind/m^2 respectively. *Rhycophila Orscura* was the most dominant Trichopteran taxon, recording a range of 29 ind/m^2 (August) 69 ind/m^2 (February). The dipteran insects contributed 20 to 30 percent of Macrozoobenthos with the density ranging from 27 ind/m^2 (September) to 86 ind/m^2 (January) respectively. The various taxa recorded included *Diamessinae* sp., *Atherix* sp. and *Simulium* sp.

Diversity indices are statistical abstraction with two components reflecting number of species (richness) and distribution pattern (abundance) of individuals at particular site with time. The monthly changes in various diversity indices calculated from the data collected during the present study are presented in Table 3. The Shannon Weiner index (H') value fluctuated from 2.82 (December) to 3.15 (January) with a mean value of 2.96. Margalef's index of species richness recorded the minimum value of 6.51 in December and the maximum value of 7.66 in April, with the mean value of 6.90. The evenness index or equitability index gives the distribution pattern of individuals in the community. The maximum evenness or homogenous distribution was recorded in April (E = 0.90), while the minimum was recorded in August (E = 0.83). As is evident from the values the distribution of various taxa was more or less uniform throughout the year, the mean value being 0.86. A comparison of the seasonal fluctuations in the various diversity indices used depicted the same trend of highest values in winter and the lowest values during summer and autumn.

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Table 1. Physico chemical parameters of Boniyar stream

PARAMETERS	Dec	Jan	Feb	Mar	April	May	June	Jul	Aug	Sep	Oct	Nov	Mean	S. D.
Water Temp °C	5	6	4	9	10	11	10	9	8	7	6	7	7.3	2.05
Transp. cm	25	35	40	25	25	32	30	25	30	25	30	25	28.91	4.90
Velocity cm/s	170	140	112	131	121	85	95	120	130	140	120	140	125.3	22.34
Conductivity µS	123	130	138	111	97	105	135	147	127	120	112	143	124	15.58
pH	8.6	8.5	8.5	8.3	8.2	8.1	8	8.2	8.1	8.3	8.1	8.3	8.2	0.18
CO_2 mg/l	2	3	4	4	8	5	8	6	7	5	6	6	7.3	1.43
Alkalinity mg/l	76	54	80	65	70	76	70	78	67	60	62	68	68.8	7.84
DO mg/l	11	11	11	9.4	9.1	8.5	8.8	12	10.9	12	12.7	12.6	10.7	1.47
Hardness mg/l	90	70	90	60	80	75	80	76	64	86	80	80	77.5	9.35
Ca mg/l	24	20	32	20	30	24	20	17	18	23	26	22	23	4.57
Mg mg/l	7	4	6	6	7	6	5	5	6	7	8	5	6	1.12
Nitrite-N µg/l	8	7	9	9	8	8	7	8	9	7	8	8	8	0.73
Nitrate-N µg/l	144	150	120	140	140	142	140	148	124	141	139	140	139	8.68
Ammonia-N µg/l	25	23	27	30	35	35	28	32	22	21	23	23	27	5
Ortho-P µg/l	8	7	7	7	8	9	8	8	6	5	6	6	7.08	1.16
Total-P µg/l	52	60	60	50	50	43	48	65	58	52	48	40	52.3	6.66

Table 2. Diversity Indices for insect community of Buniyar stream

Index	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Mean
Shannon-Weiner Diversity Index	2.82	3.15	2.99	3.05	3.12	2.92	2.95	2.91	2.87	2.88	2.9	2.93	2.96
Margalef's Index	6.51	6.95	6.7	7.18	7.66	7.34	6.97	6.72	6.69	6.53	6.61	6.9	6.90
Equitability Index	0.84	0.89	0.86	0.87	0.90	0.86	0.86	0.85	0.83	0.83	0.84	0.85	0.86

Table 3: Density of Entomofauna in Boniyar stream

Taxa	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Mean	S.D.
Diptera														
Diamessinae Larvae	24	32	27	32	36	25	26	22	25	16	18	26	20	5.70
Atherix sp.	20	32	24	16	07	08	09	07	06	05	06	31	15	10.09
Simulium sp.	18	22	23	12	08	05	07	04	05	06	07	14	11	6.81
Total	62	86	74	60	51	38	42	33	36	27	31	71	52	16.96
Ephemeroptera														
Baetella Larva	58	65	58	48	42	38	36	40	49	36	50	51	55	9.48
Ecdyonurus Larva	36	42	40	30	36	33	26	30	28	26	28	40	33	5.74
Potamentheius Larva	06	08	09	07	03	03	02	04	03	02	03	04	05	2.39
Drunella	05	07	07	06	04	02	03	04	07	02	04	04	05	1.83
Total	105	122	114	91	85	76	67	78	87	66	85	99	98	17.60
Trichoptera														
Obscura Larva	63	56	69	50	41	32	36	30	29	30	47	53	45	13.76
Rhyacophila sp.	11	13	09	09	08	12	14	09	08	05	07	09	10	2.57
Stenopsychee sp.	09	16	18	14	08	04	07	05	06	04	05	07	09	4.79
Nectopsychee sp.	07	09	05	04	03	02	02	02	04	03	02	04	04	2.19
Total	90	94	101	77	60	50	59	46	47	42	61	73	68	20.11
Grand Total	257	302	289	228	198	164	168	157	170	135	177	243	207	49.43

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The correlation coefficient between the macrozoobenthic population and various physico-chemical parameters revealed that the population showed highly significant negative correlation with water temperature (r = -0.83), velocity of water (r = -0.67) total hardness (r = -0.82), inorganic nitrogen (r= - 0.63) and total phosphorus (r= -0.69), while a significant positive relationship was revealed by the community with dissolved oxygen (r = 0.73).

DISCUSSION

The distribution, abundance and diversity of the aquatic insects are affected by inter and intra specific competition as well as tolerance capacity of organisms to changing physico-chemical features of the water. The present investigation revealed that the nature of water plays an important role in determining the density and abundance pattern of individuals in the benthic insect community. The temperature, velocity, total hardness, nitrogen and phosphorus content of water showed significant negative correlation with the density of aquatic entomofauna in the stream which is in conformity with the findings of Dobriyal *et al.* (1992) and Sharma (1986). The seasonal differences in relative abundance of major insect taxa in high altitude streams are largely governed by temperature (Gupta and Michael, 1983). In the present stream the low diversity of Ephemeroptera and Trichoptera was recorded in summer months, which is in conformity with the findings of Ide (1935) and Macan (1960). The velocity of water also plays a significant role in the distribution and abundance of insect communities in streams. The temperature regime of the present stream depicted a typical lotic phenomenon and was found to be influenced by the depth, width and velocity of water. During the present study a negative correlation was observed between the water velocity and the diversity of insects. The higher velocity during spring and summer due to rapid snow melt at higher elevations in the catchment did not support the insect communities (Gregg and Ross, 1985). Further, during this period many of the larvae and nymphs develop into the adults and leave the aquatic habitat for reproduction.

The stream water was on alkaline side with pH of 7.8 - 8.5 as also reported for other lotic system of Kashmir valley by Zutshi *et al.* (1972) Kaul (1977), Pandit *et al.* (2001), Bhat and Yousuf (2004) and Mahdi *et al.* (2005). The relatively higher pH in this segment of the stream may be due to less CO_2 less organic decomposition and presence of carbonates of alkali and alkaline earth metals (Hutchinson 1957).The total hardness of the water ranged between 63 mg/l in winter and 88 mg/l in spring and as such the stream falls under the medium to typical hard water type of Moyle (1945). The hardness of water appears to be of some importance in distribution of benthic insects as the maximum insect population was recorded in winter when the hardness was low the two showing a significant negative correlation (Dobriyal *et al.*, 1992). High dissolved oxygen of the water seemed to be conducive for the benthic organisms as it showed a positive correlation with insect population during the present study which is in conformity with the findings of Bisht and Das (1992).

The source of nitrogen in running water system includes precipitation, nitrogen fixation in water and sediments, and largely through inputs from catchments and agricultural wastes (Wetzel, 1983). The nitrogen as well as the total phosphorus content in the stream showed the peak values in summer season, which may be due to the fact that higher anthropogenic pressure and increased agricultural activities in the catchments. Concentration of both these nutrients showed a negative correlation with the insect population in the stream. Because of its snow melt origin, the stream generally contained low nutrient concentration. The low human population in its catchment also helped in maintaining the water body almost pollution free for most part of the year. This is also depicted by the presence of the insect community of the stream which is represented only by Ephemeroptra Trichoptera and Diptera that are characteristic feature of un-polluted waters.

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REFERENCES

A.P.H.A., 1995 *Standard Methods for the Examination of Water and Waste Water*. APHA, AWWA, WEFA. Washington, D. C.

Bhat, F.A. and Yousuf, A.R. 2002. Ecology of Periphytic Communityof Seven Springs of Kashmir. *J. Res. Dev.* **2**: 47 59

Bhat, F.A. and Yousuf, A.R. 2004. Limnological Features of Some Lotic Systems of Kashmir. In: *Bioresources Concerns and Conservation* (Azra N. Kamili and A. R. Yousuf, eds.) Centre of Research for Development, University of Kashmir.

Bisht, R.S. and Das, S.M. 1979. Studies on the ecology of aquatic entomofauna of Kumaon lakes. *Proc. Workshop on High Altitude Entomology and Wildlife Ecology*: Zoological Survey of India, Solan.

CSIR.1974. *Analytical Guide* (Laboratory Techniques). CSIR, Pretoria, South Africa

Dobriyal, A. K., Kumar, N., Kotnala, C. B. Bahuguna, A. K. 1992. Prelimnary observation on seasonal trends of macrozoobenthic diversity in the River Nayar of Garhwal Himalaya. In: *Recent Research in Cold Water Fisheries*. (K.L. Sehgal ed.). Today and Tomorrow's Printers Publishers, New Delhi.

Downing, J.A. and Riglar, F.H.1984. *A Manual on Methods for the Assessment of Secondary Productivity of Freshwaters*. IBP Hand Book No. 17 Blackwell.Sci.Pub. London. Edmondson, W.T. 1959. *Freshwater Biology*. John Wiley, N.Y.

Elliot, J.M.1967. The life histories and drifting of the Plecoptera and Ephemeroptera in a Dartmoor Stream. *J Anim. Ecol.*, **36:** 343-362

Engblom, E. and Lingdell, P.E.1999.Analysis of benthic invertebrates. p.9-77 In: *River Jhelum, Kashmir Valley*. Impacts on the aquatic environment (Lennart Nyman ed.) SWEDMAR Publications, Sweden

Gregg, W.W., and Ross, F.L. 1985. Influences of aquatic macrophytes on invertebrat community structure, guild structure and micro distribution in streams. *hydrobiologia*, **128**: 45 56.

Gupta, A. and Michael, R. G. 1983. Population ecology and feeding properties of two co-existing taxa of Baetidae (Insecta : Ephimeroptera). *Proc. Symp. Ecology of Animal Population*. Calcutta.

Hutchinson, G. E. 1957. *A Treatise on Limnology* Vol. 1. Geography, Physics and Chemistry. John Willey and Sons., Inc.

Ide, F. P. 1935.The Effect of temperature on the distribution of the mayfly fauna of a stream. *Publ. Ont. Fish. Res. Lab.* **50:** 1 76.

Kaul, V. 1977. Limnological survey of Kashmir lakes with reference to trophic status and conservation. *Int. J. Ecol. Environ. Sci.* **3:** 29 44.

Kumar, K. and Bhagat, M. J. 1977. Observation on the ecology of two trout streams in Kashmir and its possible effects on the brown trout (*Salmo trutta fario*) catches. *J. Inland Fish Soci. India* **10 :** 1 8.

Macan, T. T.1960. The effect of temperature on Rhithrogena Semicolorata (Ephem.). *Int. Revue ges. Hydrobiol. Hydrogr.* **45,** 197 201.

Mackereth, F.J.H. 1978. *Some Methods of Water Analysis for Limnologist*. Sci. Publ. Freshwater boil. Assoc. (England)

Mahdi, M.D., Bhat, F.A. and Yousuf, A.R. 2005. ecology of macrozoobenthos in Rambiara stream, Kashmir. *J. Res. Dev.* **5:** 95 - 100

Margalef, R. 1957. La Teria de la information en ecolgia mems. *R. Acad. Scienc. Arts Barcelona*, **3** (32): 1379.

Moyle, J. B. 1945. Some chemical factors influencing the distribution of aquatic plants in Minnesota. *Amer. Midland Nat.* **34:** 402 - 420.

Pandit, A. K., Rather, S. A. and Bhat, S. A. 2001. Liminological features of freshwaters of Uri, Kashmir. *J. Res. Dev.* **1:** 20 29.

Pennak, R.W. 1978. *Freshwater Invertebrates of United States*. John Wiley and Sons, New York.

Shannon, C.E. & Weiner, W.1963. *Mathematical Theory of Communication*. Univ. of Illinois Press, Urbana.

Sharma, R.C. 1986. Effect of Physico-chemical factors on benthic fauna of Bhagirathi River, Garhwal, Himalaya. *Indian J. Ecol.* **13** (1): 133137.

Welch, P. S.1948. *Limnology*: McGraw Hill Book Co. New York.

Wetzel, R.G. 1983. *Limnology* (2nd ed.) Saunders College Publishing. N.Y.

Zutshi, D. P., Kaul, V. and Vass, K. K. 1972. Limnology of high altitude Kashmir lakes. *Verh. Int. Verein. Limnol.* **18**: 599 - 604.