International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2016): 79.57 | Impact Factor (2015): 6.391

Macrozoobenthos as Indicators of Pollution in River Jhelum of Kashmir Himalayas

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Abstract: ***The River Jhelum (an important tributary of Indus River) is main drainage system of Kashmir valley originating from Pir Panjal range of Himalayan Mountains connected by all other lentic and lotic habitats in the valley. For present study four sites were selected in river Jhelum as Khanabal Batengu (siteI), Zero bridge in Srinagar city (siteII), Gantimulla at Baramula (SiteIII) in most densely populated areas with different types of anthropogenic activities adding different types of affluent to the river and a site in the lower reaches with least human interference and least discharge from the catchment was also selected as site IV at Dachi bridge in Uri. The River system showed an appreciable change in the chemical parameters during the study. The mean conductivity of the water ranged between177 µS and 306 µS and alkalinity from pH- 7.9 to 8.2, hardness from 165 – 236 mg/L. The inorganic nitrogen (as nitrate nitrogen) of the river recorded in the higher side of 181 µg/l to 317µg/l, total phosphorus from 79 µg/l to 228 µg/l along with other parameters showed that river receives heavy load of nutrients from the catchment along the first three sites of river than at last stretch of river segment in Uri Baramullah. In response to changing physico-chemical charecteristics of water in river Jhelum, the macro-invertebrate fauna of the sites was more or less similar in first three sites of river Jhelum and were dominated by Annelids, Molluscs and Diptera with representative species of Tubifex sp, Limnodrillus sp, Erpobdella sp, Corbicula sp, Chironomus larva and Monodiamessa sp. Which are considered to be the bio-indicators of pollution. The presence of such type of macrobenthic fauna in the river indicates the deterioration of water quality due to high anthropogenic activities going on in the aquatic environment which will affect the overall biological scenario particularly to the fish in the system.***

Keywords: River Jhelum, Physico - chemical, Macrozoobenthos, Density, Pollution

1. Introduction

The river Jhelum, lone drainage system of the valley and main fishery resources of Kashmir, flows from south to northwest, and while flowing through the valley it is joined by a number of lotic and lentic habitats of the valley. Aquatic habitats of the valley have been an attraction to large number of people from across the globe. Many a naturalist, who visited the valley of Kashmir during 19th and 20th century have made references about the status of different aquatic habitats of the region (Drew, 1875; Lawrence 1895 etc.). It is these visiting naturalists who initiated the aquatic studies in the valley (Von- Hugel, 1844; Hutchinson, 1939). The first limnological studies were conducted about Kashmir waters during the early 20th century (Edmondson and Hutchinson, 1934; Brehm, 1936; Brehm and Wolterch; 1939). Since then there have been regular references appearing about the limnological features of Kashmir waters.

Over the years the river Jhelum right from its origin at Verinag has started receiving large quantities of sewage and other pollutants without any treatment. Thus during its passage through the valley, its water quality continuously changes. Since the occurrence and abundance of an organism is dependent on the physico-chemical parameters, the aquatic life of river has also been affected by the pollution.

Even after 40 years of research work on the ecological parameters of different aquatic habitats of the valley (Zutshi and Vass, 1970; Yousuf and Qadri, 1981; Balkhi and Yousuf, 1992; Bhat and Yousuf, 2004), the limnological studies pertaining to the lotic habitats are very few (Kumar and Bhagat, 1977; Yousuf and Qadri, 1981 and Bhat and Yousuf, 2004, Mahdi etal ----, Yousuf etal). The ecological impact on the qualitative and quantitative features of benthic invertebrates, which form an important link in the food chain of fish, has altogether been neglected. In order to fill this gap in our knowledge it was proposed to conduct a study on the spatial changes in quality of water and zoobenthose which will act as indicators of pollution in River Jhelum.

2. Study Sites

For the present research work four sites were chosen in main river Jhelum (figure 1) for assessing the water quality through physico-chemical parameters and population dynamics of macrozoobenthic organisms in order to correlate the data for assessing the pollution stress of the river to manage the biological health of the river and the sites are selected as **Site I** (River Jhelum at Khanabal Batangu) The site I was located at Khanabal Batangu in Islamabad district, about 45 kilometers from Srinagar. The site is just 2 km downstream of Islamabad town from which untreated domestic sewage enters into the river. The depth of water at this site varied from 1.5 m to 6 m. The bottom texture of the site was muddy and sandy clay type with gravel and stone at certain places. **Site II** (River Jhelum at Zero Bridge) The site II was located at Zero bridge in Srinagar city. This segment of the river is characterized by dense human population on both the banks and in the river basin itself. The river Jhelum from Khanabal to Zero bridge receives domestic wastes from human settlements and cantonment areas. The depth of water at the site fluctuated from 2 m to 6 m. The sediment texture was that of muddy and loamy type. **Site III** (River Jhelum at Gantamullah village) The site III was located at Gantamulla in district Baramulla. The river in this stretch receives feacal matter and household discharges, besides the agricultural runoff. The water level fluctuated from

1.5m to 3.5m. The bottom texture was fine sandy, muddy type and at few places some bolders and stones were found. **Site IV** (River Jhelum at Dacchi Bridge) The site IV was located in the river at Dacchi Bridge near Slamabad in Uri region of Kashmir. From site III downwardly the river flows through thinly populated areas and does not receive any significant quantities of sewage. Downstream of site III the river receives important tributaries like Buniyar, Hajipir and Jabla Nallah, which considerably dilute the water of the river. The bottom texture was clay type with some stones along the banks.

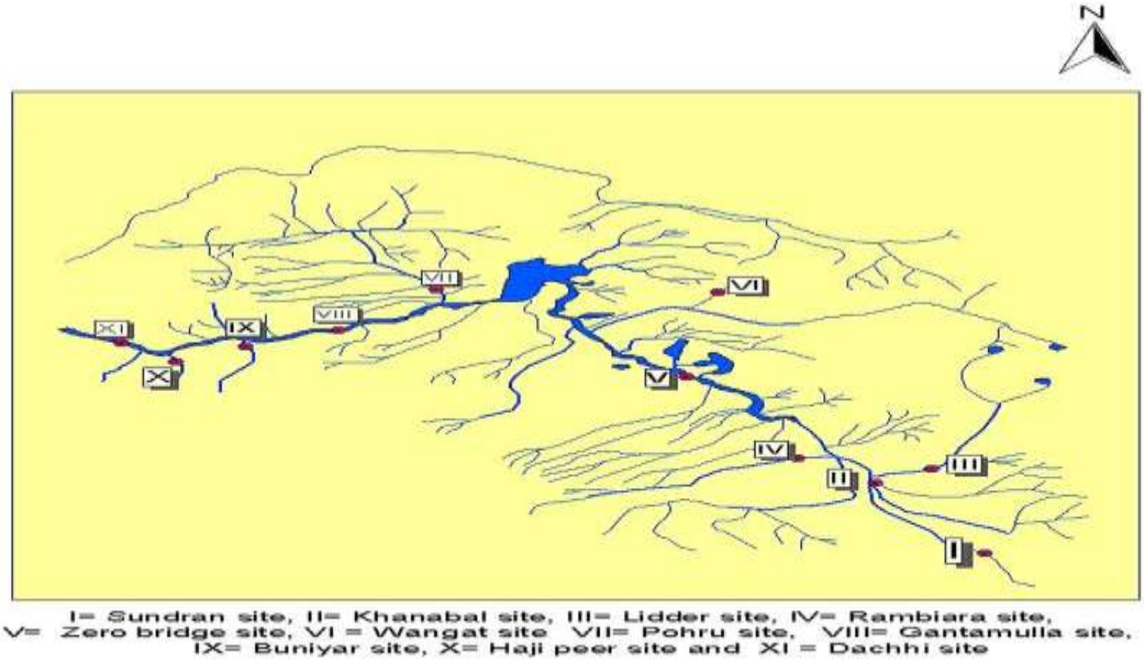

Figure 1: River Jhelum in Kashmir Himalaya showing different study sites

3. Methodology

The water samples were collected from river and streams by dipping one litre polyethylene bottle just below the surface of water. Temperature, pH, conductivity, depth and transparency were recorded on spot. For estimation of dissolved oxygen water samples were collected in glass bottles and fixed at the sampling site in accordance with Winkler's method. Free CO2, hardness, bicarbonate alkalinity and chloride were determined by titremetric methods (Mackereth et al 1978). Phosphate (Stannous chloride method), nitrate (Salicylate method), nitrite (buffer colour reagent method) and ammonia (phennate method), were analysed with the help of spectrophotometer (SISTRONICS-106) in accordance with CSIR Pretoria, 1974.

Macrozoobenthos in muddy substratum zones were collected with the help of Ekmen's dredge and sediment collected by the dredge was kept in sieve for checking the zoobenthos. The samples were taken in triplicate to avoid any error. In case of hard stony bottom, a surber type sampler was pressed against the bottom where it enclosed an area of 1600 cm^2. The stones from inside the frame were removed and checked for any zoobenthos. The gravel and sand were disturbed so that the benthos present got detached and collected in net fixed at right angle to the frame opposite to the current of water. The macroscopic organisms were collected with the help of forceps and brushes. This act was done thrice to get better average results. Animals collected by both methods were preserved in 4% formalin for detailed examination in the laboratory. Identification of macrozoobenthos was done with the help of standard taxonomical works of Edmondson (1959), Pennak (1978) and Engblom and Lingdell (1999) and later on population density of each species was determined. The various types of diversity indices were used in order to correlate the different sites varying in sediment texture and water characteristics.

4. Results and Discussion

The distribution, abundance and diversity of macro-zoobenthos is affected by inter and intra specific competition as well as tolerance capacity of organism to changing physico-chemical parameters of waters. The important factors which regulate the occurrence and distribution of stream dwelling invertebrates including current, speed, temperature, and vegetation and dissolved substances etc. Many of these factors have been used by various authors (Maccan, 1960; Cairns and Dickson, 1983) as basis for the classification of streams and rivers.

The temperature regime of the river system depicted a typical lotic phenomenon with average water temperature of less than 12^oC and average velocity was recorded in the range of 35 to 40 cm/sec of water in River Jhelum and constant flow was maintained by the water at site IV as 35 SD 3.5 cm /sec.

Conductivity which is a measure of total ionic potential in a water body reveals the impact of anthropogenic pressure on the Jhelum system as its value increased gradually with increase in the human population. The site II located in Srinagar city recorded the highest annual mean conductivity value (306 µS), which reflects the pollution at this site (Shashtree et al, 1991)

The pH in the present river system was on alkaline side (7.8 to 8.6) as also reported for lotic systems of Kashmir valley by Kaul, (1977). The chloride content in the freshwater bodies of Kashmir valley recorded below 20 mg/l as in other parts of the world (Kaul, 1977 and Mir, 1977). The average value of chloride was recorded high in first three sites of river Jhelum as wastes are directly or indirectly being added to the system (Bhat and Yousuf, 2004).

Dissolved oxygen is an important factor for distribution and diversity of Macrozoobenthos (Bisht and Das 1979) but running water typically contains relatively high concentration of dissolved oxygen and similar trend has been observed in Jhelum river system. The average value of dissolved oxygen was recorded in close range of 9.2 to 9.3 mg/l which is related to the cold nature of water and high velocity of water in the river. The source of nitrogen in river system includes precipitation, nitrogen fixation in water and sediments, inputs from catchment and agricultural wastes (Wetzel 1983). The nitrogen enters in to the complex in different ways and Nitrate-nitrogen is always in higher concentration than the other forms. The total inorganic nitrogen levels in the river Jhelum at first three sites (from its origin to the Gantimulla site) were comparatively higher than in last segement of river Jhelum (SiteIV). Particularly site II recorded the maximum values almost throughout the year due to runoff from catchment of Srinagar city. Phosphorus recorded the same trend as nitrogen and is regarded as key element in the eutrophication process (Vollenweider, 1972).

The assessment of water pollution essentially becomes a biological problem particularly because the water pollution affects living organisms inhibiting the habitat. Among biological communities macro zoobenthic fauna has been considered the most suitable means of bio indicators of pollution (Hynes, 1966; Sinha *et al*, 1989 and Mahdi *etal* -----). The site I recorded an average of 150 ind /sq.m belonging to 15 species, among which only 6 species belonged to class Arthopoda, 6 species of Annelida and 3 species of Mollusca. The Site II located in the high population area of Srinagar City at Zero-bridge receiving large amount of untreated domestic wastes by which organic pollutants deteriorating the water quality of the river. The average density of benthic organisms was recorded less than other three sites of river Jhelum as 106 ind/sq m representing 4 species of Arthopoda, 5 species of Annelida and 2 species of Mollusca. The maximum number of *Chironomus* larva *and Monodiamessa* larva along with the Annelidan and Molluscan species as pollution indicators confirm the heavy pollution load at this site than other sites of river Jhelum. The site III receives agricultural run offs and human wastes from the catchment which increase the nutrients and other chemical constituents as chlorides, calcium and magnesium in the water thereby affecting the river environment. A total of 12 species of macrozoobenthos recorded at this site with 6 species of insects, 3 species of Annelida and 2 species of Mollusca with average density of 118 ind /sq.m.

The site IV unlike the first three sites of river jhelum having rocky and stony texture with least organic pollution and less human interference favour the abundance and diversity of aquatic insects than any other species of zoobenthos. A total of 16 species of zoobenthic organisms were recorded at this site among which 15 species belonged to class insecta. The dominant species were larvae of *Diamessinae, Atherix Baetiella obscura* and *Rhycophila*. These insects thrived well in cold and clean water having less organic pollution.

The maximum value of Shannon-Weiner index ($H^/$), Simpson's diversity index winter and autumn and having maximum equitability value in winter in all the sites confirm that in winter season the river receives comparatively less pollution load from the catchment. The River Jhelum from site I to site III recorded good number of pollution tolerant species of Annelida and Mollusca like *Tubifex* larva, *Limnodrillus* sp, *Erpobdella* sp, *Lymnea auriulla* and *corbicula* sp. and only 6 species of insects like *Baetis* larva, *Hydropsychae, Nectopsychae* and *chironomous* etc which have affinity towards the polluted waters (Oliver, 1971; Milbrink 1980). However some authors relate it more towards the sediment texture than pollution structure of the water body. Site IV a fast flowing zone of River Jhelum in Uri Baramulah, recorded very high insect density and diversity. The various diversity indices used give an idea about the pollution load and distribution pattern of various organisms in the water system. The Shannon-Weiner diversity index ($H^/$) was recorded high (3.478) in winter at site IV and least (3.032) in summer at site II. The pollution tolerant species increased during summer which in turn decreases the homogeneity and evenness of individuals in the system thereby decreasing the Margalef's index value.

Acknowledgments

The present work was facilitated by the Director of Centre of Research for Development, University of Kashmir, Prof. A.R.Yousuf who encouraged and inspired me as a guide in the field of research and under his kind guidance I completed my M.phil and Ph.D programmes. This small piece of work is part of my M.phil programme which i carried 10 years before and present in this paper. My special thanks are due to Dr. Asgar Hassan Samoon, Commissioner Secretary, Deptt. Of Higher Education, J&K who constantly encouraged the principals of the colleges to sensitize the teaching faculty to write for the Scientific Journals and also to the Madam Principal of G. W. C. Nawakadal for inspiring me to write a scientific data based article to the Journal Published by the Higher Education Department.

Class/Order/Taxa	II	V	VIII	XI
Arthopoda				
Baetis larva	3	0	3	17
Ecdyonurus	0	0	0	15
Epeorus sp	0	0	0	0
Potamanthelus sp.	0	0	0	7
Rhyacophila sp	0	0	0	17
R. Obsscura	0	0	0	16
R. Yamanakensis	0	0	0	0
Stenopsychae sp	0	0	0	6
Hydropsychae sp	2	0	4	0
Nectopsychae sp	1	4	5	4
Chironomous sp	12	14	12	4
Diamessa sp	0	0	0	21
Monodiamssa sp	13	19	15	0
Simulium sp	0	0	9	17
Atherix sp	0	0	0	16
Gammarus pulex	11	10	10	0
Annelida				
Tubifex larva	32	18	18	2
Limnodrillus sp	29	12	13	1
Nais sp	2	4	0	0
Dina sp	3	0	0	0
Glossiphonia sp	2	3	0	0
Erpobdella sp	13	10	5	0
Mollusca				
Lymnaea auricular	10	3	9	0
L. columella	2	0	0	0
Corbiculla sp	7	7	15	0
Total density	**150**	**106**	**118**	**139**

Mean value of density of zoobenthos recorded in different sites of River Jhelum

References

[1] Balkhi, M.H. and A.Yousuf. 1992. Community structure of crustacuian plankton in relation to trophic conditions. *Int. J. Ecol. Environ*. 18: 155 – 168.

[2] Brehm, V. 1936. Yale north Indian Expedition. Report on cladocera. Mem. conn. *Acad. Arts. Sci*. **10:** 283 – 197.

[3] Brehm, V. and Woltereck, R. 1939. Die Daphiniden Deryale North India Expedition. *Inst. Rev. Hydrobiol.* Leipzig 38**:** 1 – 19.

[4] Bisht, R.S and Das, S.M.1980. Certain aspect of habitate ecology of aquatic entomofauna in two cold water Kumaon lakes. *Indian J. Ecol*. **7** (2): 57 – 68

[5] Bhat, F.A. and Yousuf, A.R. 2004. Limnological features of some lotic system of Kashmir In: *Bioresources concerns and Conservation* (eds. Azra N. Kamili and A.R.Yousuf) Centre of Research for Development, University of Kashmir.

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

[7] Drews, F. 1875. The Jumoo and Kashmir Territories. London

[8] Edmondson, W.T. & Hutchinson, G.E. 1934. Yele North Indian Expedition. Report On Rotatoria. *Mem. Conn. Acad. Arts and Sci*. **16**: 153 – 185.

[9] Edmondson, W.T. 1959. *Freshwater biology* John Wiley, N.Y.

[10] Engblom, E. and Lingdell, P.E. 1999. Analysis of benthic invertebrates. pp. 39 –77. In: *River Jhelum, Kashmir Valley*. Impacts on the aquatic environment (LeennartNyman ed.) Swedmar Publications, Swedan

[11] Hutchinson, G.E. 1934. Liminological studies at high altitude in Ladakh.Nature. 132 – 136.

[12] Hynes, H.B.N. 1961. The invertebrate fauna of Welsh mountain strem. *Arch, Hydrobiol* **57**: 344 – 388.

[13] Hynes N.B.N.1972. *Ecology of Polluted Waters*. Liverpool University press.

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

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

[16] Lawrence, Walter, R. 1895. *Valley of Kashmir* Kasar publisher Srinagar.

[17] Milbrink, G. 1980. Oligochaete communities in population biology: the European situation with rapid reference to lakes in Scandinavia. In: *Aquatic oligochaete Biology* (R.D. Brink hurst and D.G. Cook, eds.) Plenum press, N.Y and London, pp 433 – 455.

[18] Mir, A. M. 1977. *Plankton and water soil in relation to lake productivity*. Ph.D thesis Univ. Kash.

[19] Oliver, D.R. 1971. Life Histroy of chironomidae. *Ann. Rev*.

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

[21] Sinha, M.P. Sinha, R. and Mehrotra, P.N 1993.Role of the aquatic insects as bio Indicators of pollution of aquatic biotop. *Poll. Res*. **12**(4): 257 – 260.

[22] Vollenweider, R.A. 1972. Input output models with specialreference to the phosphorus-loading concept in limnology. *Workshop Conf. Kestanienbaum, Switzarland.*

[23] Wetzel, R.G. 1983. *Limnology* 2nd ed. Saunders College Publishing. N.Y.
[24] Yousuf, A.R. and Qadri, M.Y.1981 Seasonal abundance of Rotifera in a Warm monomictic lake *J. Indian Inst. Sci*. On lake typology of Kashmir Envi

Table 1: Mean value of physicochemical parameters at various sites in River Jhelum.

Parameters	SITE I		SITEII		SITEIII		SITEIV	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Air Temperature (°C)	20	7.29	18	8.16	20	6.9	20	8.56
Water Temperature (°C)	11	4.58	10.5	5.31	12	3.7	11.5	4.26
Depth (cm)	300	127.02	450	133.99	250	79.32	245	43.49
Transparency (cm)	40	11.54	35	5.64	35	10.02	35	3.58
Velocity (cm/sec)	40	12.27	37.5	7.38	40	22.16	35	3.34
Conductivity (µS/cm)	293	26.3	306	35.28	263.5	29.99	176.5	55.88
pH	8	0.09	7.9	0.12	8.05	0.16	8.2	0.13
Carbondioxide (mg/l)	11	1.61	10	1.94	10	2.3	7.5	2.93
Alkalinity (mg/l)	162	21.82	161	13.72	150	10.76	139.5	22.28
Dissolved oxygen (mg/l)	9.2	0.8	9.2	0.78	9.3	0.75	9.2	0.4
Chloride (mg/l)	13	4.12	13.5	3.17	12	2.57	8.5	1.56
Total Hardness (mg/l)	198	49.39	235.5	26.93	170	16.62	165	29.82
Calcium (mg/l)	49	14.81	56.5	6.49	52	6.94	42	9.71
Magnesium (mg/l)	16	4.56	22	4.94	9.5	2.31	13.5	3.86
Nitrite-Nitrogen (µg/l)	20	4.63	35	4.86	21	4.54	12	3.25
Nitrate-Nitrogen (µg/l)	226	42.81	317	61.39	188.5	25.28	181	21.49
Ammonical-Nitrogen (µg/l)	62	13.38	85.5	9.06	62.5	18.03	39	13.06
Orthophosphorus (µg/l)	20	6.43	40	7.54	19	5.26	10	2.33
Total Phosphorus (µg/l)	120	29.94	228	58	88.5	9.09	79. 00	11.06