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Morphometrics and length-weight relationship of *Schizothorax curvifrons* Heckel 1838 in River Jhelum, Kashmir, India

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ABSTRACT

Schizothorax curvifrons, an indigenous cyprinid fish of Kashmir, forms an important coldwater fishery resource of the valley. This study was aimed to describe the morphometrics and length-weight relationship of *S. curvifrons* in River Jhelum Kashmir. The various morphometric characters showed high co-efficient of correlation (r) values, indicating that the characters were highly correlated to each other. The length-weight relationship was established logarithmically as Log W = -3.9323 + 2.5863 Log L (r^2=0.746) for males, Log W = -4.1708 + 2.6852 (r^2=0.745) Log L for females and Log W = -3.9975 + 2.6138 Log L (r^2=0.746) for pooled data. The b value (2.6138) was found to be significantly different from 3 indicating negative allometric growth.

Key words: Jhelum, Length-weight relationship, Morphometrics, *Schizothorax curvifrons*.

INTRODUCTION

Morphometric characters are continuous characters describing aspects of body shape and have been commonly used in fisheries biology to measure discreteness between different fish stocks. Similarly, length-weight relationships of fishes are important in fisheries biology because they allow the estimation of the average weight of the fish of a given length group by establishing a mathematical relation between the two (Beyer, 1987). Like any other morphometric character, the length-weight relationship can be used as a character for the differentiation of taxonomic units and the relationship changes with various developmental events in life such as metamorphosis, growth and the onset of maturity (Thomas *et al*., 2003). This relationship is helpful for estimating the weight of a fish of a given length and can be used in studies of gonad development, rate of feeding, metamorphosis, maturity and condition (Le Cren, 1951).

The subfamily Schizothoracinae is a group of specialized fishes, dominant in the torrential mountain streams of the Himalayas and Central Asia. They are confined to cold regions and to localities possessing snow fed rivers and thus commonly called as snow trouts. Among Schizothoracids, the cyprinid, *Schizothorax curvifrons* Heckel, 1838, locally known as *Sattar Gad*, is an indigenous omnivorous coldwater teleost of Kashmir Valley, inhabiting rivers, lakes and swamps. This species can be recognized by an elongated and streamlined body, somewhat compressed with its depth 5.1 to 5.8 times in standard length. There are two pairs of barbels (maxillary and rostral), much shorter than eye diameter. Colour in life is light brownish and belly is silvery (Talwar and Jhingran, 1991). The maximum reported size of this fish is 56 cm in total length (Berg, 1964) and 1.3 kg in weight (Talwar and Jhingran, 1991). Studies on the growth and reproductive biology of fishes of Indian sub-continent have been made by a number of researchers. However, little information is available on morphometry and length-weight relationship of *S. curvifrons* from River Jhelum. In the present paper an attempt has been made to investigate the morphometry and length-weight relationship of *S. curvifrons* in River Jhelum.

MATERIALS AND METHODS

During the present study, 298 specimens of *S. curvifrons* ranging from 140 to 446 mm in total length and 71 to 442 g in weight were collected from Chattabal Landing Centre from May 2013 to April 2014. The morphometric characters (in mm) were measured in laboratory using standard methods as described by Lagler *et al.,* (1962), Laevastu (1965), Lowe-McConnel (1971), Dwivedi and Menezes (1974) and Grant and Spain (1977). The morphometric characters measured were total length (TL), standard length (SL), pre-dorsal length (PDL), pre-pectoral length (PPL), pre-pelvic length (PPeL), pre-anal length (PAL), head length (HL), snout length (SNL), body depth (BD), eye diameter (ED) and caudal fin length (CFL). Relationships between various body measurements to total length and head length have been established. Scattergram of morphometric characters were plotted and the linear regression equation was fitted using least square method

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described by Laevastu (1965) and Snedecor and Cochran (1967). The relationships were represented by the equation:

$Y = a + b X$

Where, 'Y' is the dependent variable, 'X' is the independent variable, 'a' is a constant (intercept) and 'b' the regression coefficient (slope). The values of constants 'a' and 'b' were determined by the equation:

$a = y - bx$ and $b = [n\sum xy - \sum x \sum y] / [n\sum x^2 - (\sum x)^2]$

The correlation coefficient (r) is usually calculated to express the degree of linear association or interdependence of two variables as:

$r = [n\sum xy - \sum x \sum y] / \sqrt{[n\sum x^2 - (\sum x)^2] [n\sum y^2 - (\sum y)^2]}$

Length-weight relationship: The study of length-weight relationship was based on 214 male and 84 female specimens of *S. curvifrons*. Immediately after bringing the specimen to the laboratory, the total length (TL) was measured to nearest mm using measuring board and weight was noted to the nearest 0.01 g accuracy with an electronic balance. The length-weight relationship was estimated using the allometric formula proposed by Le Cren (1951) separately for both sexes and significant differences, if any, in the slopes of the regression lines for males and females were ascertained.

$W = aL^b$ or $\text{Log } W = \log a + b \times \log L$

Where, 'W' is the weight of fish in g, 'L' is the length of fish in mm, 'a' is the intercept and 'b' is the slope of the growth. The analysis of covariance was done to determine variation in 'b' values among the sexes at 1% and 5% level of significance by following Snedecor and Cochran (1967). To test 'b' value against the value of '3', student's t-test was employed to predict any significant deviation. The t-statistic was calculated as follows:

The hypothesis given is,

H_0 : Growth is isometric i.e. H_0: $b = 3$

H_1 : Growth is not isometric i.e. H_1: $b \neq 3$

The t statistics used are given by:

$t = |b-3| / S_b$

Where, S_b = Standard error of "b" and t has (n-2) degrees of freedom.

$S_b = \sqrt{(1/(n-2))} * [(S_y/S_x)^2 - b^2]$

Where, "S_x" and "S_y" are the standard deviations of x and y respectively. The t-value was compared with t-table value for (n-2) degrees of freedom at 1% and 5% significance level.

RESULTS AND DISCUSSION

Morphometry: Measurements of various morphometric characters of *S. curvifrons*, their range, mean, median, standard error, standard deviation and coefficient of correlation are presented in Table1. Caudal fin length showed a maximum coefficient of variation (0.40%) while snout length showed minimum variation (0.11). The relationship between various 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, head length v/s snout length and head length v/s eye diameter are presented in Table 2 and Figure 1. High degree of correlation between compared characters is evident from 'r' values that ranged from 0.72% to 0.94%. Standard length showed maximum degree of correlation (0.94%) with total length while head length showed the minimum degree of correlation with total length (0.72%), indicating very high degree of relationship between the characters compared. Values of constants "a" and "b" and correlation "r" for the various morphometric relationships are depicted in Table 2.

Length-weight relationship

The length-weight was established logarithmically as:

Male: $\text{Log } W = -3.9323 + 2.5863 \text{ Log } L$ ($R^2 = 0.746$)

Female: $\text{Log } W = -4.1708 + 2.6852 \text{ Log } L$ ($R^2 = 0.745$)

The scattergram of logarithmic relation of length weight was plotted separately for males (Fig. 2) and females (Fig. 3). Analysis of Covariance (Table 3) indicated that the regression of coefficient of length-weight relationship of both the sexes show no significant variation at 1% or 5% level. Hence, the length-weight data of males and females was

Table 1: Statistical estimates of various morphometric characters of *S. curvifrons*

Statistical estimates	Range (mm)		Mean	Median	Standard	Standard	Coeffecient of
	Min	Max	(mm)	(mm)	error	deviation	variation (%)
Total length (TL)	140	446	253	251	2.45	42.59	0.17
Standard length (SL)	120	311	215	215	1.98	34.43	0.16
Pre-dorsal length (PDL)	57	153	107	108	1.02	17.76	0.18
Pre-pectoral length (PPL)	28	60	44	46	0.34	5.89	0.13
Pre- pelvic length (PPeL)	60	157	110	110	1.03	17.93	0.16
Pre-anal length (PAL)	95	251	166	165	1.57	27.23	0.16
Head length (HL)	25	66	43	43	0.45	7.79	0.18
Snout length (SNL)	11	22	16	16	0.11	1.86	0.11
Body depth (BD)	27	64	46	46	0.46	7.99	0.13
Eye diameter (ED)	5	11	8	8	0.60	1.00	0.13
Caudal fin length (CFL)	10	140	38	36	0.89	15.4	0.40

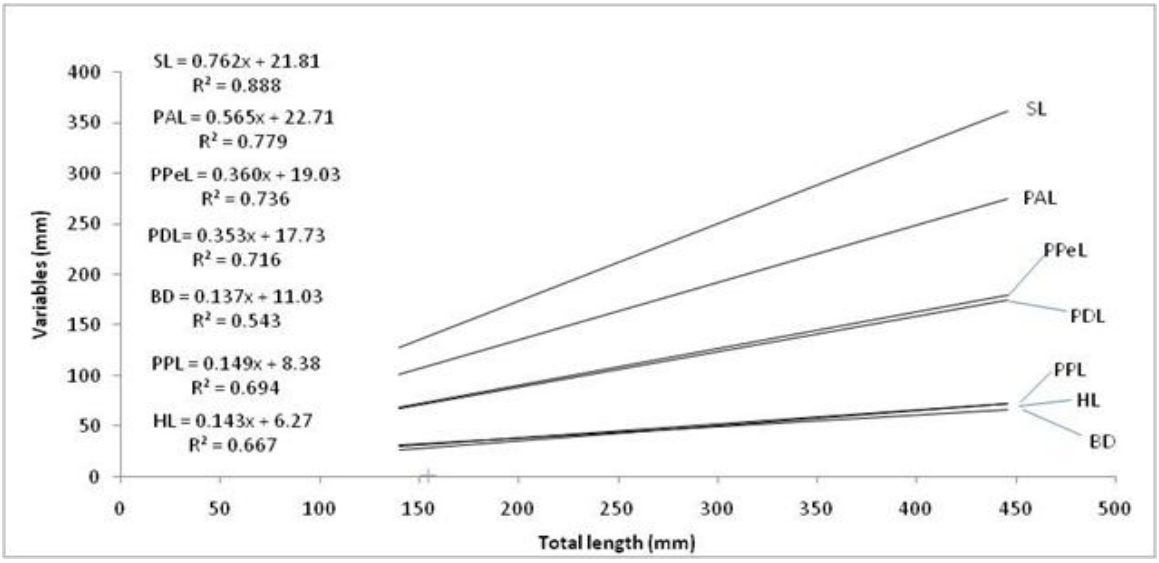

Fig 1: Relationship between different morphometric characters with total length in *S. curvifrons*

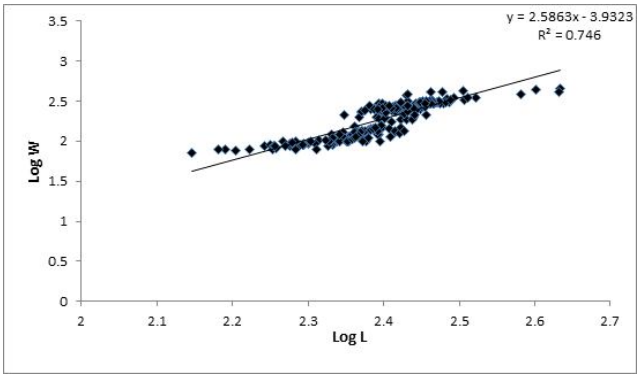

Fig 2: Logarithmic relationship between length and weight in *S. curvifrons* (Male)

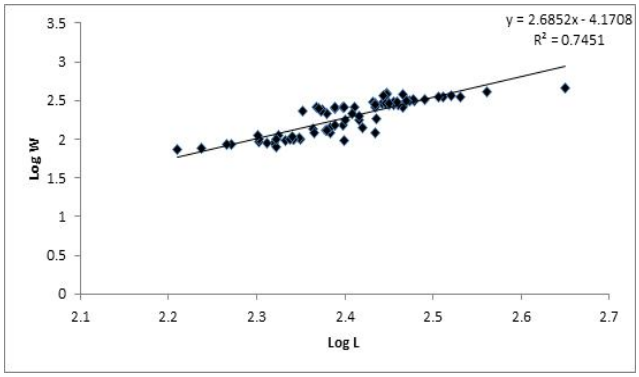

Fig 3: Logarithmic relationship between length and weight in *S. curvifrons* (Female)

Table 2: Relationship between various morphometric characters of *S. curvifrons*

Morphometric character	Intercept (a)	Slope (b)	Y= a + b X	Correlation (r)
Total Length & Standard Length	21.816	0.762	Y = 21.816 + 0.762X	0.94
Total Length & Pre-dorsal Length	17.738	0.353	Y = 17.738 + 0.353X	0.84
Total Length & Pre- Pectoral Length	8.387	0.149	Y = 8.387 + 0.149X	0.73
Total Length & Pre-anal Length	22.719	0.565	Y = 22.719 + 0.565X	0.88
Total Length & Head Length	6.278	0.143	Y = 6.278 + 0.143X	0.72
Total Length & Body Depth	11.03	0.137	Y = 11.03 + 0.137X	0.74
Total Length & Pre- Pelvic Length	19.03	0.36	Y = 19.03 + 0.360X	0.84
Head Length & Snout Length	8.563	0.181	Y = 8.563 + 0.181X	0.83
Head Length & Eye Diameter	3.518	0.100	Y = 3.518 + 0.100X	0.84

pooled together and length weight relationship was established logarithmically (Fig. 4) as:

Pooled: Log W = -3.9975 + 2.6138 Log L (R^2 = 0.7462)

In order to test whether the pooled length- weight relationship follows the isometric growth pattern or not, Student's t-test was applied.

t = -4.3599

The calculated "t" value was found to be significantly different from 3 at 1% level indicating negative allometric growth for *S. curvifrons*.

In the present study, various morphometric characters compared showed high coefficient of correlation (r) values, which indicate that the morphometric characters investigated are highly correlated to each other. The 'b'

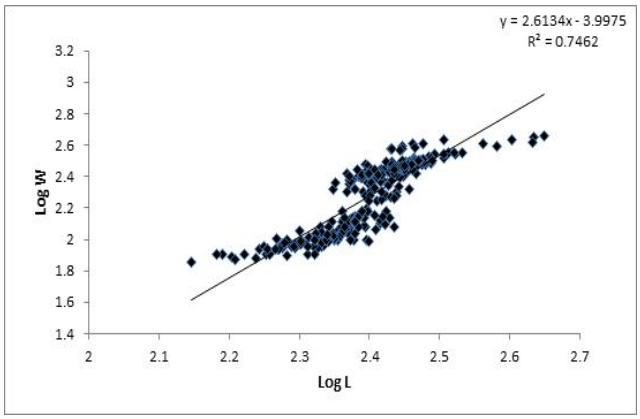

Fig 4: Logarithmic relationship between length and weight in *S. curvifrons* (Pooled)

values obtained showed highest degree of correlation between total length and standard length and lowest between total length and head length. There was a significant positive correlation between growths of all other parameters with respect to total length. The morphometric analysis of fish is an important key in the study of biology of fish (Hussain *et al.*, 2012. Yousuf *et al.*, 2003). Bhat *et al.,* (2010) studied the morphometric characteristics of *Schizothorax* spp. in the River Lidder of Kashmir and reported maximum growth in standard length (0.9080) and least in maximum body depth (0.1730) with respect to the total length of the fish. Shah *et al.,* (2011) investigated the morphometry of farmed rainbow trout in Kashmir and reported high level of interdependence between the fourteen morphometric characters studied. Gharaie (2012) studied the morphometric characters of snow trout *Schizothorax zarudnyi* and reported that the studied morphometric characters were not significantly different in both sexes (P>0.05). Bhat *et al.,* (2013) while studying the morphometric characteristics of Schizothoracines in River Lidder of Kashmir observed positive correlation coefficient of total length with other parameters under comparison, the correlation coefficient 'r' of total length with standard length was observed to be maximum (r = 0.999) compared to all other parameters studied. Sharma *et al*., 2014 studied the relationship of total length and external body parts while analyzing the morphometric and meristic characteristics of *Botia birdi* in the Indus basin, Jammu and Kashmir and reported a positive correlation in all parameters with total length. The highly correlated body parameters in relation to total length was fork length (r = 0.999) while as least correlation was observed for Post orbital Length (r = 0.776).

In the present study, the values of regression coefficient for the length weight relationship were estimated at 0.746, 0.745 and 0.746 for the males, females and pooled data respectively. The calculated t value for the student's t-test was found to be significant at 1% level indicating negative allometric growth for *S. curvifrons.* Similar results have been reported by various workers on schizothoracids and other fishes inhabiting the waters of Kashmir and elsewhere. Sunder (1979) has reported the value of regression coefficient to be 2.347 in case of *Schizothorax niger* in Dal Lake of Kashmir. Qadri and Mir (1979) recorded the value of 'b' to be equal to 2.448 in case of *S. richardsoni* of Sindh Nallah. Bhagat and Sunder (1984) calculated the value of 'b' in *S. esocinus* to be 3.0180 from Dal Lake Kashmir. Sunder (1984) recorded the value of regression coefficient 'b' of *S. curvifrons* in River Jhelum Kashmir to be 2.888. In the present study, a similar value of 2.6138 was obtained for the exponent 'b'. Pandit (1987) reported the regression coefficient to be equal to 2.977 for *S. niger* in Dal Lake in Kashmir. Yousuf *et al*., (1992) studied the length weight relationship of *S. niger* and *C. carpio* from Manasbal Lake, Kashmir and reported the value of 'b' equal to 3.014 and 2.89 respectively. Mir *et al*., (2012) reported the different values of 'b' (< 3) in different months in *S. curvifrons* from River Jhelum. Khan and Sabah (2013) reported the exponential value of 'b' equal to 2.69 for *S. curvifrons*. Shah *et al.,* (2013) investigated the length weight relationship of rainbow trout (*Onchorynchus mykiss*) from Dachigam stream in Kashmir. The authors estimated the value of b at 2.9618 which did not differ significantly from 3. The coefficient of correlation (r) for the length weight relationship was

Table 3: Analysis of covariance for testing length-weight relationship of males and females in *S. curvifrons*

Source	d.f.	ssx	Ssy	Spxy	Reg. coef	Deviations from regression				
						d.f.	S.S.	M.S	F	Prob
Within										
Males	213	6.1064	54.7508	15.7932	2.5863	212	13.9042	0.0655		
Females	83	2.3503	22.7426	6.3110	2.6852	82	5.79616	0.0706		
						294	**19.7003**	**0.0670**		
Pooled W	296	8.4567	77.4934		22.1043	2.6138	295 19.7169	0.0668		
			Difference between slopes				**1 0.01659**	**0.0165**	**0.2482**	**0.6186916**
Between B										
W+B	297	8.4899	77.7034		22.1878		296 19.7173			
			Between adjusted means				**1 0.00032**	**0.00032**	**0.0048**	**0.9444470**
Note:		If Prob <0.05 then significant at 5% level								
		If Prob <0.01 then significant at 1% level								

estimated at 0.9968 which showed a high degree of positive correlation between the length and weight of the fish.

The value of exponent 'b' is influenced by the geographical and ecological differences which lead to variations in water quality parameters and food availability thereby affecting the growth of fish (Mommsen, 1998). Similar observations were mentioned by earlier workers from this region as well as other areas of the world (Sunder and Subla, 1985; Weatherley and Gill, 1987; Zarger *et al*., 2012). High 'b' values in case of males were reported by Sunder (1984) and Yousuf *et al*., (2001).

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