



REVIEW ARTICLE

PATTERNS BENEATH THE WATERS: UNRAVELLING MACROZOOBENTHIC ECOLOGY IN KASHMIR'S LIFELINE RIVER JHELUM OF HIMALAYAS

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ABSTRACT

The River Jhelum (an important tributary of Indus River) is main drainage system of Kashmir valley originating from PirPanjal 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 KhanabalBatengu (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 site IV in the lower reaches with least human interference and least discharge from the catchment was also selected at Dachi bridge in Uri. The River system showed an appreciable change in the physico-chemical parameters during the study. The mean conductivity of the water ranged between 177 μ S and 306 μ S 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 μ g/l to 317 μ g/l, total phosphorus from 79 μ g/l to 228 μ g/l. In response to changing physico-chemical characteristics 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 dominant species as Tubifex, Limnodrilus, Erpobdella, Corbiculasp, Chironomuslarva which indicates the deterioration of water quality due to high anthropogenic activities along the river.

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INTRODUCTION

The river Jhelum, lone drainage system of the valley and one of the 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. 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 sediment texture, physico-chemical parameters, the other ecosystem interactions has also been affected by the pollution. Even after decades 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, Yousuf *et al*, 2007 and Mahdi etal 2018.). The ecological impact on the spatial distribution of benthic invertebrates, which form an important link in the food chain of fish, has been neglected. In order to fill this gap in our knowledge it was proposed to conduct a study on the changes in quality of water affecting distribution of Zoobenthose along the river Jhelum from its source to the last site before entering Pakistan occupied Kashmir.

MATERIALS AND METHODS

For the present research work four sites were selected across the main river Jhelum (figure 1) for assessing population dynamics of macrozoobenthic organisms to manage the biological health of the river for healthy ecosystem as **Site I** located at Khanabal Batangu in Islamabad district, the first site after the source. The bottom texture of the site was muddy and sandy clay type with gravel and stone at certain places. **Site II** was located at Zero bridge in Srinagar city. This segment of the river is characterized by dense human population on both the bank. The river Jhelum from Khanabal to Zero bridge receives domestic wastes from human settlements and cantonment areas. The sediment texture was that of muddy and

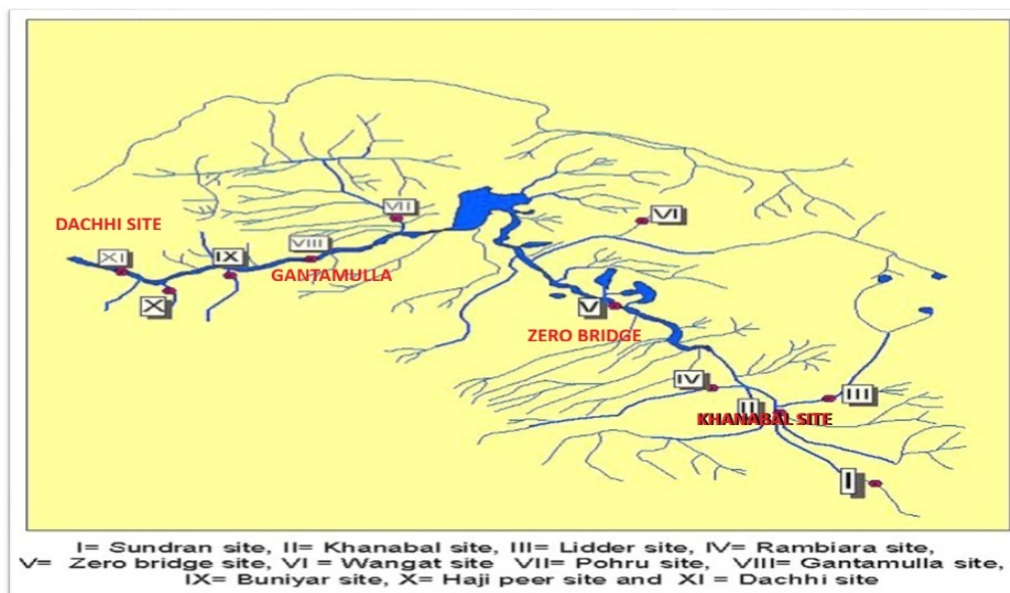
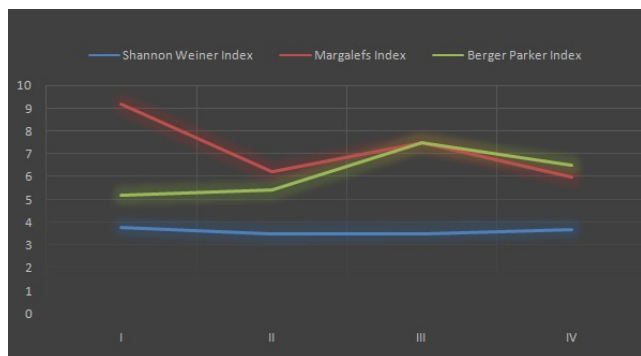


Figure 1. River Jhelum System in Kashmir Himalaya showing different study sites in red as selected sites in the Jhelum
Mean value of Physico-chemical Parameters recorded in the river Jhelum at different sites

Parameters	Site I		Site II		Site III		Site IV	
	Mean	S.D	Mean	S.D	Mean	S.D	Mean	S.D
Water Temperature (°C)	11	4.58	10.50	5.31	12.00	3.70	11.50	4.26
Depth (cm)	300	127.02	450.00	133.99	250.00	79.32	245.00	43.49
Transparency (cm)	40	11.54	35.00	5.64	35.00	10.02	35.00	3.58
Velocity (cm/sec)	40	12.27	37.50	7.38	40.00	22.16	35.00	3.34
Conductivity (µS/cm)	293	26.30	306.00	35.28	263.50	29.99	176.50	55.88
pH	8	0.09	7.90	0.12	8.05	0.16	8.20	0.13
Carbondioxide (mg/l)	11	1.61	10.00	1.94	10.00	2.30	7.50	2.93
Alkalinity (mg/l)	162	21.82	161.00	13.72	150.00	10.76	139.50	22.28
Dissolved oxygen (mg/l)	9.2	0.80	9.20	0.78	9.30	0.75	9.20	0.40
Chloride (mg/l)	13	4.12	13.50	3.17	12.00	2.57	8.50	1.56
Total Hardness (mg/l)	198	49.39	235.50	26.93	170.00	16.62	165.00	29.82
Calcium (mg/l)	49	14.81	56.50	6.49	52.00	6.94	42.00	9.71
Magnesium (mg/l)	16	4.56	22.00	4.94	9.50	2.31	13.50	3.86
Nitrate-Nitrogen (µg/l)	226	42.81	317.00	61.39	188.50	25.28	181.00	21.49
Ammonical-Nitrogen (µg/l)	62	13.38	85.50	9.06	62.50	18.03	39.00	13.06
Total Phosphorus (µg/l)	120	29.94	228.00	58.00	88.50	9.09	79.00	11.06

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

Class/Order/Taxa	I	II	III	IV
Arthropoda				
<i>Baetis larva</i>	3	0	3	17
<i>Ecdyonurus</i>	0	0	0	15
<i>Epeorussp</i>	0	0	0	0
<i>Potamanthelus sp.</i>	0	0	0	7
<i>Rhyacophilasp</i>	0	0	0	17
<i>R. Obscura</i>	0	0	0	16
<i>R. Yamanakensis</i>	0	0	0	0
<i>Stenopsychasp</i>	0	0	0	6
<i>Hydropsychasp</i>	2	0	4	0
<i>Nectopsychasp</i>	1	4	5	4
<i>Chironomoussp</i>	12	14	12	4
<i>Diamesasp</i>	0	0	0	21
<i>Monodiamssasp</i>	13	19	15	0
<i>Simuliumsp</i>	0	0	9	17
<i>Atherixsp</i>	0	0	0	16
<i>Gammaruspulex</i>	11	10	10	0
Annelida				
<i>Tubifex larva</i>	32	18	18	2
<i>Limnodrillussp</i>	29	12	13	1
<i>Naissp</i>	2	4	0	0
<i>Dina sp</i>	3	0	0	0
<i>Glossiphoniasp</i>	2	3	0	0
<i>Erpobdellasp</i>	13	10	5	0
Mollusca				
<i>Lymnaea auricular</i>	10	3	9	0
<i>L. columella</i>	2	0	0	0
<i>Corbicullasp</i>	7	7	15	0
Total density	150	106	118	139



Graph showing different diversity patterns along River Jhelum

loamy type. Site III was located at Gantamulla in district Baramulla. The river in this stretch receives fecal matter and household discharges, besides the agricultural runoff. The bottom texture was fine sandy, muddy type and at few places some boulders and stones were found. 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. Water samples were collected in accordance with APHA 2003 and was analysed as per standard methods of APHA 2003. Macrozoobenthos were collected with the help of Ekmen's dredge and a Surber type sampler depending upon the sediment texture. Macrozoobenthos 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, Abundance and diversity indices were calculated and correlated with different.

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°C 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 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 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 segment of river Jhelum (Site IV). 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 and Sinha 1993 and Mahdi *et al* 2007). The site I recorded an average of 150 ind /sq.m belonging to 15 species, among which only 6 species belonged to class Arthropoda, 6 species of Annelida and 3 species of Mollusca. The Site II located in 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 Arthropoda, 5 species of Annelida and 2 species of Mollusca. The maximum number of *Chironomus* larva and *Monodiamessa* larva along with the species of Annelidans and Molluscans 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. 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 *Rhyacophila*. These insects thrived well in cold and clean water having less organic pollution (Mahdi *et al* 2018). The River Jhelum from site I to site III recorded good number of pollution tolerant species of Annelida and Mollusca like *Tubifex* larva, *Limnodrilus* sp, *Erbobdell asp*, *Lymnaea auricula* 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. River Jhelum at Dachi Uri (site IV) a fast flowing zone of River 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.

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