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Limnological Features of River Jhelum and its Important Tributaries in Kashmir Himalaya with a Note on Fish Fauna

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ABSTRACT

A detailed limnological study of the River Jhelum and its important tributaries in the Kashmir Himalaya was conducted during 2002-2005 Eleven study sites were selected for the collection of data from the Jhelum and its important tributaries including Sundran, Lidder, Rambiara, Wangat Nalla, Pohru Nalla, Buniyar Nalla and Haji Pir Nalla. The ionic composition of water of the streams varied in close relationship with the catchment pattern of the concerned water body. While the Wangat Nalla recorded the lowest, the Jhelum receiving all sorts of allochthonus material from the catchment had the highest conductivity. The water of the all the streams was well buffered and with pH >7. Comparatively the tributaries were less hard than the main river and the hardness seemed to be influenced by the anthropogenic activity in the catchment area. Nutrient concentration depicted significant spatial variations.

27 species of Macrozoobenthos were recorded from the system. Arthropoda was the most dominant group, comprising 18 species, followed by Annelida with 6 and Mollusca with 3 species. The hard, stony bottomed sites, mostly tributaries, were dominated by insects belonging to Ephemeroptera, Trichoptera and Diptera.

19 species of fishes belonging to Cypriniformes, Siluriformes, Cyprinodontiformes and Salmoniformes were collected. The ichthyofauna of the tributaries of the Jhelum was rather limited in nature, particularly in the fast flowing zones of the streams. A peculiar feature of the Wangat Nalla was the presence of *Diptychus maculatus,* which is mainly found on the other side of the Greater Himalaya in the Ladakh waters. The fish fauna in the slow flowing areas of the tributaries was similar to that of the main river but in their fast flowing areas the ichthyofauna was rather different than in the main river. The fishing effort varied from 173.2g to 360.1g per man-hour. On the whole the fish population in the river as well as its tributaries was low.

Keywords: Jhelum River, tributaries, physico-chemical limnology, macrozoobenthos, ichthyofauna

INTRODUCTION

The River Jhelum is one of the main tributaries of the Indus River and is the longest river of Kashmir valley originating from Pir Panjal range of mountains. It receives a number of perennial streams on its both banks throughout its course in Kashmir (Fig.1). The important right bank tributaries of the river in Kashmir Himalay are Sundran, Bringhi, Aripath, Lidder, Sindh, Pohru, Limber, Chandanwari and Maidan Nalla, while on the left bank its important tributaries include the Vishav, Rambiarah, Romshi, Doodganga, Ferozpur, Mandri, Buniyar, Haji Pir, Salamabad and Goalta Nalla. Only a few reports are available on the limnology of the Jhelum and its tributaries (Vass *et al.*, 1977; Kumar and Bhagat, 1977; Qadri *et al.*, 1981; Wanganeo *et al.*, 1984; Yousuf and Shah, 1988; Pandit *et al.*, 2001; Bhat and Yousuf, 2002; Yousuf *et al.*, 2003 and Bhat and Yousuf, 2004). In order to have an insight into the different limnological features of the river system in the area a detailed limnological study was conducted during 2002 - 2005 under a Research project sponsored by G. B. Pant Institute of Himalayan Ecology and Development, Almora. In the present communication some of the data collected during the tenure of this project are briefly described.

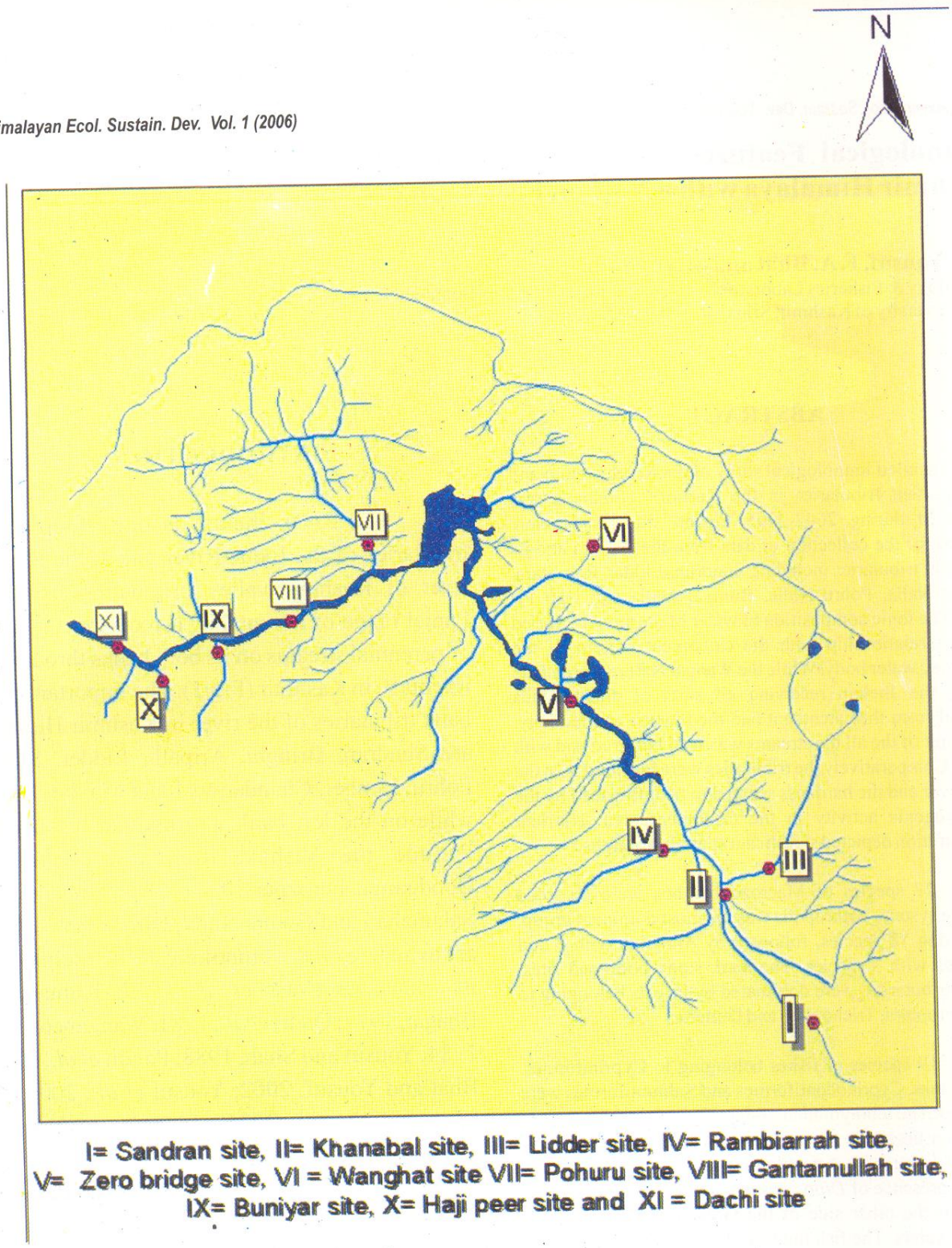

Fig. 1 River Jhelum and its tributaries in Kashmir Himalaya

STUDY SITES

After its origin from the Pir Panjal Range of mountains the Jhelum flows through the Valley of Kashmir in northwesterly direction till it falls in to the Wular Lake near Banyari village in Baramulla District. After its re-emergence from the Wular near Ningli in Sopur, it takes a southwesterly direction, leaves the valley through a gorge near Baramulla and continues its journey through Uri before entering the Pakistan Occupied Kashmir. In order to have a true picture about the limnological characteristics of the river and its tributaries in the Kashmir Himalaya eleven study sites were selected for the present study. The selection of the sites was done keeping in mind different types of habitats available in the system, i.e., fast flowing areas, slow zones as well as areas having human interference. The sites selected were:

(a) Site I: Sundran Nalla

It is the primary constituent of the River Jhelum in the Pir Panjal range and its head waters catch the snow melt from a wide area in the Pir Panjal. It flows for about 25 km up to Anantnag, where it unites with the Bringhi Nalla and also receives water from the famous Kokarnag spring. Together with the water from the Verinag spring it gives shape to the Jhelum. The study site in the stream was selected at Duroo, Shahabad, about 22 km above Islamabad (Anantnag).

(b) Site II: River Jhelum at Butengoo (Khanabal)

The site II (1st study site in the main Jhelum) was located in the Jhelum at Butengoo (Khanabal) in Anantnag district, about 45 km from Srinagar and 2 km downstream of Islamabad town. In this area large quantities of untreated domestic sewage enter into the river from the Islamabad Township of the Anantnag district. The depth of water at the site varied from 1.5 m to 6 m. The bottom texture at the site was muddy and sandy clay type with gravel and stone at certain places.

(c) Site III: Lidder Nalla

It was located in the Nambal Nalla, one of the main branches of the Lidder stream, at Nambal village, near Kathsoo Village in Anantnag. The Lidder rises at the base of the Kolahai and the Shishnag snowfields in the form of two streams, the east and the west Lidder, which unite at Pahalgam to form the Lidder stream. The bottom at the collection site was sandy with gravel and boulders.

(d) Site IV: Rambiara Nalla

The Rambiara stream rises in the Rupri Ridge of Pir Panjal, its main feeders originating from Rupri peak, the Baghsar Lake, the Pir Panjal and the Naba passes and its main branch joins the Jhelum at Nyayun. The study site in the stream was located near the bridge at Littar village in Pulwama district. The bottom texture at the study site was sandy and clay type and the average water depth about 60 cm.

(e) Site V: River Jhelum at Zero Bridge.

The site V (2nd study site in the main Jhelum) was located at Zero bridge in Srinagar city. This stretch of the Jhelum River is characterized by congested human population on both its banks. All along its course from Khanabal to Srinagar the river receives significant quantities of domestic wastes from human settlements and army cantonment areas. The depth of water at the study site fluctuated from 2m to 6m and the texture of sediment was muddy and loamy type.

(f) Site VI: Wangat Tributary of Sind Stream

The Wangat Nalla originates in the Greater Himalayan Range. It is an important

tributary of the Sind stream, which merges with Jhelum at Shadipur. The study site was located in Wangat Nalla at Narayan Nag. The average depth at the site was 50cm and the bottom texture was sandy with boulders.

(g) Site VII: Pohru Nalla

It was located near Noupur, Sopur, in the Pohru stream about 5km upstream of its confluence with the Jhelum. The Pohru has its source in the mountains and springs of Lolab and passes through the Kamraj pass, receiving a number of tributaries like Lolab, Kahmil, Talar and Mawar streams on its way.

(h) Site VIII: River Jhelum at Gantamulla

This site (the 3rd site in the main Jhelum) was located at Gantamulla in district Baramulla. The water level at the study site fluctuated from 1.5m to 3.5m. The bottom texture was fine sandy and muddy type with boulders and stones at places.

(i) Site IX: Buniyar Nalla

Buniyar Nalla, also called the Hapath Khai, is formed in the Gazan forest, near Mindi Gali and Mohardari and joins the Jhelum on its left bank at Buniyar, just below the Barrage of the Uri - I Hydroelectric Project. The study site in this stream was located near Buniyar, about 1 km ahead of its confluence with the Jhelum.

(j) Site X: Haji Pir (Nambla) Nalla

This is the most important tributary of the Jhelum in the vicinity of Uri town and originates from the water divide between Uri and Poonch, joining the Jhelum below Lagama. The study site was located at 1km ahead of its confluence with the Jhelum.

(k) Site XI: River Jhelum at Dachhi Bridge (Uri)

This study site was located in the main river adjacent to the Dachhi Bridge below Uri town very close to the mouth of Salamabad or Jabla Nalla. This Nalla also originates from the water divide between Poonch and Uri and flows through Murrees, bringing in a lot of sediment into the Jhelum, especially during rainy days. The average depth of water at this site was 3 m and the bottom texture was clay type with some stones along the banks.

METHODOLOGY

Data on various limnological parameters of the water were collected from all the study sites. Standard methods given in Welch (1952), CSIR (1974), Mackereth *et al.* (1978) and APHA (1995) and listed by Bhat and Yousuf (2002 , 2004), Pandit and Yousuf (2002), Yousuf *et al.* (2003) and Mahdi *et al.* (2005) were used for the analysis of various limnological parameters.

RESULTS AND DISCUSSION

Physico-Chemical Parameters

The Physico-chemical characteristics of water have a great role over the distribution and abundance of living organisms. A perusal of the limnological data indicated significant variations in the limnological characteristics at the different sites (Table 1). The air temperature ranged between a mean annual value of 10°C at site VII and 20°C at sites II, VIII and XI. The water temperature showed close relationship with the air temperature and ranged between an annual mean value of 7°C at site IX and 12°C at site VIII. In general, the main river sites depicted slightly higher values than the tributaries, which is mainly due to the fact that the water in the torrential streams is less influenced by the atmospheric temperature than in that in the slow flowing river water. The water at site V (Zero Bridge in Srinagar city) was the most turbid, solar light

penetrating only up to a depth of 35 cm in a water column of about 450 cm. On the other hand, the water at site III was most transparent, transparency 32.5 cm in a total water column of 59 cm. The maximum velocity of 124 cm/sec was recorded at site IX (Buniyar Nalla), followed by 86 cm/sec at site X (Haji Pir Nalla) and 75.8 cm/sec at site III (Lidder Nalla). On the other hand, the sites II and VIII in the main Jhelum showed the minimum velocity of 40 cm/sec.

The ionic composition of water varied in close relationship with the catchment characteristics of the concerned water body. While the Wangat Nalla recorded the lowest conductivity, with an annual mean value of 63.5 μ S/cm, the Jhelum receiving all sorts of allochthonus material from the catchment and having diversified catchment had the highest conductivity (annual mean value 306 μ S/cm at site V). The increase in the conductivity values showed a close relationship with the human activity in the catchment of the water bodies concerned. The water of the whole river system was well buffered and pH >7 was recorded at all the study sites. The site III depicted highest mean pH value of 8.36 followed by sites VI and IX with the values of 8.3 each as against the lowest value of 7.9 recorded at site V. The lower pH in the Srinagar city segment of the Jhelum clearly indicated the impact of the domestic sewage on the water as the decomposition of the organic matter results in the decrease in the pH value and increase in carbon dioxide and bicarbonate content of the water. The highest mean value of alkalinity was recorded at site IV (166.5 mg/l) followed by site II (162.5 mg/l) and site V (161.0 mg/l) as against the lowest values of 41 mg/l at the site VI. The total hardness was more than 70 mg/l at all the sites and hence the river system as a whole belongs to the hard water type. Comparatively the tributaries were less hard than the main river and the hardness seemed to be influenced by the anthropogenic activity in the catchment area. The calcium hardness recorded maximum annual mean of 61.16 mg/l at site I and minimum of 17 mg/l at site VI. On the other hand, Magnesium hardness depicted highest annual mean of 22.0 mg/l at site V and lowest of 6 mg/l at site IX.

The dissolved oxygen did not show any appreciable variation and the values of more than 8 mg/l were recorded at all the study sites. The maximum mean value of 11.5 mg/l was recorded at site IX as against the minimum value of 8.2 mg/l at site VII. The annual mean concentration of chloride fluctuated between 8.5 mg/l at site VI and 14.3 mg/l at site VII. The sites VI, IX and XI depicted significantly lower concentration of chlorides as against other sites. Nitrate was the most dominant form of nitrogen. The annual mean values of nitrate nitrogen fluctuated between 113.6μg/l at site III and 317μg/l at site V. In general, sites I, II, IV, VII and X depicted higher concentrations of nitrate nitrogen. The ammonia nitrogen was the second most dominant form of nitrogen after nitrate. The lowest concentration of ammonia nitrogen was recorded at site VI which recorded an annual mean value of 11μg/l and the highest concentration was recorded at site V with an annual mean of 85.5μg/l. The nitrite nitrogen was present in low concentration as the maximum value of 35μg/l was recorded at site V as against the minimum value of 5μg/l at site VI.

In general orthophosphate phosphorus was low and ranged between an annual mean value of 5.5μg/l at site VI and 40μg/l at site V. The total phosphate phosphorus depicted clear spatial variations. The highest concentration of total phosphate phosphorus was recorded at site V with an annual mean value of 228 μg/l and the lowest concentration at site VI with an annual mean value of 40 μg/l. A comparison of the physico-chemical data presented by earlier workers (Vass *et al.*, 1977; Raina *et al.*, 1982; Andersson, 1999;

Andersson, 1999; Pandit *et al.*, 2001; Wani and Pandit, 2004) with the present study reveals that there has been a gradual increase in the pollution level of the River Jhelum over the years. Although the various tributaries of the river have not received much attention in the past, the comparison of the limnological parameters of the various tributaries *inter se* and with the Jhelum shows that the lower reaches of these streams are also under stress due to increased human activity in their close vicinity.

Macrozoobenthos

27 species of Macrozoobenthos were recorded during the period of investigation. Arthropoda was the most dominant group, comprising 18 species, followed by Annelida with 6 and Mollusca with 3 species (Table 2). The maximum diversity (21 species) and population density (256 ind.m^{-2}) was recorded at site I and the minimum diversity (11 species) and density (106 ind.m^{-2}) at site V. In general, the density of Macrozoobenthos followed the spatial order as Site I > Site VI > Site IX > Site III > Site X > Site II > Site XI > Site IV > Site VII > Site VIII > Site V. In general, Arthropoda depicted the highest relative abundance at almost all the study sites with 100% contribution at site VI, IX and X. The Annelida showed highest relative abundance of 57% at site II but was completely absent at sites VI, IX and X. Mollusca was the least abundant group with the highest relative abundance of only 20.33% at site VIII.

The distribution of the benthic invertebrates depends, besides water quality, on the bottom texture (Sharma, 1986 and Dobriyal *et al.*, 1992). The main River Jhelum and some of its tributaries (Sites II, IV, V, VII, and VIII) were dominated by individuals from Amphipoda, Mollusca and Annelida (Fig. 2). The Annelida dominated over the two at these sampling sites. The contribution of other groups was low.

The hard, stony bottomed sites, mostly tributaries and at Dachhi site (Uri segment) in the River Jhelum (i.e., Sites I, III, VI, IX, X, XI) were mostly dominated by insects and individuals from phylum Mollusca and Annelida were only

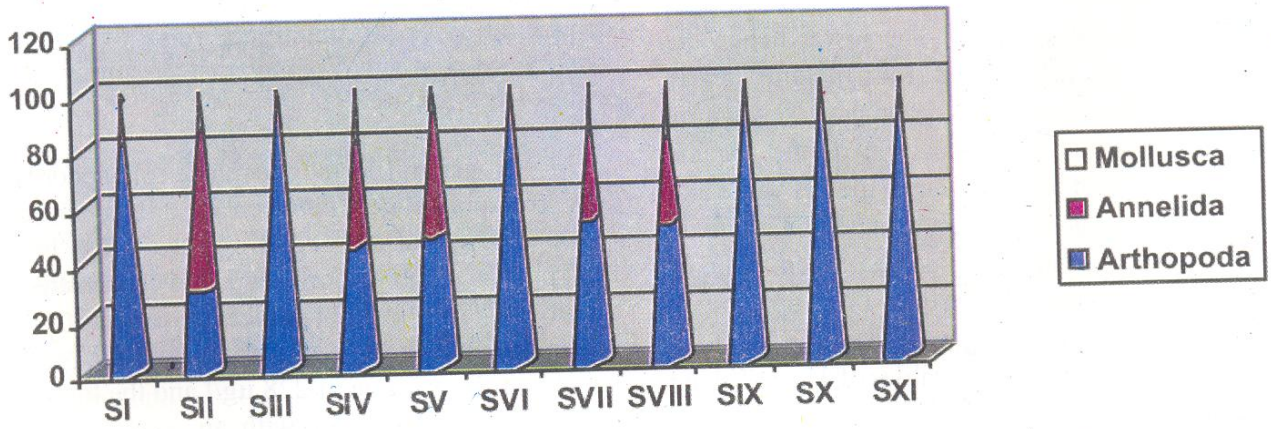

Fig. 2. Relative abundance of different macro-zoobenthic groups at different sites in the Jhelum System

Table 1. Mean values of Physico – chemical characteristics of the Jhelum and its tributaries

S NO	PARAMETERS	I	II	III	IV	V	VI	VII	VIII	IX	X	XI
1	Air Temp(°C)	15.2	20	16	19	18	15	10	20	13.6	17.3	20
2	Water Temp(°C)	9.2	11	9	11.5	10.5	8	6.6	12	7	10.2	11.5
3	Depth(cm)	55	300	59	65	450	57	256.5	250	58	60	245
4	Transp.(cm)	24	40	32.5	27.5	35	25	33	35	29	22.5	35
5	Velocity(cm/s)	55	40	75.8	60	37.5	30	51	40	124	86	35
6	Conductivity(µS)	268	293.5	141	299.5	306	63.5	159	263	124	278	176.5
7	pH	8.15	8	8.36	8.1	7.9	8.3	8.1	8.05	8.35	8.21	8.2
8	($C0_2$) mg/l	13	11	7	11	10	3.5	9	10	7.33	5.5	7.5
9	Alkalinity(mg/l)	156	162.5	85	166.5	161	41	103	150	69	122	139.5
10	DO(mg/l)	9.56	9.15	10.9	8.7	9.2	10.4	8.2	9.3	11.5	9.61	9.2
11	Chloride(mg/l)	13.3	13	11.5	12	13.5	8.5	14.3	12	9	13	8.5
12	Hardness(mg/l)	203	198.5	98	140	235.5	72	138	170	79	170	165
13	Ca(mg/l)	61.16	49.5	36	33	56.5	17	37	52	23	49	42
14	Mg(mg/l)	13	16.5	9	11.5	22	7.5	11	9.5	6	13	13.5
15	Nitrite-N(µg/l)	17.6	20	6	13.5	35	5	14.6	21	8	20	12
16	Nitrate-N(µg/l)	194.5	226	113.6	190	317	127	195	188.5	139	220	181
17	Ammonia-N(µg/l)	53	62	29	51	85	11	61	62	27	46	39
18	Ortho-P(µg/l)	12.6	20.5	8.6	6	40	5.5	12	19	7	12	10
19	Total-P(µg/l)	75	120	65	72	228	40	69	88	52	79	79

Table 2. Annual mean density (individuals/ m^2) of macrozoobenthos at different places in the Jhelum River system in Kashmir Himalaya

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI
Arthropoda											
Baetis larva	40	3	29	4	-	26	-	3	46	30	17
Ecdyonurs sp.	22	-	18	-	-	21	-	-	35	20	15
Epeorus sp.	3	-	4	-	-	6	-	-	12	12	-
Potamanthelus sp.	4	-	3	-	-	4	-	-	15	13	7
Rhyacophila sp.	12	-	12	-	-	14	-	-	6	4	17
R.obscura	10	-	16	-	-	19	-	-	4	6	16
R. yamanakensis	3	-	3	-	-	4	-	-	2	-	-
Stenopsychae sp.	2	-	6	-	-	3	-	-	-	-	6
Hydropsyshae sp.	4	2	7	4	-	4	-	4	2	-	-
Nectopsychae sp.	2	1	6	3	4	2	-	5	-	-	4
Chironomus sp.	-	12	-	16	14	-	24	12	-	-	4
Diamessa sp.	21	-	18	-	-	52	-	-	32	29	21
Monodiamessa sp.	-	13	-	14	19	-	22	15	-	-	-
Simulium sp.	4	-	22	-	-	37	12	9	26	24	17
Atherix sp.	12	-	13	-	-	22	-	-	11	12	16
Perilidae sp.	5	-	5	-	-	5	-	-	2	2	-
Elmidae larva	-	-	3	-	-	2	-	-	3	2	-
Gammarus pulex	65	11	18	19	10	13	4	10	6	8	-
Annelida											
Tubifex larva	13	32	-	23	18	-	23	18	-	-	2
Limnodrillus sp.	6	29	-	19	12	-	12	13	-	-	1
Nais sp.	-	2	-	-	4	-	2	-	-	-	-
Glossiphonia sp.	-	2	-	-	3	-	3	-	-	-	-
Dina sp.	-	3	-	-	-	-	-	-	-	-	-
Erpobdella sp.	20	13	4	10	10	-	3	5	-	-	-
Mollusca											
Lymnaea auricula	3	10	-	8	3	-	6	9	-	-	-
Lymnaea columella	2	2	-	4	-	-	3	-	-	-	-
Corbicula sp.	3	7	2	14	7	-	7	15	-	-	-
Total density	256	150	189	138	106	234	121	118	202	162	139

few. The insects were mostly represented by orders Ephemeroptera, Trichoptera and Diptera. At these sites the class Insecta contributed more than 60% of the benthic population and was dominated by Ephemeroptera, Trichoptera and Diptera (Table 3).

Fish Distribution

Kullander *et al* (1999) reported 18 species of fish from the Jhelum and its tributaries including streams as well as lakes in the Valley. During the present study 19 species belonging to Cypriniformes, Siluriformes, Cyprinodontiformes, and Salmoniformes were collected (Table 4 & 5). As per the species composition of the experimental fishing done with the help of Electro-fisher as well as cast net the dominance pattern of the species by number of the main constituents of the ichthyofauna showed the trend as: *Schizothorax plagiostomus* > *S. labiatus* > *S. esocinus* > *Glyptosternon reticulatum* > *Crossocheilus diplochilus* > *Triplophysa kashmirensis*. In the main river 13 species of fishes [*Schizothorax plagiostomus, S. labiatus, S. esocinus, S. curvifrons, S. niger, Gambusia affinis, Triplophysa* sp., *Crossocheilus diplochilus, Glyptothorax kashmirensis, Puntius conchonius, Bangana diplostoma, Cyprinus carpio communis, C. c. specularis and Carassius carassius*] were recorded with the maximum number of 11 species at Zero bridge (Site V) in Srinagar.

The community structure of the fish at different collection sites is primarily influenced by the water current. The Khanabal and Zero Bridge sites, especially the latter, are located in the areas where the river is rather slow and the fish community included even the typical lacustrine forms like *S. niger, C. diplochilus, C. carassius, C. c. specularis and C. c. communis.* Against this the Gantamulla and Dachhi sites represent the fast flowing areas of the river and in these areas typical lotic ichthyofauna was found. The ichthyofauna of the tributaries of the Jhelum was rather limited in nature, particularly in the fast flowing zones of the streams, e. g., Wangat Nalla and Nambal area of Lidder stream. In the Sundran Nalla only 4 species, i.e., *S. plagiostomus, S. labiatus, Salmo trutta fario* and *Triplophysa* sp., were collected. The community

Table 3. Relative abundance (%) of various taxonomic groups of macro-zoobenthos at places in the Jhelum River System in Kashmir

	Study Sites										
Group	**I**	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	**IX**	**X**	**XI**
Arthropoda	81.64	29.6	96.82	43.5	46.22	100	51.2	49.15	100	100	97.84
Annelida	15.23	57	2.11	37.7	44.33	0	35.53	30.50	0	0	2.15
Mollusca	3.12	13.4	1.05	18.9	9.43	0	13.22	20.33	0	0	0

Table 4. Percent contribution (by Number) of different fish in river Jhelum and its important tributaries

Fish	I	II	III	IV	V	VI	VII	VIII	IX	X	XI
S. plagiostomus	60.7	22.7	69.3		10.28	36.6		30.3	38.5	64.37	31.5
S labiatus	25 3	14 9	9 5		10 59	5 2	12 1	44 7	1 3		10 5
S. esocinus		26.9	12.7		9.03	0.65					
S. curvifrons					40.80						
S niger					14 64						
D. maculatus						35.1					
G. reticulatum			0.13			7.5			59.4	33.00	
S. trutta fario	3 8		0 78			11 2					
C. diplochilus		42.65	2.35								
G. kashmirensis								9.13			47.4
Triplophysa spp.	10.1	5.3	5.2								
T. kashmirensis				66.1							
T. marmorata				18 3							
P. conchonius				15.6	3.70						
B. diplostoma		5.54			2.10						5.26
S. punjabensis										2.57	5.26
C c communis					3 70		20 68				
C c specularis					0 62		50 0				
C carassius					0 62		17 3				
Gambusia affinis					3.70						

Table 5. Percent contribution (by weight) of different fish in river Jhelum and its important tributaries

Fish	I	II	III	IV	V	VI	VII	VIII	IX	X
S. plagiostomus	68.6	43.4	72.5		15.2	30.46		24.8	47.1	61.7
S. labiatus	19.6	15.7	12.2		20.60	6.63	20.7	48.2	1.4	
S. esocinus		14.52	12.1		14.70	4.93		25.8	1.1	
S. curvifrons					21.10					
S. niger					25.30					
D. maculatus						39.85				
G. reticulatum			0.16			3.13			50.4	37.8
S. trutta fario	9.6		2.1			14.8				
Triplophysa spp.	2.1	6.03	0.95							
C. diplochilus		17.0	1.2							
G. kashmirensis	1.14									
T. kashmirensis				64.9						
T. marmorata				20.2						
P. conchonius				14.9	0.21					
B. diplostoma		6.1			0.30					
S. punjabensis										0.89
C. . c. communis					1.88		16.21			
C. c. specularis					0.47		46.8			
C. carassius					0.87		16.1			
Gambusia affinis					0.23					

was dominated by *S. plagiostomus, which contributed* 60.7% of the individuals and 68.6% of the biomass. *S. trutta fario* is an exotic species in the valley and is generally found in the headwater zone of the hill streams in the region. It formed only 3.8% of the individuals caught. *Triplophysa* sp. remains generally hidden under stones and is difficult to catch by cast netting as well as by electro fishing. It formed only 2.1% of the catch by number.

A peculiar feature of the Wangat Nalla was the presence of *Diptychus maculatus,* which is mainly found on the other side of the Greater Himalaya in the Ladakh waters. The species co-occurred with *S. plagiostomus* and the two contributed almost equal proportion (35.1% and 39% by number respectively) of the experimental fish catch obtained with electro-fisher.

On the whole, it was observed that in the slow flowing areas of the tributaries the fish fauna was similar to that of the main river, the Jhelum, but in their fast flowing areas the fauna was rather different than in the main river. Further, the fish catch recorded variations in time and space. During the winter months when the water level was low, the fish catch in the main river was high, while in the tributaries it varied. In Sundran and Lidder streams the catch was highest in the winter months. In others the catch showed fluctuations throughout the year. Though the number of fish in the spring and summer seasons was low as compared to winter but the weight of individuals was significantly higher due to the up migration of mature individuals for breeding (Table 6).

The commercial fishing in the Jhelum River System is mainly restricted to the main river only, that too only up to Gantamulla in Baramulla District in the segment where the river is slow. In case of tributaries the commercial fishing is limited to the lower reaches only and no commercial fishing is undertaken in the upper reaches. As such the fishing effort of the local fishermen was worked out for sites II, V and VIII located in the Jhelum and site VII located in the lower reaches of the Pohru stream. Fishing in the lotic waters needs two persons per boat, one for rowing the boat and the second for fishing with the net. As is evident from the data (Table 6) the catch per man-hour showed variations not only between the sites, but even at the same place with time. On the whole the mean fishing effort was 173.2g - 360.1g per man-hour. Previously Sunder and Subla (1984) reported the fishing effort in the Jhelum to be 261 - 829g/man hour. Since fishing effort is an index of the fish population structure in a water body, it clearly indicates that the fish population in the river is very low, probably because of overexploitation, habitat destruction as a consequence of deforestation vis a vis soil erosion and siltation of breeding grounds as well as encroachment, diversion of water for agriculture and power generation and above all gradual aquatic pollution (Sunder and Raina, 2002).

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Table 6. Fishing Effort (g/man/hour) at different study sites in River Jhelum. No commercial fishing is undertaken at other sites

	Study sites			
Months	II	V	VII	VIII
Nov 02	284	202 5	188 7	373
Dec		243 7		
Jan 03		298 5		260 7
Feb				258
March		169 4	228 3	
April		217.6		597
May	347 7	135 4	106 3	181
June	289	292.8		289
July	222 8	134 9		472 3
August		148.5	135	
Sept				
Oct	183.8	106.8		628
Nov	106 5			449
Dec				358
Jan 04				248
Feb				268
March	298	87	209 8	285 8
April	399	122		352
May	287	185 8	177	555
June		207		189.8
July		264 7		
August				
Average	268 6	188 2	173 2	360 1

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