

# Ecological Study of Sonamarg: With Special Reference to the Ichthyofauna of River Sindh in Kashmir Himalaya

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## ABSTRACT

Brown trout and rainbow trout are the two species which constitute trout fishery in the Indian uplands. In the Himalayan region, Brown trout is the only trout which supports sport fishing while in the southern region rainbow trout is the principal one. The valley of Kashmir abounds number of aquatic resources. Among lotic habitats, the river Jhelum occupies an important place in the valley followed by streams. The major fishery of the river is constituted by the *Schizothoracines*. The fish fauna of the valley is quite different from the rest of country and is dominated by the important endemic *Schizothoracine* group. During the present study, a total of 5 species of fish were recorded in maximum number from site III from river Sindh. All the species had a distinct distribution pattern was evident from their occurrence and catches from various sites. *Schizothoracines* are the most important endemic fish occurring in the Himalayan aquatic habitats.

**Key words:** Brown trout, Schizothorax, River sindh, Lotic habitats, Kashmir Himalaya.

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## INTRODUCTION

Freshwater biomes are among the world's most productive and diverse ecosystems, supporting approximately 18,000 species of fish.<sup>[1]</sup> Fishes are the most abundant vertebrate class in terms of number and diversity in size, biology, shape, and habitat,<sup>[2]</sup> accounting for about half of all vertebrates in the world. India is one of the biosphere's mega diversity countries, and it ranks ninth in terms of freshwater biodiversity.<sup>[3]</sup> 1027 fishes inhabit or visit freshwater bodies,<sup>[4]</sup> out of a total of 3439 fishes documented from India.<sup>[5]</sup>

The fish fauna of the valley is quite different from the rest of the country and is dominated by the *Schizothoracinae* group. Fish fauna studies in Kashmir were initiated.

During the study, 16 species of fish which were all new to science were reported and published in the book "Fishes of Kashmir" later on workers like<sup>[6-8]</sup> and many others worked on the ichthyofauna of Kashmir in different habitats. The authors reported about 37 species of fish from Kashmir Himalaya. These few like: *Cyprinus carpio*, *Barbus conbonius*, *Labeo dero*, *Labeo dyocheilus*, *Tor putitora*, *Diptichus maculatus*, *Schizothorax richardsonii*, *Ptycobarbus conirostris*, *Schizothorax nasus*, *S. planifrons*, *S. hugelli*, *S. esocinus*, *S. niger*, *S. curvifrons*, *S. progastus*, *Crossocobelus latius*, *C. diplobelius*, *Botia birdi*, *Nemacheilus gracillius*, *N. Kashmirensis*, *N. rupicola*, *N. yasinesis*, *N. stoliczkae*, *Glyptothorax Kashmirensis*, *Salmo trutta fario*, and *Oncorhynchus mykiss*.

The term "Cold water Fish" vaguely refers to the members of the family salmonidae, much sought after by anglers all over the world. In India, however, some *Cyprinids* are belonging to sub-family *cyprininae* and *Schizothoracinae* and loaches (*Nemachilidae*) and some others which inhabit streams, lakes and reservoir receiving snow-melt water directly from their watersheds are also included in this definition. An important aspect of coldwater fish of the

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uplands is the opportunity the species provide for sport. Brown trout (*Salmo trutta fario*) and certain species of large-scaled barbells are the principal species of sport value in Kashmir, Himachal Pradesh, Uttarakhand, North-Bengal, Nilgris, Kodai Hills and Munnar ranges where the Indian and Foreign tourist visit annually in large numbers. In certain regions, sport fishery generates huge revenue.<sup>[9]</sup> Coldwater fisheries in the broad sense include those fishes which can survive at a lower level of thermal scale. These are present in water with temperature values ranging from 0-20°C. It is the upper limit that determines their basis of temperature tolerance coldwater encompasses 2 categories of fishes (i) stenothermal- having narrow temperature tolerance like trout's and loaches (ii) eurythermal- having wide temperature tolerance beyond 20°C like Mahaseer and mirror carp species.

The Himalaya is covered with rich pristine forests, a diverse flora and fauna, and is home to a number of beautiful fishes.<sup>[10-12]</sup> The first account of fishes inhabiting cold regions of India was given by<sup>[13]</sup> in Fishes of Ganges and its watershed. Brown trout and rainbow trout are the two species which constitutes trout fishery in the Indian uplands. In the Himalayan region brown trout is the only trout which supports sport fishing while in the southern region rainbow trout is the principal one.<sup>[14]</sup>

The valley of Kashmir, called as “the paradise on Earth” lies between the coordinates of 33°1' to 35°00' N latitude and 73°48' to 75°E longitude. This region is defined by the presence of a large number of aquatic resources. The major fishery of the river is constituted by the *Schizothoracines*, *Triplophysa* spp, *Ghyptothorax* spp. and the *Salmonids* prefer the clean flowing waters of spring and snow fed streams like Bringhi, Erin, Buniyar, Sindh, etc. Trout is the most prized fish found in these water bodies. The other aquatic ecosystems like ponds, springs, and inundated rice-fields also occupy an important place and can be harnessed for fish production. Fish is favorite food stuff for the majority of societies. Fish meal contains most important nutritional components and serves as a source of energy for human beings.<sup>[15,16]</sup> There are few ichthyologists<sup>[17-21]</sup> who have furnished details on fish fauna from different parts of the country. It is the fruit generated by the hard work of these researchers that India now ranks third in the world fisheries production.<sup>[22]</sup> An attempt has been made to document the fish species from river Sindh of Ganderbal district of the Union Territory (UT) of Jammu and Kashmir (J & K), India in this paper.

## MATERIALS AND METHODS

### Study Area and Sampling Design

The Sind Valley is situated within the jurisdiction of Kangan tehsil, of Ganderbal district. It has a steep gradient of 1365m up to Gagangir, below which the slope is relatively gentle, with a drop in level of 729m.<sup>[23]</sup> Based in the Ganderbal district of Jammu and Kashmir, river Sindh locally known as “Sendh” is the longest tributary of river Jhelum (Veth). The source of the river lies in Machoi Glacier at an elevation of 4800 meters, east of the Amaranth temple and south of Zojila pass.<sup>[24]</sup> The main origin of river Sindh is from Panjarni glacial fields at an altitude of 4250 m at the base of Saskut, a peak 4693m. From Saskut, river Sindh drops steeply northwest ward to reach the main strike valley. Gathering momentum, the river runs towards Sonamarg between steeply towering mountain walls, over a boulder stream bed, emerging into the Sonamarg, therefore, it once again becomes torrential through the Gagangeer gorge, reaching the well wooded vale gently curving to the south-west discharging over a wide delta.

### Study sites

A total of four sites were selected for sampling purposes on the basis of distance from main Sonamarg, approach to the site and easy accessibility (Figure 1). We employed a Global Positioning System (Garmin *etrex 20*) equipment to record the altitude and geo-coordinates at each site.

### Physical Parameters

Temperature, (a) Temperature of air was recorded by Celsius thermometer under shade at each sampling site. (b) Temperature of water was recorded by dipping the thermometer in water sample as soon as collected. (c) Water depth at study sited was recorded by sounding the river water with the standard lead weight attached to a marked rope at various sites on sampling days. The results are expressed in meters. (d) Speed velocity was

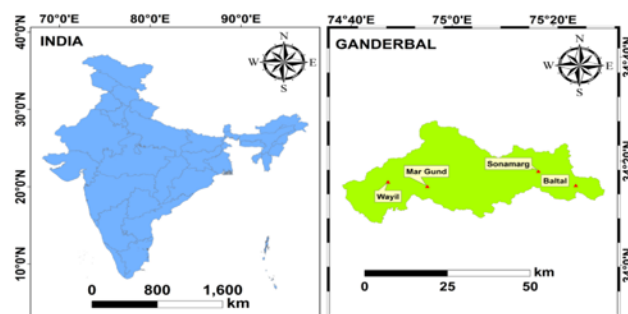


Figure 1: Location map of the study area: dark brown squares represent different study sites.

recorded by using a paper boat at each sampling site. Distance covered for a particular time was recorded, using a stop watch the results were expressed in cm/sec.

### Chemical Parameters

(a) pH: The hydrogen ion concentration of water was obtained by using the digital pH meter. The pH meter was standardized before use with known buffer solution. (b) Dissolved Oxygen: Winkler's method was followed for the estimation of DO in water. Fixation of Dissolved oxygen was done by adding 1ml of MnSO<sub>4</sub> and 1 ml of alkaline iodide. After setting down of the ppt, 1ml of conc. H<sub>2</sub>SO<sub>4</sub> was added to the solution drop-wise. The bottles were then transported to the laboratory, where 50ml of this solution was titrated against 0.0256 N sodium thiosulphate using starch as the indicator.<sup>[25]</sup> (c) Fishes: We conducted field samplings once a month at each study site and collected the fish using electrofisher.

### Method of Preservation of Fishes

Whole fishes were preserved in a solution of formaline, and this solution made by diluting one part of commercial formaldehyde with nine parts of water. The morphometric measurements of specimen were made on a standard in millimeters using broad scale, glass jars, sharp pointed dividers, thread etc. Various body measurements of a fish taken included: Standard length, Fork length, Total length, Head length, Snout length, Upper Jaw length, Lower Jaw length, Eye length, Girth length, Predorsal length, Prepectoral length, Preanal length, Length of the Caudal Peduncle, Nape, Isthmus and Breast. Fish specimens were identified with the help of the standard taxonomic works.<sup>[26]</sup>

## RESULTS

During the present study five species of fish belonging to three families viz, Cyprinidae, Cobitidae and Salmonidae were collected. These include: *Schizothorax plagiostomus*, *Schizothorax esocinus*, *Triplophysa kashmirensis*, *Triplophysa marmorata* and *Salmo trutta fario* (Figure 2).

### Taxonomical position of fishes

**Order:** Cypriniformes

**Family:** Cyprinidae

1. *Schizothorax kashmirensis*

2. *Schizothorax plagiostomus*

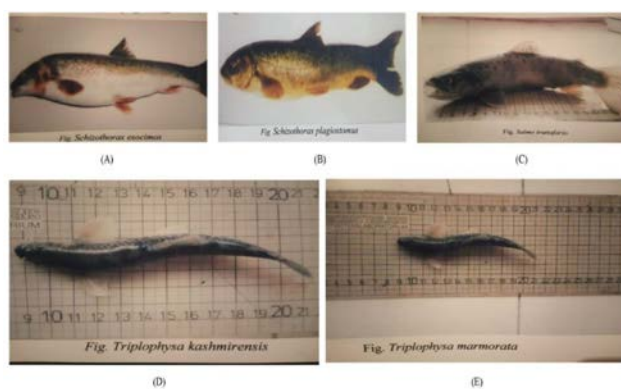
**Order:** Cypriniformes

**Family:** Balitoridae

1. *Triplophysa kashmirensis*

2. *Triplophysa marmorata*

**Order:** Salmoniformes



**Figure 2: (A) *Schizothorax esocinus* (B) *Schizothorax plagiostomus* (C) *Salmo trutta fario* (D) *Triplophysa kashmirensis* (E) *Triplophysa marmorata*.**

**Table 1: Shows percent contribution by number of different fish in Sindh River.**

S. No	Fish	Site I	Site II	Site III	Site IV
1	<i>Schizothorax plagiostomus</i>	6	5	3	4
2	<i>Schizothorax esocinus</i>	0	0	2	2
3	<i>Triplophysa kashmirensis</i>	0	2	5	4
4	<i>Triplophysa marmorata</i>	0	5	11	6
5	<i>Salmo trutta fario</i>	2	5	10	7
	Total	8	17	31	23

### Family: Salmonidae

#### 1. *Salmo trutta fario*

At site I only two species *Schizothorax plagiostomus* and *Salmo trutta fario* belonging to order Cypriniformes and Salmoniformes were recorded. These two fishes were present throughout the study period. However, their number varied from one month to another. During the study period only 8 fishes were collected from this site out of which 6 were *S. plagiostomus* and 2 were *Salmo trutta fario*. At site II four species were collected. During the study period total of 17 fishes were collected, out of which 5 were *S. plagiostomus*, 2 were *Triplophysa kashmirensis*, 5 were *Triplophysa marmorata*, and 5 were *Salmo trutta fario*. At site III 5 species of fishes were collected. A total of 31 fishes were collected from this site, out of which 3 were *S. plagiostomus*, 2 were *Schizothorax esocinus*, 5 were *Triplophysa kashmirensis*, 11 were *Triplophysa marmorata* and 10 were *Salmo trutta fario* and At site IV also 5 species of fishes were collected. A total of 23 fishes were recorded from this site. Out of which of 4 were *S. plagiostomus*, 2 were *Schizothorax esocinus*, 4 were *Triplophysa kashmirensis*,



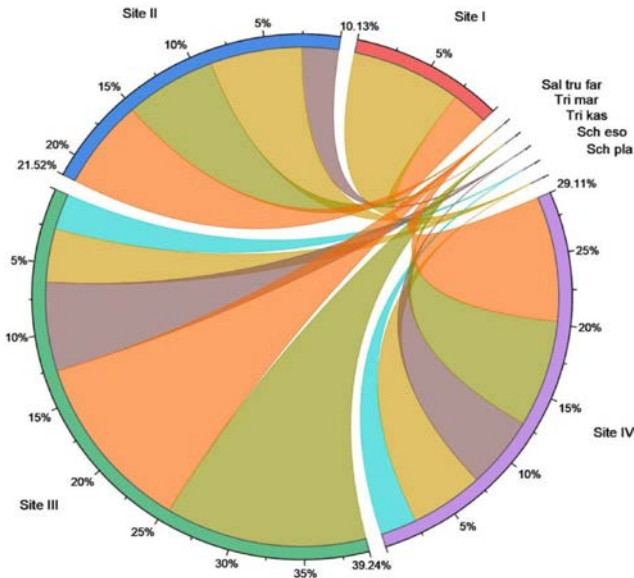


Figure 3: Chord diagram shows the percent contribution of different sites in Sindh River.

Sal tru far\_ *Salmo trutta fario*; Tri mar\_ *Triplophysa marmorata*; Tri kas\_ *Triplophysa kashmirensis*; Sch eso\_ *Schizothorax esocinus* and Sch pla\_ *Schizothorax plagiostomus*.

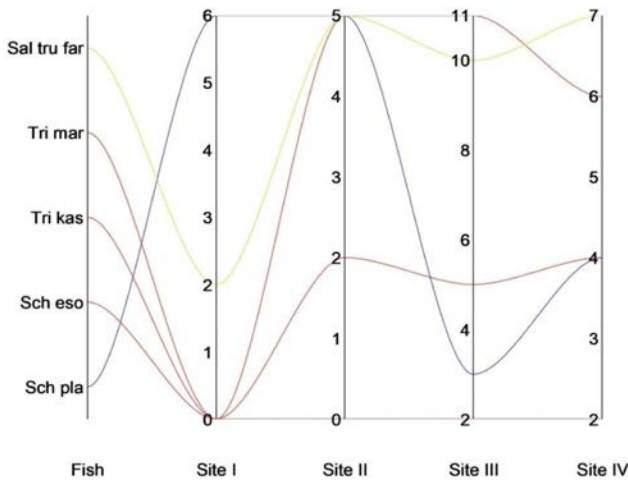


Figure 4: Parallel plot showing by number of different fish in Sindh river.

6 *Triplophysa marmorata*, and 7 *Salmo trutta fario* (Table 1; Figures 3, 4).

In addition to this, Site IV Shows dominance of fishes by weight to the total catch in gms followed by Site II, Site III and site I in Sindh river (Table 2; Figures 5, 6).

## DISCUSSION

The present study reveals a significant richness of cold-water fishes all along the river Sindh and about 05 species were successfully identified from the study stream. Similar kind of observations was also recorded

Table 2: Shows dominance of fishes by weight to the total catch in gms at different sites Sindh river.

S. No	Fish	Site I	Site II	Site III	Site IV
1	<i>Schizothorax plagiostomus</i>	610	580	475	320
2	<i>Schizothorax esocinus</i>	0	0	210	370
3	<i>Triplophysa kashmirensis</i>	0	220	465	450
4	<i>Triplophysa marmorata</i>	0	575	600	814
5	<i>Salmo trutta fario</i>	220	565	715	810
	Total	830	1940	1465	2764

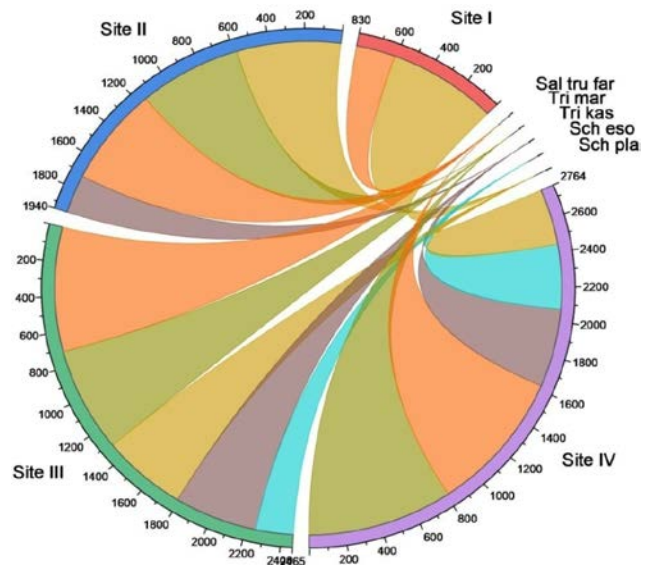


Figure 5: Chord diagram showing dominance of fishes by weight in gms at the different sites in Sindh River.

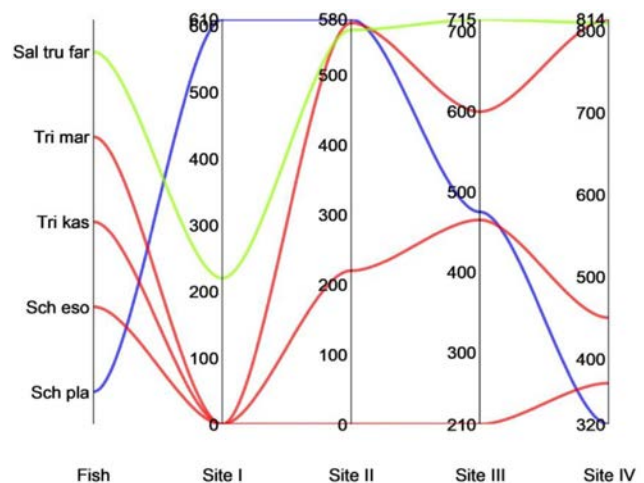


Figure 6: Parallel plot showing the number of fishes by weight in gms at the different sites in Sindh River.

by.<sup>[27]</sup> The trout fishes have been found dominant at all sites as reported by other researchers as well.<sup>[28-31]</sup> All the species had a distinct distribution pattern as was evident from their occurrence and catches from various sites. According to,<sup>[10]</sup> the main factors influencing the fish life in the Himalayan streams are: current velocity, fluctuation in water discharge, water temperature and dissolved oxygen level, substratum, shelter from the current, and food availability represented mainly by organisms clinging to and growing on rock and stone surface in fast current. In the Himalayas streams, the fish species distribution depends on the flow rate, nature of substratum, water temperature and the food availability. Compared to brown and rainbow trout, the snow trout (*Schizothorax*) thrived well in low gradient area of the Sindh. However, these were also present from high gradient sites, but their distribution was patchy. *Triplophysa kashmirensis*, on the other hand, was found in the side channels of Sindh, being characterized by a mixture of stratus, boulder, gravel and muddy substrate. The reach-wise distribution of fish species was well recognized as the upper-reaches recorded presence of only two species viz., *Salmo trutta*, and *Schizothorax plagiostomus*. The middle-reaches of the river Sindh recorded *Salmo trutta fairo*, *Schizothorax esocinus*, *Triplophysa marmorata* and *Triplophysa Kashmirensis* as shown above in Figures respectively. Finally, the lower-reaches were represented by *Schizothorax esocinus*, *S. plagiostomus* and *T. kashmirensis*. This means that the highest fish diversity was noticed in the middle reaches followed by the lower reaches, the upper reaches registered only two species. Schizothoracines and brown trout remain operative in the near-zero temperatures during December and January. However, *schizothoracine* fishes migrate downstream during the winter months to cover with the very high fall in temperature.

*Schizothoracines* are the greatest significant native fish occurring in the Himalayan aquatic habitats. The biggest threat to the fisheries of the Sindh, and other tributaries is the diversion of water by making barrages and dikes for power generation, drinking water supply and irrigation purposes. The present viewpoint coincides with similar results documented earlier.<sup>[32,33]</sup> From the current study, it has been observed that the number and the diversity of fishes decrease from upstream to downstream.<sup>[34,35]</sup>

## CONCLUSION

The present study reveals that a total of 5 species of fish were recorded from the river Sindh of Ganderbal district of the Union Territory (UT) of Jammu

and Kashmir (J and K), India. All the species had a distinct distribution pattern as was evident from their occurrence and catches from various sites. In total, five species of fish belonging to 3 genera and 3 families were found to dominate these ecosystems. The study found that the highest number of fish species were Site III, followed by Site IV, Site II and Site I. This means that the highest fish diversity was noticed in the middle reaches followed by the lower reaches and then the upper reaches. The upper reaches of the Sindh River, where trout was recorded can be regarded as trout zone while downstream, due to the presence of species like *Triplophysa kashmirensis*, and *S. esocinus*, *T. marmorata* can be regarded as carp zone. The presence of smaller sized fish (fry and fingerlings) in the downstream and midstream seems to be related with the feeding and breeding grounds of *Schizothoracines*. In order to manage the fisheries, especially Schizothorax fishes in the river, immediate steps need to be taken to control the entry of sewage, agriculture wastes and domestic effluents into it. Moreover, local government can involve the local people in mass culturing of these fishes so that a great economy can be generated. This study provides baseline information for environmentalists and researchers for studying the Ichthyofauna of river Sindh in Kashmir Himalaya and can be used for the subsequent ecological surveys.

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## Authors Contribution

This work was carried out in collaboration among all authors. All the authors approved final draft of the manuscript for submission.

## CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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