STUDY OF MORPHOLOGICAL AND REPRODUCTIVE TRAITS OF SCHIZOTHORAX SPECIES FROM RIVER JHELUM

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ABSTRACT

This study investigates the morphological and reproductive traits of Schizothorax species inhabiting the River Jhelum, aiming to provide comprehensive insights into their biological characteristics and ecological adaptations. The Schizothorax species, a significant component of the river's ichthyofauna, were sampled from multiple locations along the river to capture a diverse representation of the population.Morphological analysis included detailed measurements of body length, weight, fin dimensions, and other key physical parameters. These traits were quantified using precise morphometric techniques to identify variations within and between populations. The study also examined sexual dimorphism and its implications for species identification and ecological roles. Reproductive traits were assessed by analyzing gonadal development stages and seasonal variations in reproductive activity. Histological examination of gonads provided data on maturity stages, fecundity, and spawning periods. This information is crucial for understanding the reproductive health and sustainability of Schizothorax populations in the River Jhelum.

1. NTRODUCTION

Indian Himalayan region abounds in water resources mainly in the form of rivers and lakes which are inhabited by a large number of plants and animals. The indigenous fish species are important elements of the biodiversity. Notably, India has significant fishery resources from north-western to the north-eastern Himalayan region and some parts of the Western Ghats (Sivaraman et al., 2014). This is substantiated by the earlier findings of Karmakar (2000) who put forth a distributional list of 276 species of fish thriving in the Himalayan drainage systems. Among these, Snow trouts constitute an important part of cold water fishery and are economically important fishes of the fast flowing snow-fed streams and lakes (Barat et al., 2012).

Generally, conservation measures target protection of larger specimens in order to help the fish population withstand environmental variations and over fishing. This is achieved primarily because the larger fish are conferred a higher reproductive value for the age and size dependant traits (Le Bris et al., 2015). Unfortunately, the importance of higher reproductive value of larger fish has been underappreciated in fisheries managementand there have been renewed demands to implement management measures for preserving the larger specimens (Xu and Schneider, 2012). Several biological attributes such as higher fecundity, spawning periodicity and existence of size- and age-dependant maternal effects have been studied to be responsible for the higher reproductive potential of the larger individuals (Marshall et al., 1998; Green, 2008; Wright and Trippel, 2009).

A number of tools including morphometric and meristic, traditional tags, parasites as natural tags, otolith composition and molecular genetics are being used for the purpose of identifying fish species and stocks. However, the study of morphometric characters is the most frequently employed and cost-effective method (Mir et al., 2013). Traditional multivariate morphometrics, taking into consideration the shape and size variations have been able to successfully discriminate many fish stocks (Turan, 1999).

1.1 Schizothorax species:

Schizothorax is a genus of cyprinid fish belonging to the sub-family Schizothoracinae, constituting a specialized group of fishes with reduced scales and barbels that are adapted to high altitude streams and lakes. They are also called as snow-trouts for inhabiting the fast flowing snow fed streams. The subfamily Schizothoracinae (Family: Cyprinidae) consist of 15 genera and over hundred species distributed to certain regions around the world (Mirza, 1991). The Indian snow trouts are categorized into seven genera, constituting an important part of coldwater fishery in the Himalayan region (Tilak, 1987). Being economically important fish a number of these species are overexploited as a result of which many of these species were listed as 'endangered' by the National Environmental Protection Agency and Endangered Species Scientific Commission (Sung et al., 1998).

The valley of Kashmir is known for its fresh water bodies throughout the world, having an enormous potential for the development of cold water fisheries. The fish fauna of the Jhelum River is one of the earliest fish faunas known to science. Carl Alexander Anselm von Hügel made the first collection after a long voyage through Eurasia during 1831-1836, and put it down in the Naturehistorisches Museum in Vienna, Austria. Heckel (1838, 1844) put forth some exemplified taxonomic descriptions of this collection based on Hügel's specimens, which were 16 species in total and he considered them to be new to science. Out of these, ten species belong to the cyprinid fishes now commonly referred to as oreinins, schizothoracines, snow trout, mountain barbels or snow barbels. Ichthyologists consider the Kashmir valley to be the Snow Barbel place forever. A number of studies have been conducted in the past on the icthyofaunal diversity of the Valley. Kullander et al. (1999) carried out a systematic fishing for a period of eight years in the Jhelum basin in Kashmir valley and reported fourteen native and four introduced fish species, five species of Schiozothorax, four of which are specialized lotic forms and one of which (Schiozothorax niger) is chiefly found in lakes.

1.2 Schizothorax plagiostomus (Heckel, 1838)

Distribution: Schizothorax plagiostomus is distributed all along the Himalayas, from

Jammu and Kashmir to Assam, through Sikkim and Bhutan, Nepal, Afghanistan, Pakistan.

Taxonomic position

Phylum	**Chordata**
Sub Phylum	Vertebrata
Super Class	Gnathostomata
Grade	Teleostomi
Class	Actinopterygii
Super Order	Cyprinae
Order	Cypriniformes
Family	Cyprinidae
Sub Family	Schizothoracinae
Genus	Schizothorax (Heckel, 1838)
Specie	plagiostomus (Heckel, 1838)

Schizothorax plagiostomus, locally known as “Khont”, is distinguished remarkably by an elongated body, having a projecting snout and a characteristically inferior mouth, with a deep and wide lower jaw, followed by a strip of hard papillated structure at the chin (Plate 1.1). Lower lip fold is expanded and papillae. The fish is typically a bottom feeder, herbivore feeding by scrapping and scooping; Plant matter, 67% subsisting mainly on diatoms and animal matter, 24% (Jan and Das, 1970).

1.3 Schizothorax esocinus (Heckel, 1838)

Distribution: Schizothorax esocinus is distributed in Jhelum drainage in Kashmir, Indus, including parts in Ladakh, Gilgit and Afghanistan.

Taxonomic position

Phylum	**Chordata**
Sub Phylum	Vertebrata
Super Class	Gnathostomata
Grade	Teleostomi
Class	Actinopterygii
Super Order	Cyprinae
Order	Cypriniformes
Family	Cyprinidae
Sub Family	Schizothoracinae
Genus	Schizothorax (Heckel, 1838)
Species	esocinus (Heckel, 1838)

Schizothorax esocinus, locally known as “Churru”, differs from all other Kashmir valley Schizothorax in having a typical pike like head with distinctively longer jaws and thick fleshy lips (Plate 1.2). The mouth is horse-shoe shaped with deep cleft lips; lower labial fold is interrupted centrally and not guarded by the papillated structure. The body is streamlined, silvery in colour with numerous small, dark and irregular spots on back and flanks. The fins have distinctive colour pattern with light ground color and contrasting black spots in most specimens.This species is herbivorous consuming 65-75% planktonic and macrophytic food and 30-35% animal food (Subla and

Das, 1970). The fish is reported to be an omnivore, preferring to feed at the bottom (Bhagat and Sundar, 1984). Barbels are two pairs, rostral pair about 1.5 times longer than eye diameter and maxillary pair slightly shorter.

1.3 Schizothorax labiatus (McClelland, 1842)

Distribution: Schizothorax labiatus is distributed to Jhelum drainage in Kashmir, Indus, including parts in Ladakh, Gilgit and Afghanistan.

Taxonomic position

Phylum	**Chordata**
Sub Phylum	Vertebrata
Super Class	Gnathostomata
Grade	Teleostomi
Class	Actinopterygii
Super Order	Cyprinae
Order	Cypriniformes
Family	Cyprinidae
Sub Family	Schizothoracinae
Genus	Schizothorax (Heckel, 1838)
Species	labiatus (McClelland, 1842)

S. labiatus (McClelland, 1842) locally known as “chush”, has an elongate, distinguished fusiform, body with a prognathous upper jaw, a lower jaw with wide lip folds usually separated by a distinct raised pad (Plate 1.3). S. labiatus has a rounded lower jaw, with a narrow cornified margin, no keratinized cutting edge, and lips restricted to wide lateral flaps and a more or less well developed median thickening, without enlarged papillae (Kullander et al., 1999). It is a foul feeder, feeding mainly on dead animal matter, rooted vegetation, insects, sand and other organic debris. With the help of the protrusible upper jaw it can feed on mud and suck up food mixed with sand.

Plate 1.1(a) Schizothorax plagiostomus (Heckel, 1838);(b) ventral view of head region;(c) line drawing adopted from Tilak (1987).

Jammu and Kashmir lies between six mountain ranges, covers an area of 2,22236 sq. kilometers and is located between 32° 17' and 36° 58' North latitude, and between 72° 26' and 80° 30' East longitude. The then, Indian state of Jammu and Kashmir (Union Territory w.e.f. 31-10-2019), covers an area of 42,241 km^2, with an elevation range of about 247 to 5425 masl. This excludes the Ladakh region, which was previously part of the state and has been given the status of a separate Union territory. The region of Jammu and Kashmir lies to the West of Ladakh and to the North of the neighboring states of Himachal Pradesh and Punjab. Jammu and Kashmir is home to a number of valleys, the most prominent being Kashmir valley, Chenab Valley and Tawi valley. The Kashmir valley is the largest in the region and is spread over 15600 sq.

2. River Jhelum:

The present study is focused on the river Jhelum which is the major Himalayan river flowing in the Kashmir valley. The river Jhelum originates from an octagonal spring called 'Verinag' situated at the foot of the Pir-Panjal in the south-eastern part of the valley of Kashmir and traverses a distance of 203 km up to Khadanyar, the place where it leaves the main valley. After originating in the south Kashmir and flowing through the central part of the valley, Jhelum drains into a massive freshwater lake called Wular located in the Bandipora district in the North from where it re-emerges near Sopore of the Baramullah district. After its re-emergence the Outfall channel (OFC) is joined by Ningal nallah just downstream of Wular lake on its southern bank. The OFC flows in between high banks upto Baramulla and through high mountains thereafter upto the Khadanyar gorge and follows a westerly course for another 120 kilometers joining Kishanganga, Chenab and Indus rivers in Pakistan and finally drains into the Arabian Sea. Therefore the river from the origin to the exit almost traverses the entire length of Kashmir valley. Jhelum forms the major tributary of Indus river system and has a total length of about 730 kilometres. Jhelum serves as a lifeline of Kashmir valley by catering to the huge demand of water supply.

The drainage system of Jhelum is complex and well established as the main channel is joined by around 24 tributaries on both sides along its length in the valley. On the left join its tributaries that drain from the slope of the Pir-panjal range while on the right bank join the tributaries flowing from Himalayan range. Lidder River at Khanabal in Anantnag district and Sind River at Shadipora in Bandipora district are the two major tributaries. Other important tributaries include Sandran, Bringi, Arpat Kol, Vishav, Dudhganga and Ferozpore Nallah. These tributaries are perennial in nature being fed by the glacial melt of the Pir-Panjal and the Himalayan mountain ranges. Overall, the Jhelum basin has around 790 wetlands and other water bodies including high altitude lakes.

Although the valley is not heavily industrialized a number of small scale industries have been established at multiple places along the basin that have poor pollution control measures in place.

In addition to this, the conversion of the floodplains into the Jhelum riverfront in the middle stretch around the highly urbanized Srinagar and encroachments on either side has an adverse impact on the floodwater storage that clearly reflected in the September 2014 and subsequent floods. Moreover, sand mining in the Jhelum main and gravel and boulder mining in the tributaries is a common practice. The mining of the sand and gravel from the riverbed is being done haphazardly impacting the flood control and mitigation adversely. The haphazard mining of the gravel has made the channel to change the course of flow in some of the high gradient upstream tributaries of the Jhelum. This unregulated extraction of the substratum from the riverbed also affects the spawning physiology of the fish including the Schizothorax species.

3. Regional Geology

The physico-chemical characteristics of a river are reflected in the geological formations of its catchment area. Therefore, it is pertinent to describe the geology of the region.

The State of Jammu and Kashmir has been geologically divided into three structural zones (Raza et al., 1978). These are (i) Outer Himalayas (The Siwalik region), (ii) Middle range (Lesser or middle Himalayas) and (iii) Inner Himalayas (The Zanskar range).

4. REVIEW OF LITERATURE:

The condition of an aquatic ecosystem is reflected by the physico-chemical characteristics[1] of its water and the biological diversity existing in it. In the natural water bodies, the quality of water is ever changing as many constituents enter through erosion of geological formations and through various activities of man. However, water quality is mainly deteriorated by human activities including agricultural developments, mining, industrialization and urbanization thereby adding hazardous wastes to the water. In addition to the effluents from the industries, domestic waste is also disposed off into the open drains which ultimately enter the water bodies.

The main aim of analyzing physico-chemical characteristics such as dissolved oxygen, free carbon dioxide, dissolved solids, turbidity, temperature and hardness[2] etc. of water is to determine its nutrient status, hence the productivity that is contributed by them in various proportions (Agarwal and Rajwar, 2010)[3]. The importance of variability in flow upholding the healthy status of fluvial ecosystems has lately been focused by water resource managers, recommending the need for a better understanding of the relationship between flow and the response of the ecosystem (Gillespie et al., 2015). Several aspects of water quality have been discussed from time to time by different workers both at the national and the international level and there is an enormous amount of literature available which makes it really difficult to mention all the scientists, who have worked on the river water quality.

The literature available on the study of water quality of the Jhelum basin in Kashmir valley suggests that very little was known about it until the end of the 20th century[4]. A study made by Vass et al. (1977) on the hydrobiology of river Jhelum reported a high dissolved oxygen concentration. This high DO concentration

was attributed to low biological activity (Qadri et al., 1981). A comparative limnological study of three freshwater bodies of Kashmir valley was conducted by Qadri and Yousuf (1988)[5]. Moreover, Abubakr and Kundangar (2008) analyzed plankton communities and macrophytes with respect to environmental variables of floodplain lakes within the Jhelum basin. In addition, Khan et al. (2012) studied physicochemical properties of River Jhelum and assessed the variations spatiotemporally[6].

RESULTS

During the present investigation various physicochemical parameters viz., water temperature, depth, river width, current velocity, transparency, turbidity, discharge, dissolved oxygen, free CO_2, pH, conductivity and total dissolved solids were recorded at the three selected sampling sites, one each in upper, middle and lower stretch of River Jhelum for a period of two years from May 2016 to April 2018. The distribution and abundance of living organisms is greatly affected by the seasonal variations in the physicochemical parameters (Odum and Barrett, 1971)[7]. The spatial and temporal differences observed in the physicochemical parameters during the study period are described as follows:

Water temperature: During the present study, the water temperature at S1 (Khanabal) was observed to range between 5.72°C (Winter) and 17.24°C (Summer) The average water temperature in Year I ranged from 6.52±1.2°C in winter to a maximum of 15.70±1.30°C in Summer, while in Year II it varied between 6.83±1.48°C in Winter and 15.85±1.37°C in Summer.

At S2 (Srinagar), the water temperature varied between 5.65°C (Winter) and 19.50°C (Summer) during the study period. The average water temperature ranged from 6.83±1.48°C in Winter to 18.3±1.39°C in Summer in Year I while as it ranged from 6.89±1.28°C to 18.63±1.11°C respectively in Winter and Summer in Year II[8].

.2±1.03°C in Summer.

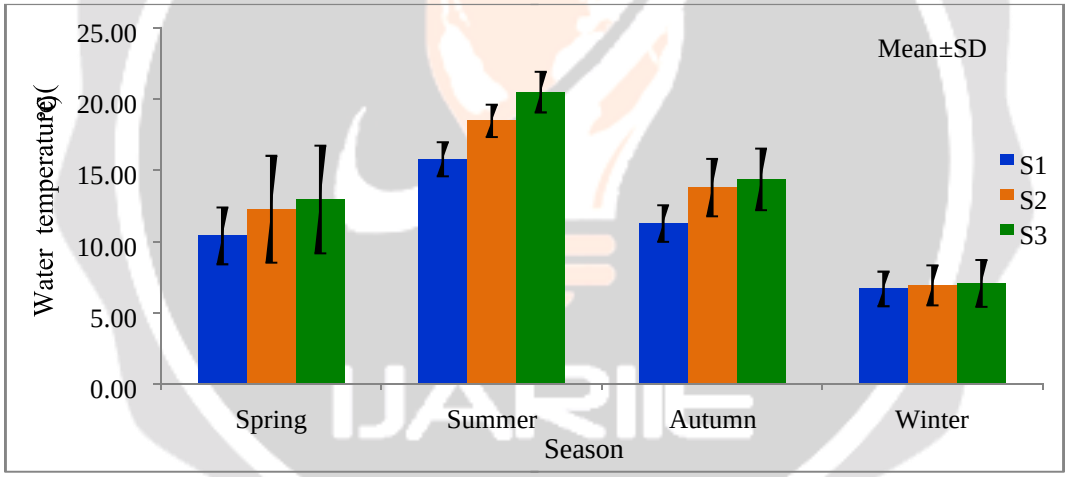

Fig 1.2 Seasonal variation in water temperature at S1, S2 and S3 during two years of the study

Substratum Analysis:

It is an established fact that substratum characteristics play an important role in the temporal and spatial distribution of aquatic organisms including fish species. The data on substratum composition was collected from all the three selected sites of river Jhelum during May 2016 to April 2018.

Khanabal (S1): The substratum composition at Khanabal (S1) was largely composed of sand particles of various groups categorized on the basis of sieve size. The total sand composition was 77.93%, which varied from very coarse (4.44%) to very fine (27.87%)[9].

Table 1.1 Summary of the substratum analysis of River Jhelum at Khanabal (S1) during May 2016 to April 2018

Khanabal (S1)	
Particle Size	Percent (%)
Cobbles (>64) mm	0

Pebbles (64-16) mm	0
Gravel (16-2) mm	5%
Very coarse sand (1-2) mm	4.44%
Coarse sand (0.5-1) mm	11.08%
Medium sand (0.25-0.5) mm	13.94
Fine sand (0.125-0.25) mm	20.60%
Very fine sand (0.05-0.125) mm	27.87%
Total Sand per cent	77.93%
Silt (0.002-0.05) mm	13.74%
Lutum (<0.002) mm	3.35%

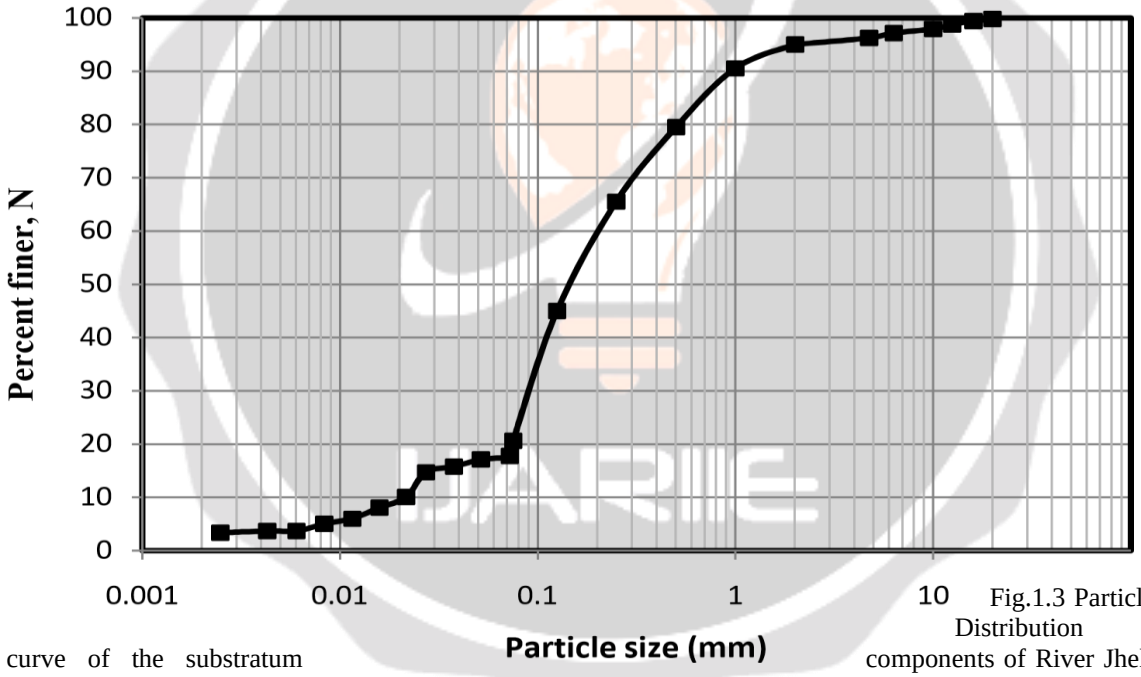

Fig.1.3 Particle Size Distribution (PSD) curve of the substratum components of River Jhelum at Khanabal (S1) during May 2016 to April 2018

Table 1.2 Summary of the particle sizes obtained from the PSD curve used to quantify Co-efficient of uniformity (Cu) and Coefficient of curvature (Cc) for substratum types at each site in River Jhelum

	Khanabal (S1)	Srinagar (S2)	Baramulla (S3)
D_{60}	0.2	0.04	0.03
D_{50}	0.15	0.03	0.02
D_{30}	0.09	0.009	0.01
D_{10}	0.022	0.004	0.004
C_u	9.091	10.00	8.571

C_C	1.841	0.473	0.640

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