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Biometrical relationships between body lengths by several body measurements using regression analysis in freshwater catfish *macrones vittatus* (bloch, 1794) from bhategaon dam (M.S.), India

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ABSTRACT
This study was conducted to estimate relationships between body lengths from several biometrical traits viz. Total length relationship between Standard length, Head length, Interorbital space, Length of the snout, Depth at the origin of dorsal fin and Orbit diameter of *Macrones vittatus* (Bloch, 1794). Samples of 419 individuals (ranging between 86-175 mm) were studied in the present investigation. The linear regression equation and coefficient correlation for Total length and Standard length is 0.785, r=0.99, Total length and Head length is 0.166, r=0.949, Total length and Interorbital space is 0.182, r=0.995, Total length and Length of the snout is 0.083, r=0.938, Total length and Depth at the origin of the dorsal fin is 0.260, r=0.991 and Total length and Orbit diameter is 0.033, r=0.924.

Introduction

The study on the statistical relationship helps in the determination of the degree of association between body measurements and to establish the equations, enabling conversion of one measurement into another. Fish morphometrics have been in the hot-spot of ichthyological studies for many decades, but the initial steps date back to the time of Galileo Galilei (Froese, 2006). Yet, the scientific basis for morphometry in fishes, and especially the mathematical way that weight relates to length, was set by Fulton, in 1906, who for the first time introduced fisheries science into 'allometry' (Froese, 2006).

Size is generally more important than age in fish, mainly because several ecological and physiological factors are more size-dependent than age-dependent (Kalayci *et al*., 2007). Experiments related to animal science are often conducted to develop a model to represent and explain the relationships between variables. Published reports on the relationship between body weight and morphometric measurements of fish are important for the studies on biology, population dynamics and management of species (Ismen, 2002; Mendes *et al*., 2004; Fafioye & Oluajo, 2005). However, less work have been carried out on the statistical relationship between body measurements of *Macrones vittatus* (Bloch, 1794).

Material And Methods

The present investigation was carried out on *Macrones vittatus* (Bloch, 1794) from Bhategaon Dam, District Hingoli, with a view to establish the relationship between various body measurements of the fish and its total length. A series of measurements of 419 individuals ranging between 86 to 175 mm in total length were taken. The statistical analysis of the relationship between 1) Total length and Standard length, 2) Total length and Head length, 3) Total length and Inter-orbital space, 4) Total length and Length of the snout, 5) Total length and Depth at the origin of the dorsal fin and 6) Total length and Orbit diameter have been carried out. All the measurements were taken with the help of engineering dividers with a screw.

The various terms regarding the body measurements are explained as follows:

Total length: From the anterior tip of the longest jaw to the most posterior part of the caudal fin.

Standard length: From the tip of the snout to the origin of the caudal fin, from the anterior tip of the longest jaw to the tip of the hypural bone (urostyle).

Head length: This is the distance between the tip of the snout to the end of gill cover.

Inter-orbital space: The space between the two orbits.

Length of the snout: From the tip of the snout to the anterior margin of the orbit.

Depth at the origin of the dorsal fin: Height of the fish from the origin of the dorsal fin, on a line perpendicular to the long axis of the fish.

Orbit length:
Diameter of right eye was measured.

To express the relationship between two morphometric measurements, the equation for the regression line Y = a + b X was used where, 'a' and 'b' are constants 'X' represents the total length and 'Y' the variable, such as the standard length, head length, orbit diameter, inter-orbital space, length of the snout and depth at the origin of the dorsal fin. The values of the constant 'a' and 'b' were found out from the formulae as given below:

$$A = \frac{\sum Y \times \sum X^2 - \sum X \times \sum XY}{N \times \sum X^2 - (\sum X)^2}$$

and

$$B = \frac{N \times \sum XY - \sum X \times \sum Y}{N \times \sum X^2 - (\sum X)^2}$$

Where, N= Number of length groups.

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Results

The relationship between the total length and the different variables are shown by the following equations.

Total length (X) and Standard length (Y)

Y = -1.031+0.785 X (Table-1 and Figure-1)

r = 0.9988

Total length (X) and Head length (Y)

Y = 0.097+0.16667 X (Table-2 and Figure-1)

r = 0.9499

Total length (X) and Inter-orbital space (Y)

Y = 1.3893+0.1822 X (Table-3 and Figure-1)

r = 0.9951

Total length (X) and Length of the snout (Y)

Y = -1.7601 +0.0835 X (Table-4 and Figure-1)

r = 0.9388

Total length (X) and Depth at the origin of dorsal fin (Y)

Y= -0.1299+0.2606 X (Table-5 and Figure-1)

r = 0.9911

Total length (X) and Orbit diameter (Y)

Y = 0.8318 + 0.0334 X (Table-6 and Figure-1)

r = 0.9240

In *Macrones vittatus* (Bloch, 1794) the average values of female fish for all characteristics were higher than those of male fish. Pearson correlation coefficient between Total length of fish and Standard Length, Head Length, Interorbital Space, Length of Snout, Depth at the origin of dorsal fin and Orbit Diameter were found positive. The highest correlation was determined in Total length and Standard Length of fish i.e. r = 0.9988. However, the lowest correlation were found to be between Total Length and Orbit Diameter of male and female fish i.e. r = 0.9240.

The regression correlation of Total Length and Standard Length, Head Length, Interorbital Space, Length of the Snout, Depth at the origin of dorsal fin and Orbit Diameter were found positive and negative. The positive correlation was determined in Total Length and Head Length, Interorbital Space, Orbit Diameter were as, negative results of correlation were found in Total Length and Standard Length, Length of Snout, Depth at the origin of dorsal fin.

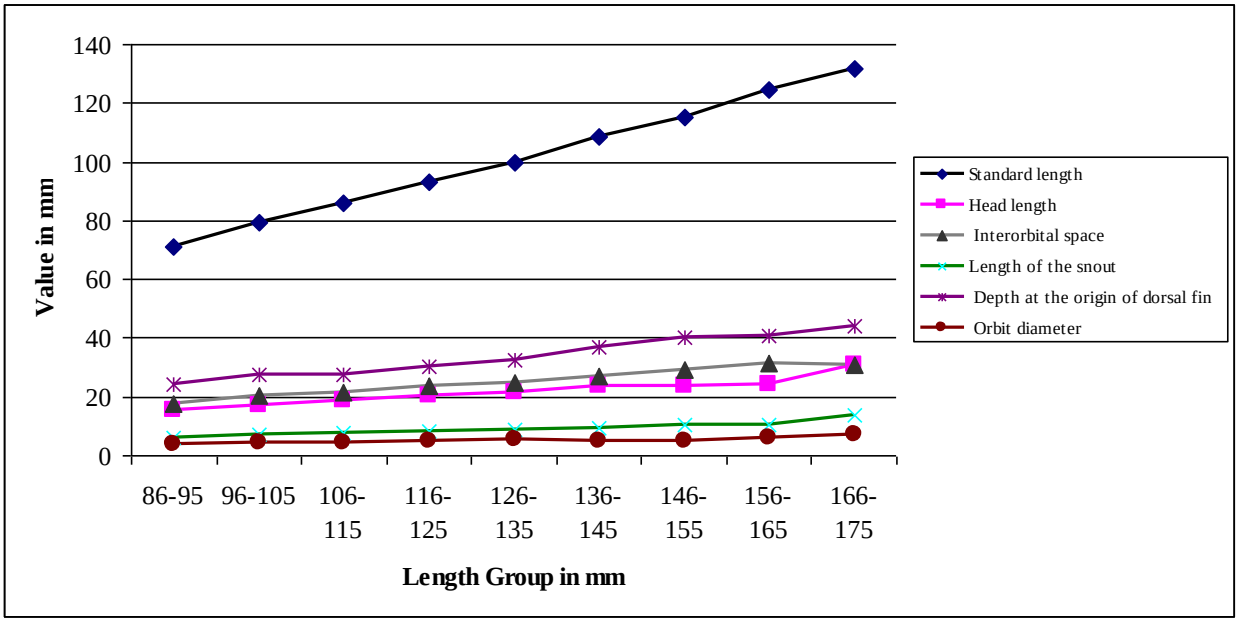

Figure 1: Relationship between Total Length and Standard Length, Head Length, Interorbital Space, Length of Snout, Depth of origin of Dorsal fin, Orbit Diameter

Table 1: Relationship between Total length and Standard length of *Macrones vittatus* (Bloch, 1794)

Length group in mm	Total length in mm X	Standard length in mm Y	X^2	XY	Calculated values of Y
86-95	91.14	71.1428	8306.49	6483.95	70.49
96-105	102.31	79.5961	10467.3300	8143.47	79.253
106-115	110.47	86.1041	12203.62	9511.91	85.66
116-125	120.57	93.1274	14537.12	11228.37	93.583
126-135	129.73	100.03	16829.87	12976.89	100.77
136-145	141.24	108.674	19948.73	15349.11	109.80
146-155	149.72	115.349	22416.07	17270.05	116.46
156-165	160.00	124.54	25600.00	19926.40	124.53
166-175	167	132	27889	22044	130.02
Total	1172.2	910.565	158198.23	122934.15	910.56
Average	130.24	101.174	17577.581	13659.35	101.17

Table 2: Relationship between Total length and Head length in *Macrones vittatus* (Bloch, 1794)

Length group in mm	Total length in mm X	Head length in mm Y	X^2	XY	Calculated values of Y
86-95	91.14	15.4285	8306.49	1406.15	15.288
96-105	102.31	17.33	10467.3300	1773.03	17.15
106-115	110.47	18.9166	12203.62	2089.71	18.51
116-125	120.57	20.3823	14537.12	2457.49	20.193
126-135	129.73	21.2881	16829.87	2761.7	21.72
136-145	141.24	23.6086	19948.73	3334.47	23.64
146-155	149.72	23.8372	22416.07	3568.9	25.052
156-165	160.00	24.46	25600.00	3913.60	26.77
166-175	167	31.00	27889	5177	27.93
Total	1172.2	196.25	158198.23	26482.05	196.25
Average	130.24	21.81	17577.581	2942.45	21.81

Table 3: Relationship between Total length and Interorbital space in *Macrones vittatus* (Bloch, 1794)

Length group in mm	Total Length in mm X	Interorbital space in mm Y	X^2	XY	Calculated values of Y
86-95	91.14	17.8571	8306.49	1627.49	18.004
96-105	102.31	20.25	10467.3300	2071.77	20.039
106-115	110.47	21.421	12203.62	2366.37	21.527
116-125	120.57	23.4257	14537.12	2824.43	23.36
126-135	129.73	24.95	16829.87	3236.76	25.03
136-145	141.24	26.7782	19948.73	3782.15	27.13
146-155	149.72	29.1162	22416.07	4359.27	28.68
156-165	160.00	31.3846	25600.00	5021.53	30.55
166-175	167	31	27889	5177	31.83
Total	1172.2	226.18	158198.23	30466.77	226.15
Average	130.24	25.1313	17577.581	3385.20	25.13

Table No 4: Relationship between Total length and Length of the snout in *Macrones vittatus* (Bloch, 1794)

Length group in mm	Total Length in mm X	Length of the snout in mm Y	X^2	XY	Calculated values of Y
86-95	91.14	6.1428	8306.49	559.85	5.8552
96-105	102.31	7	10467.3300	716.17	6.7883
106-115	110.47	7.6041	12203.62	840.02	7.4703
116-125	120.57	8.2647	14537.12	996.47	8.3142
126-135	129.73	8.8135	16829.87	1143.37	9.0796
136-145	141.24	9.4347	19948.73	1332.55	10.04
146-155	149.72	10.3023	22416.07	1542.46	10.75
156-165	160.00	10.54	25600.00	1686.40	11.61
166-175	167	14	27889	2338	12.19
Total	1172.2	82.10	158198.23	11155.29	82.10
Average	130.24	16.42	17577.581	1239.48	9.12

Table 5: Relationship between Total length and Depth at the origin of fin in *Macrones vittatus* (Bloch, 1794)

Length group in mm	Total Length in mm X	Depth at the origin of dorsal fin in mm Y	X^2	XY	Calculated values of Y
86-95	91.14	24.43	8306.49	2226.55	23.62
96-105	102.31	27.54	10467.3300	2817.61	26.53
106-115	110.47	27.625	12203.62	3051.73	28.66
116-125	120.57	30.19	14537.12	3640.00	31.29
126-135	129.73	32.7627	16829.87	4250.3	33.68
136-145	141.24	36.7826	19948.73	5195.17	36.68
146-155	149.72	40.00	22416.07	5988.8	38.89
156-165	160.00	41.00	25600.00	6560.00	41.57
166-175	167	44	27889	7348	43.39
Total	1172.2	304.32	158198.23	41078.16	304.31
Average	130.24	33.81	17577.581	4564.24	33.81

Table No 6: Relationship between Total length and Orbit diameter in *Macrones vittatus* (Bloch, 1794)

Length group in mm	Total Length in mm X	Orbit diameter in mm Y	X^2	XY	Calculated values of Y
86-95	91.14	3.7142	8306.49	338.5121	3.88
96-105	102.31	4.5	10467.3300	460.395	4.26
106-115	110.47	4.5625	12203.62	504.0193	4.5304
116-125	120.57	5.147	14537.12	620.5737	4.8686
126-135	129.73	5.2711	16829.87	683.8198	5.18
136-145	141.24	5.1739	19948.73	730.76	5.56
146-155	149.72	5.21	22416.07	780.0412	5.84
156-165	160.00	6.1538	25600.00	984.608	6.19
166-175	167	7.00	27889	1169.00	6.42
Total	1172.2	46.7318	158198.23	6271.7307	46.73
Average	130.24	5.19	17577.581	696.86	5.19

Discussion

Findings on eliminating multicollinearity problem were in consistent with those reported by other authors (Riva *et al*., 2004; Keskin *et al.*, 2007a & b; Sangun *et al.*, 2009; Ecevit *et al*., 2010). Ecevit, *et al*., (2010) studied in Brown Trout's positive coefficient correlation in body weight and Total Length, Fork Length, Body Height, Head Length and Adipose fin width. The regression of body weight on Total Length and Head Length in male and Body Height, Adipose fin width and Adipose fin length in female trouts were significant. The present results are comparable with earlier available studies Hossain *et al.,* (2010) recorded positive allometric growth for Standard length-Body weight relationship in *Puntius ticto* .There may be a number of factors which affect the proportion of Standard length, Fork length, and Total length of fishes including growth phase, food availability and quality, size range, health and general fish condition and preservation techniques as well as sampling procedure, namely sample size and length range (Gaygusuz *et al.*, 2006).

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