



Study of Some Morphometric and Meristic Traits of Chirru Snowtrout (*Schizothorax esocinus*) from River Jhelum, Kashmir, India

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Authors' contributions

This work was carried out in collaboration between all authors. Authors BS and THS designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript.

Authors BAB, SG, FAB and AA managed the analyses of the study. Authors OAA, ZH and NUA managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

A study was conducted to analyze morphological characteristics of a Schizothoracid species: *Schizothorax esocinus* collected from three sites of river Jhelum in Kashmir. *S. esocinus* is locally known as "Churru" and forms an important food element of the local population., *Schizothorax esocinus* is one of the most important species in the genus *Schizothorax* and it has continued to contribute immensely to the nutritional needs, economic growth and development of the Kashmir valley. Furthermore, this fish is very sensitive to any environmental changes so it acts as bioindicator of aquatic pollution. A total of 180 samples were taken for the study of the morphometric and meristic characters utilizing ethnic fishing gears. Thirteen conventional morphometric characters examined in the present study, showed high co-efficient of determination (R^2) values ranging from 0.55 to 0.91 for district Srinagar from 0.56 to 0.92 for district Anantnag, and 0.56 to 0.98 for district Baramulla signifying that the traits were highly correlated to each other.

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Out of six meristic characters examined, two characters were not remarkably different ($p > 0.05$). The fin formula of *S. esocinus* was devised as D, I + 5-10, P, I + 7-11, C, I + 15-23, A, I + 3-7, LL, 55-170. This study is purely aimed at studying the morphology and meristics of *S. esocinus* and not at estimating the length-weight relationship or condition factor.

Keywords: Schizothoracid; morphometry; meristics; *S. esocinus*; river Jhelum.

1. INTRODUCTION

Schizothoracids, the indigenous cyprinids are predominant in foothill streams of the Himalaya and Central Asia and dwell in both lotic as well as lentic water bodies of Kashmir. These fish are usually called snow trouts and are restricted to cold regions and to the habitats owning snow fed rivers. *S. esocinus* is the most valuable species of the Kashmir valley, forms an important delicacy of local population and is well suited to crystal clear and oxygenated waters of the valley but indiscriminate fishing pressure, introduction of exotic species such as carps and other human made activities such as pollution, urbanization, overfishing will ultimately lead the status of this species make more vulnerable for their living. They are designated as prized fishes, and are believed to have migrated into lakes and streams of Kashmir from Central Asian watersheds bordered by inner and southern slopes of Hindu Kush, Karakoram and inner ends of north western Himalayan and Suleiman Ranges [1].

Schizothorax esocinus locally known as Churru, is a species of cyprinid fish found in the Himalayas in Pakistan, India, Afghanistan, Nepal and China. They are moderately sized native benthopelagic fish mostly found in mountain streams, rivers and gravel-bottomed rivers. Body of the fish is elongated with minute scales. Mouth slightly ascending forward, the upper jaw being little longer than the lower. Head depressed with long snout. Barbels are longer than eye and origin of dorsal fin is somewhat nearer to the root of caudal than to the end of snout. Anal fin is slender reaching to base of caudal when laid backward. Anal scales are ascetically developed. Body with numerous black spots. [2].

Morphometric and meristic characters of fish are the assessable or countable traits prevalent to all fishes. Morphometric measurements and meristic counts are well categorized as the simplest and reliable methods for the documentation of specimen which is labelled as morphological systematic [3]. Morphological measurements, meristic counts, shape and size offer data beneficial for taxonomic position [4]. In general,

fish demonstrate greater variances in morphological traits both within and amongst populations than other vertebrates and are more susceptible to environmentally induced morphological variations. Morphometric and meristic studies can thus be a primary step in investigating the stock structure of species with a large sized population. Fish are very sensitive to environmental changes and quickly adapt themselves by changing necessary morphometrics [5]. Knowledge of the morphometric characters of fishes and the investigation of statistical relationship among them are indispensable for taxonomic studies [6].

2. MATERIALS AND METHODS

A total of 180 samples of *S. esocinus* were collected from three sampling sites of river Jhelum namely Srinagar, Anantnag and Baramulla during the period from October 2017 to March 2018. These are three main sites of river Jhelum in the Kashmir valley and are mostly subjected to be under the influence of human activities. Increasing human activities such as discharge of waste into the water body has largely depleted the environmental condition of the river at these three sites. The total geographical area of Jhelum basin upto Indo-Pakistan border is about 34775 Sq. Kms. with a total length of 402 Kms but the length of Jhelum in India upto existing ceasefire line is about 165 Kms. River Jhelum originates from Verinag Spring situated at the Southeastern part of Kashmir valley in India, is the tributary of Indus basin and flows in Western Himalayan region of India; it has a total length of about 813km. Studies of morphometric and meristic characters followed the methods given by Lagler et al., [7], Laevastu [8], Lowe-McConnel [9], Dwivedi and Menezes [10] and Grant and Spain [11]. Morphometric measurements were made using digital callipers. In Laboratory, about 13 morphometric and 6 meristic characters of each fish sample were studied. Total length (TL) and all other measurements were taken in millimetres. Meristic counts were analysed following the conventional method as described by Hubbs and Lagler [12]. All the meristic counts

were set up against incoming light direction in the room with the help of needle and small pins for easy counting.

3. RESULTS AND DISCUSSION

With 24 tributaries, River Jhelum is the main water resource of the Kashmir valley with immense socio-economic significance. The Jhelum is greatly utilised for its water and food such as fish. Since Jhelum passes through many rural and urban settlements, the river gets polluted with sewage from settlements, agricultural runoff and effluent discharges from various small and large scale industrial units. Measurements of numerous morphometric traits of *S. esocinus*, their range, mean, median, standard error, standard deviation and coefficient of determination are described in Table 1. Out of three sampling sites, pre-orbital length displayed highest coefficient of variation (27.39%) and total length displayed lowest coefficient of variation (16.11%). The correspondence amongst several characters i.e., total length v/s standard length, total length v/s pre dorsal length, total length v/s pre pectoral length, total length v/s pre pelvic length, total length v/s pre anal length, total length v/s head length, total length v/s snout length, total length v/s eye diameter, total length v/s caudal fin length, total length v/s body depth, total length v/s pre orbital length and total length v/s post orbital length are described in Table 2,3 and 4. Substantial coefficient of determination (R^2) values fluctuating from 0.55 to 0.91 for district Srinagar from 0.56 to 0.92 for district

Anantnag, and 0.56 to 0.98 for district Baramulla signifying that the traits were largely interrelated to each other, thereby suggesting great degree of homogeneity within the assessed populations. For meristics, the Kruskal Wallis (H) test, displayed in Table 5 the number of dorsal fin rays and caudal fin rays were not significantly ($p>0.05$) different amongst fish from these stocks and variance existed in other meristic traits (Lateral line scales: $H = 19.58$, $p<0.01$; Pectoral fin rays: $H = 64.06$, $p<0.01$; Pelvic fin rays: $H=27.29$, $p<0.01$; Anal fin rays: $H=5.44$, $p<0.01$). In Univariate statistics (ANOVA) similar results were attained. The dorsal fin rays and caudal fin rays exhibited non-significant difference ($p>0.05$).

In the present study, numerous morphometric traits compared exhibited high coefficient of correlations (r) values, which specify that the morphometric characters investigated are extremely correlated to each other. The 'b' values found exhibited maximum degree of correlation between total length and standard length and lowest between total length and head length. There was a substantial positive correlation amongst growths of all other parameters with respect to total length. Renjini and Bijoy [13] while investigating morphometry of *Liza parsia* testified positive correlation between total length and external body parts. Shah et al., [14] examined the morphometry of farmed female rainbow trout in Kashmir and testified great level of interdependence amongst the fourteen morphometric characters studied.

Table 1. Descriptive statistics of morphometric traits of *S. Esocinus*

Morphometric Measurement	Minimum	Maximum	Mean \pm SE	CV%
Total Length(TL)	141.55	360.85	242.37 \pm 2.91	16.11
Standard Length (SL)	119.36	307.31	206.96 \pm 2.63	17.02
Pre-Dorsal Length (PDL)	50.81	157.18	105.03 \pm 1.30	16.61
Pre-Pelvic Length (PPvL)	41.27	188.35	110.18 \pm 1.58	19.28
Pre-Pectoral Length (PPcL)	25.01	99.76	55.14 \pm 0.92	22.29
Snout Length (SNL)	10.01	14.16	14.97 \pm 0.23	20.99
Head Length (HL)	17.73	57.95	38.30 \pm 0.63	21.89
Body Depth (BD)	20.88	60.91	38.92 \pm 0.47	16.34
Caudal Fin Length (CFL)	19.71	60.86	36.90 \pm 0.56	20.44
Eye Diameter (ED)	9.34	14.61	10.07 \pm 0.14	19.29
Pre-Anal Length (PAL)	90.06	227.73	159.81 \pm 1.82	15.31
Pre-Orbital Length (PrOL)	10.29	23.44	15.94 \pm 0.33	27.39
Post-Orbital Length (PoOL)	15.09	37.79	25.52 \pm 0.47	24.45

*unit of morphometric measurements were taken in millimetres (mm)

Table 2. Correlation between various morphometric traits of *S.esocinus* for Srinagar

Morphometric characters	River jhelum			
	Intercept	Slope	y=a+bx	R ² (co-efficient of determination)
Total length and Standard length	16.73	0.95x	16.73+0.95x	0.91
Total length and Pre dorsal length	21.61	0.54x	21.61+0.54x	0.71
Total length and Pre pelvic length	16.68	0.54x	16.68+0.54x	0.66
Total length and Pre pectoral length	42.94	0.43x	42.94+0.43x	0.59
Total length and Snout length	2.62	0.08x	2.62+0.08x	0.60
Total length and Head length	26.53	0.27x	26.53+0.27x	0.60
Total length and Body depth	32.67	0.32x	32.67+0.32x	0.66
Total length and Caudal fin length	20.24	0.24x	20.24+0.24x	0.60
Total length and Eye Diameter	6.69	0.08x	6.69+0.08x	0.65
Total length and Pre Anal length	13.42	0.63x	13.42+0.63x	0.68
Total length and Pre Orbital length	6.67	0.10x	6.67+0.10x	0.55
Total length and Post orbital length	8.22	0.15x	8.22+0.15x	0.62

*unit of morphometric measurements were taken in millimetres (mm)

Table 3. Correlation between various morphometric traits of *S. esocinus* for Anantnag

Morphometric characters	River jhelum			
	Intercept	Slope	y=a+bx	R ² (co-efficient of determination)
Total length and Standard length	21.43	0.92x	21.43+0.92x	0.92
Total length and Pre dorsal length	2.04	0.43x	2.04+0.43x	0.81
Total length and Pre pelvic length	4.62	0.43x	4.62+0.43x	0.80
Total length and Pre pectoral length	0.64	0.22x	0.64+0.22x	0.72
Total length and Snout length	5.82	0.08x	5.82+0.08x	0.61
Total length and Head length	5.54	0.18x	5.54+0.18x	0.67
Total length and Body depth	2.16	0.15x	2.16+0.15x	0.62
Total length and Caudal fin length	6.03	0.14x	6.03+0.14x	0.57
Total length and Eye Diameter	4.20	0.06x	4.20+0.06x	0.62
Total length and Pre Anal length	23.97	0.55x	23.97+0.55x	0.67
Total length and Pre Orbital length	10.90	0.11x	10.90+0.11x	0.72
Total length and Post orbital length	17.59	0.18x	17.59+0.18x	0.77

*unit of morphometric measurements were taken in millimetres (mm)

Table 4. Correlation between various morphometric traits of *S. esocinus* for Baramulla

Morphometric characters	River jhelum			
	Intercept	Slope	y=a+bx	R ² (co-efficient of determination)
Total length and Standard length	11.11	0.89x	11.11+0.89x	0.99
Total length and Pre dorsal length	19.81	0.35x	19.81+0.35x	0.81
Total length and Pre pelvic length	7.11	0.41x	7.11+0.41x	0.90
Total length and Pre pectoral length	11.20	0.17x	11.20+0.17x	0.63
Total length and Snout length	1.96	0.05x	1.96+0.05x	0.65
Total length and Head length	11.72	0.11x	11.72+0.11x	0.58
Total length and Body depth	10.16	0.12x	10.16+0.12x	0.79
Total length and Caudal fin length	11.76	0.10x	11.76+0.10x	0.57
Total length and Eye Diameter	5.46	0.02x	5.46+0.02x	0.58
Total length and Pre Anal length	17.69	0.58x	17.69+0.58x	0.96
Total length and Pre Orbital length	2.67	0.06x	2.67+0.06x	0.59
Total length and Post orbital length	1.36	0.10x	1.36+0.10x	0.69

*unit of morphometric measurements were taken in millimetres (mm)

Table 5. Test of significance of meristic traits among Srinagar, Anantnag and Baramulla stocks of *S. Esocinus*

Meristic Characters	Srinagar Mean ± SD	Anantnag Mean ± SD	Baramulla Mean ± SD	H value	P value
Lateral line scales	101.67±16.38	107.85 ± 15.8	90.72 ±19.7	19.58	<0.01
Dorsal fin rays	7.50 ±0.70	7.73±0.63	7.55±0.87	3.42	>0.05
Pectoral fin rays	9.15 ±1.01	10.77±1.65	11.68± 1.80	64.06	<0.01
Pelvic fin rays	7.87±0.47	8.45±0.85	8.65±0.84	27.29	<0.01
Caudal fin rays	17.77 ±0.65	17.33±0.8	17.95±1.73	6.45	>0.05
Anal fin rays	5.00 ±0.00	5.03±0.37	5.28±0.61	5.44	<0.01

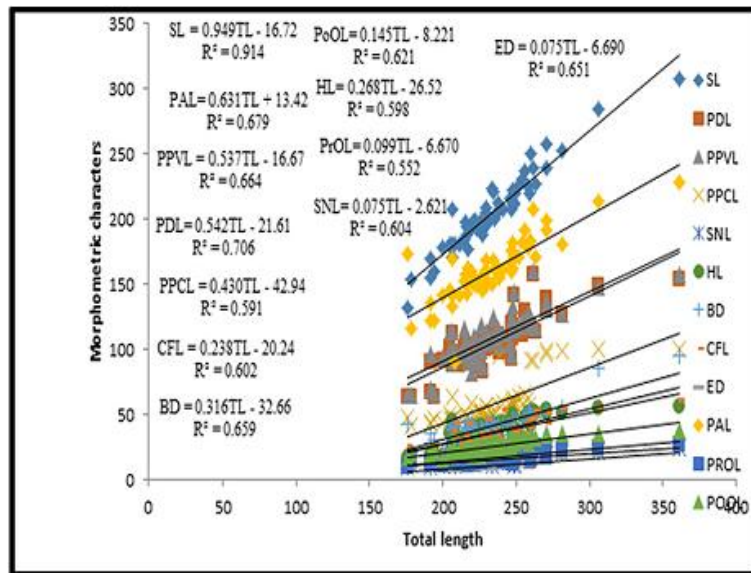


Fig. 1. Logarithmic relationship of different morphometric characters with total length (mm) in *S. esocinus* from river Jhelum (Srinagar)

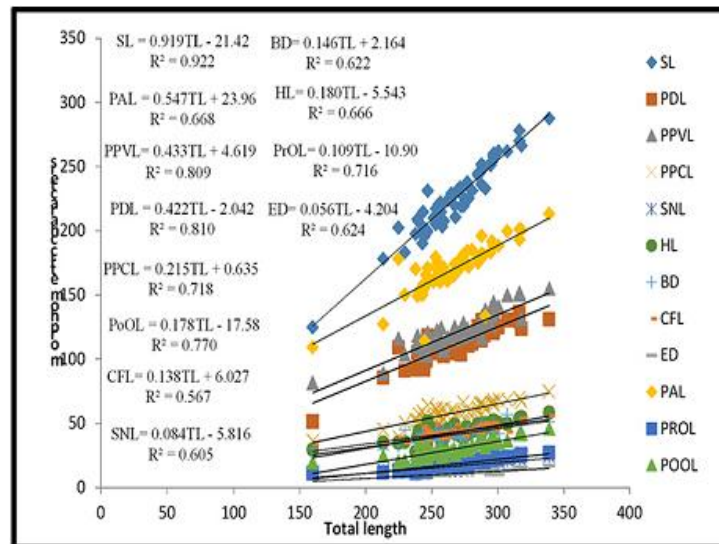


Fig. 2. Logarithmic relationship of different morphometric characters with total length (mm) in *S. esocinus* from river Jhelum (Anantnag)

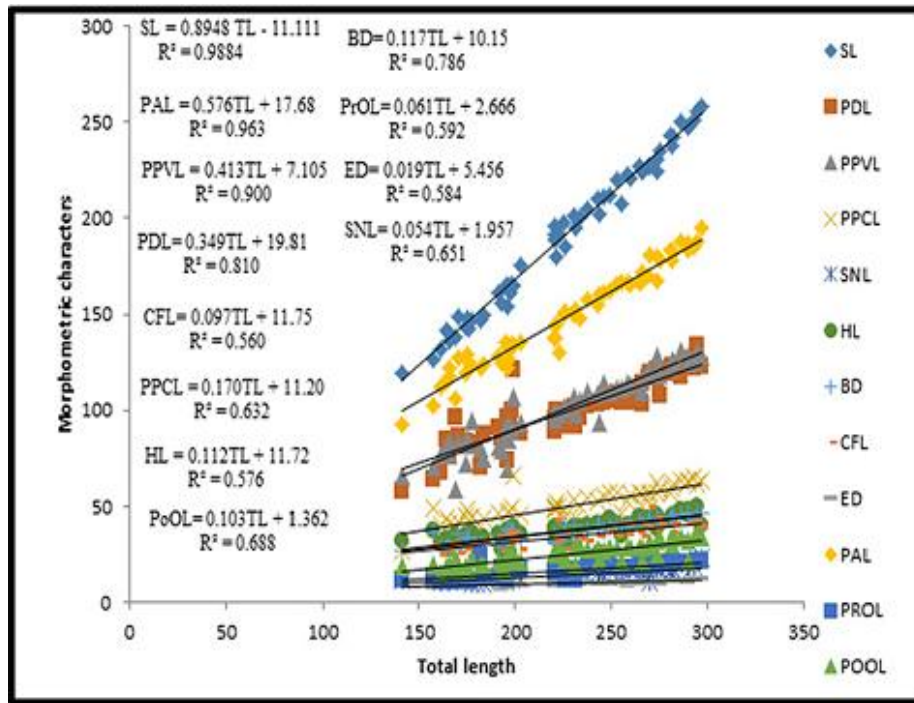


Fig. 3. Logarithmic relationship of different morphometric characters with total length (mm) in *S. esocinus* from river Jhelum (Baramulla)

Bhat et al., [15] while reviewing the morphometric traits of schizothoracines in Lidder stream of Kashmir reported positive correlation coefficient of total length with other parameters under assessment, the coefficient of correction 'r' of total length with standard length was observed to be maximum ($R^2 = 0.99$) in consideration to all other specifications studied. Braich and Akhter 2015 while reviewing morphometric traits of *Crossocheilus latius* noted positive correlation between total length and external body parts. Bhat et al., [16] documented similar results in *Cyprinus* sp. Out of eighteen characters in relation to total fish length, ten characters showed high values of correlation coefficient and eight characters showed moderate correlation coefficient. Qadri et al., [17] observed high coefficient of correction (r) values for various morphometric traits with standard length showing highest degree of correlation ($R^2=0.88$) with total length in *S. curvifrons*. The results of the present investigation for meristics exhibited substantial difference in all the characters studied except for dorsal fin rays and caudal fin rays (Using Kruskal-Wallis test). Similar results were reported by Gain et al., [18] in 6 of 8 meristic characters of *Cirrhinus cirrhosis* from wild and hatchery stocks in Bangladesh. Hossain et al., [5] also detected substantial differences in two of 9 meristic counts

in threatened carp, *Labeo calbasu* from stocks of two isolated rivers, the Jamuna and the Halda and a hatchery in Bangladesh. The difference in meristic characters can be accredited to the sensitivity of the fish in response to differences in environmental conditions (temperature and food abundance) as explained by Allendorf et al., [19] and Swain et al., [20].

Our present study latter can be helpful to the researchers of fisheries, fisheries biologists and taxonomists for the correct identification of *S. esocinus* in various locations of Kashmir.

4. CONCLUSION

This study provides basic information about the morphometric and meristic measurements of *S. esocinus* which can be used to determine the stock structure of the species. Separate management strategies can be formulated so as to sustain the stocks of *S. esocinus* for future viz. development of proper guidelines for implementation of appropriate mesh sizes and season wise restriction of fishing, which will eventually succor to sustain the resource for future use. This method along with biotechnological approaches such as DNA sequence polymorphism can be useful in species

characterization, detect phenotypic variation and to discriminate between species, subspecies and populations.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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