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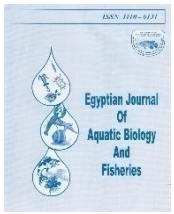

Morphometric Analysis of Different Parameters for *Labeo boga* from Head Panjnad, Alipur, Punjab, Pakistan

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ABSTRACT

This study was designed to analyze the external morphometric characteristics of *Labeoboga* from Head Panjnad, Alipur, Punjab, Pakistan. About 48 specimens were collected and examined to address the growth patterns of the species under study for the first time, together with their morphometric characteristics for the analysis of morphological characters. The analysis of the present results for the length-weight relationship revealed that the value of regression coefficient 'b' was <3.0 according to the cube law, showing a negative allometric growth pattern (b = 2.710). Additionally, a highly significant positive correlation (r > 0.931; $P < 0.05$) was recorded for the correlation value 'r' among weight and length. A linear correlation was observed among 11 morphometric characters vs total length (TL), which revealed a highly significant correlation between total length vs standard length, body weight, fork length, dorsal fin length, body girth, body depth, anal fin length, and pectoral fin length, respectively. While, a moderate correlation was recorded between total length vs head length, eye diameter, and caudal peduncle length. Furthermore, the same trend was observed in the correlation significance between total body weight and other morphometric characters. The current study would be helpful for ichthyologists and zoologists in comparing different morphometric characteristics of *Labeoboga*.

INTRODUCTION

Cyprinidae, native to North America, Africa and Eurasia, is the largest known freshwater fish family, with about 3000 living and extinct species in about 370 genera **(Froese*et al.*, 2016; Eschmeyer*et al.*, 2017)**. Labeoboga commonly called as bogalabeo, has recently been cultured in water tanks and ponds in the North West region of Bangladesh since it is becoming endangered. It is widely distributed in India, Nepal, Bangladesh and Myanmar but recorded mainly in Pakistan. Its maximum length is 200-250 mm, while the unsexed male has a length of 30cm **(Rahman, 2005)**.

This benthopelagic and potamodromous fish species has darkish or bluish dorsal side, silvery ventral side and its operculum is light orange in color. It gives shiny appearance but sometimes shows an odd pattern color **(Riede, 2004)**. These fish individuals live in large river and above tidal influence **(Menon, 1999)** and can also migrate in streams. The favorable environment conditions for them are freshwater, brackish and demersal: depth range 10-100m; tropical 25°N-16°N. They are also bottom dwellers and live in canals, hoar boars, lakes and other closed water bodies **(Bhuiyan, 1964)**. Despite being widely studied, the morphometric characters of this endangered species have not been addressed yet.

Therefore, the current study was organized to analyze the morphometric characters of *Labeoboga* which is an endangered species in Bangladesh. A total of 11 morphometric characters were assessed, including the standard length, total length, fork length, eye diameter, body depth, head length, body girth, length of dorsal fin, length of anal fin, length of tail, and wet weight. In addition, the relationship between these morphometric characters and the total length and wet weight of the species under study was determined, as well as their correlation.

MATERIALS AND METHODS

Fish sampling and study site

48 specimens of *Labeoboga* were examined from Head PanjnadAlipur in summer season from Head Panjnadis located in Punjab, Pakistan. The collected samples were transported to the Fisheries Research Lab, Department of Zoology, Govt. Emerson College Bosan road Multan, Pakistan.

Morphometric Characters

In the present investigation, a total of 11 morphometric characteristics were analyzed in relation to the total length and wet weight. Morphometric parameters includes, e.g., standard length (SL), forked length (FL), total length (TL), head length (HL), body depth (BD), body girth (BG), eye diameter (ED), dorsal fin length (DFL),analfin length (AFL) and pectoral fin length (PtFL) were under consideration.

Total length (TL) is the measurement taken with the lobes aligned along the midline, generally from snout tip to caudal fin with the help of wooden measuring board. This measurement is a straight line without taking the body curvature in to consideration. The standard length (SL) and total length (TL) measurements were taken from snout tip to tail tip and from distal length o side of the mouth tobaese of caudal fin base, respectively. Depth of bodyis the deepest region of the fish body along vertical line. Simply, it is the measurement from highest region in back to the strait and deepest region in the body in vertical surface. Eye diameter is the diameter of eye cup and measured with scale. Dorsal fin length is the largest length measurement of the fin. Pectoral fin length is the fin ray with longest length of pectoral fin. Pelvic fin length was also measured by measuring scale. Anal fin length was another parameter to support this study. It is simply the largest length of anal fin. In fish, caudal peduncle length is referred to the part of body which correspond to the caudal vertebrae after thetail comes the caudal fin. Simply, caudal peduncle length is the part of the

fishbodyfrom the vent posteriorly to, but not including the caudal fin. It is also measured and included in this study.

Length-weight relationship

Total body length of each specimen was measured in centimeters by a measuring scale. The length is measured from snout tip to the tip of extended anal fin to the nearest 21.4 to 27.3cmThe body weight was measured in grams by electric balance for each specimen to the nearest 4.25 to 7.85 g. To determine the growth pattern of fish and whether development is allometric or isometric, the cube law proposed by (**Le Cren, 1951**) was used to measure the pattern of growth of fish as follows:

$$\mathbf{Wt = aL^b}$$

Where W for Body weight, L for length, 'a' as for intercept and 'b' for the slope. The Log transformed equation was as;

$$\mathbf{LogW = log\ a + b\ log\ L}$$

The b value indicates a positive pattern of allometric growth if it was '3.0', fish become more in weight with an increases in the fish size, an isometric pattern of growth if it is 3.0 and a negative allometric pattern of growth,if b<3 **(Bagenal, 1978)**.

The statistical relationships between fish total leength and body weight were analyzed by using a linear transformation (**Zar, 1984).**

Coefficient of correlation

In the current study, correlation coefficient was performed for accessing the relationship. A linear regression analysis at 5% level of significance($p<0.05$). A value of $r \leq 0.50$ indicates weak correlation; if $r \geq 0.60$, then it indicates a moderate correlation, however if r>0.70then it indicates a strong correlation. This indicates a direct relationship among weight and length of the fish, concluding if length of the fish increased, as fish weight accordingly.

Condition factor

For the calculation of condition factor, following formula has been used

$$\mathbf{Condition\ factor = 100 \times \frac{W}{L3}}$$

Where W indicates weight of fish and L indicates length of fish. Fulton's condition factor was determined using the following formula as given by **(Fulton, 1902)**

$$\mathbf{Condition\ factor = 100 \times \frac{W}{L3}}$$

RESULTS

48 samples of *Labeoboga* were collected from Head panjnad Pakistan. The mean value, SD and range of various morphometric characters of external body parts of *Labeoboga*wererevealed in **Table (1)**. The mean value and SD of the total length is

24.49±1.40cm and range value is 21.40-27.30cm. The mean value and standard deviation of wet body weight is 5.65±0.96g and range value is 3.95-7.85g. The Pearson correlation coefficient "r" was also observed among total length and various morphometric characters as in**Table (2)**. The intensity of relationships among total length and various morphometric parameter, a linear regression equation was applied.

$$\mathbf{Y = bX \pm a}$$

Whereas; "Y" for different morphometric parameters and "X" forfishtotal body length. The linear correlation among total length and morphometric parameters of *Labeoboga*wereshown in**Table (2)**, which showed a relationship of total length with various morphometric parameters. A strong correlation (r = 0.974, r =0.973, r=0.931) was observed as TL with SL, FL, and Wet wt., while the moderate correlation was observed among L vs TL, HL vs TL, and ED vs TL. weak and non-negative relationship was observed.

Table 1: Mean values and ranges of different external morphometric parameters of *Labeo boga*(n = 40)

Morphometric parameters	Mean±S.D.	Ranges
Total length (TL)cm	24.49± 1.40	21.40 – 27.30
Wet weight (Wet-W)g	5.65 ± 0.96	3.95 – 7.85
Standard length (SL)cm	19.98 ± 1.23	17.80 – 22.80
Fork length (FL)cm	21.44 ± 1.27	19.00 – 24.60
Eye diameter(ED)cm	0.83 ± 0.06	0.7 - 0.9
Head length (HL)cm	3.71 ± 0.30	3.20 – 4.40
Body girth (BG)cm	12.82 ± 0.85	11.30 – 14.60
Dorsal fin length (DFL)cm	4.60 ± 0.29	4.10 - 5.30
Pectoral fin length(PtFL)cm	3.85 ± 0.30	3.30 – 4.50
Anal fin length (AFL)cm	3.27 ± 0.27	2.80 – 3.90
Caudal peduncle length (CPL)cm	5.95 ± 0.47	4.80 – 7.10
Body depth (BD)cm	6.41 ± 0.42	5.65 – 7.30
Condition Factor(K)	0.04 ± 0.00	0.03 – 0.05

S.D = Standard Deviation

Table 2: Descriptive statistics analysis of total length with different morphometrics parameters for *Labeo boga*

Correlation equations	Parameters		95% CI of 'a'	95% CI of 'b'	R	r^2
	a	b				
Wet wt.=a+bTL	-9.926	0.636	-11.932	0.717	0.931***	0.867
FL=a+bTL	-0.115	0.880	-1.787	0.811	0.973***	0.947
SL=a+bTL	-0.893	0.852	-2.486	0.787	0.974***	0.948
ED=a+bTL	0.154	0.027	-0.080	0.018	0.687***	0.471
HL=a+bTL	0.072	0.148	-1.188	0.097	0.688***	0.474
BG=a+bTL	1.398	0.466	-1.684	0.340	0.772***	0.597
DFL=a+bTL	0.364	0.172	-0.568	0.134	0.830***	0.690
PtFL=a+bTL	-0.389	0.173	-1.410	0.131	0.807***	0.651
AFL=a+bTL	-0.392	0.149	-1.359	0.109	0.779***	0.607
CPL=a+bTL	0.692	0.214	-1.397	0.129	0.637***	0.406
BD=a+bTL	0.699	0.233	-0.842	0.170	0.772***	0.597
K=a+bTL	0.049	0.0004	0.036	-0.0009	0.266^{ns}	0.071

Abbreviations of different morphometricsas in Table (1); Cl: confidence intervals; r: correlation coefficient; r^2: coefficient of determination, a: intercept; b: regression coefficient; ***: $p < 0.001$; ns: $p>0.05$

Relationship between log total length and log external morphometric parameters:

The cube law for observing growth pattern between log total length and log of all external morphometric parameters is shown in **(Table 3)**. Only negative allometric pattern of growth was presentasthe regression coefficient observed was b<3.0. However, a strong positive correlation was observed among log wet weight withTL, log SL, log dorsal fin length, log length of pectoral. Moreover, a moderate positive correlation was observed among log total length and log ED, log HL, log anal fin length, log BG, log CPL and log body depth. While a weak positive correlation among condition factor and total length was observed.

Relationship between wet body weight and externalmorphometric parameters

The linear regression relationship of weight of the body with different morphometric characters of *Labeo boga* is shown in**Table(4)**, which showed the correlation of weight of the body (W) with different morphometric characters. A weakcorrelation was observed between condition factor and wet body weight. However, a moderate correlation among wet bodyweight and eye diameter. While a strong correlation among wet body weight of and TL, SL, FL, HL, BG, pectoral finlength,dorsalfinlength,anal fin length and body depth. This indicates with the increase in the weight of the body, all morphometric characters increase accordingly

Relationship between log wet body weight of the body and different morphometric parameters

the cube law for observing growth pattern between log weight of the body and log of all external morphometric parameters was shown in**Table(5)**, and only negative allometric pattern of growth was observed asthevalue of regression coefficient b>0.0. However, a strong positive correlation was observed between log wet of the body and log TL,log FL, log SL, log BG, logdorsalfinlength,logpectoralfinlength,loganal fin length and log body depth. Moreover, a moderate positive correlation was observed between log eye diameter and log head length. While a weak positive correlation was observed between condition factor and wet weight of the body.

Table 3: Log external morphometric characters with log TL regression coefficients (cube law) for *Labeo boga*

Correlation equations	Parameters		95% CI of 'a'	95% CI of 'b'	r	r^2
	a	b				
Log Wet-wt.=a+b LogTL	-3.017	2.710	-3.493	2.367	0.933***	0.870
Log SL=a+bLogTL	-0.138	1.036	-0.250	0.955	0.973***	0.946
Log FL=a+bLogTL	-0.056	0.999	-0.164	0.921	0.973***	0.946
Log ED=a+bLogTL	-1.212	0.814	-1.608	0.529	0.684***	0.468
Log HL=a+bLogTL	-0.780	0.971	-1.243	0.638	0.691***	0.478
Log BG=a+bLogTL	-0.127	0.889	-0.455	0.653	0.777***	0.604
Log DFL=a+bLogTL	-0.608	0.914	-0.893	0.709	0.825***	0.680
Log PtFL=a+bLogTL	-0.967	1.117	-1.334	0.852	0.811***	0.857
Log AFL=a+bLogTL	-1.023	1.106	-1.423	0.818	0.783***	0.614
Log CPL=a+bLogTL	-0.442	0.875	-0.941	0.516	0.624***	0.390
Log BD=a+bLogTL	-0.428	0.889	-0.756	0.653	0.777***	0.604
Log K=a+bLo TL	-1.017	-0.289	-1.493	-0.632	0.266^{ns}	0.071

Table 4: Descrptive statistics of body weight with different morphometrics parameters for *Labeo boga*

Correlation equations	Parameters		95% CI of 'a'	95% CI of 'b'	r	r^2
	a	b				
TL = a + b W	16.787	1.363	15.783	1.188	0.931***	0.867
SL = a + b W	13.005	1.233	12.357	1.120	0.963***	0.927
FL = a + b W	14.259	1.270	13.561	1.149	0.959***	0.921
ED = a + b W	0.600	0.040	0.520	0.026	0.692***	0.478
HL = a + b W	2.393	0.233	1.992	0.163	0.738***	0.545
BG = a + b W	8.604	0.745	7.713	0.589	0.843***	0.712
DFL = a + b W	3.221	0.243	2.877	0.183	0.799***	0.639
PtFL = a + b W	2.464	0.245	2.095	0.180	0.781***	0.610
AFL = a + b W	1.994	0.225	1.679	0.170	0.802***	0.644
CPL = a + b W	4.204	0.308	3.481	0.182	0.626***	0.391
BD = a + b W	4.302	0.372	3.856	0.294	0.843***	0.712
K = a + b W	0.036	2.357	0.032	-0.0005	0.094^{ns}	0.008

Table 5: Descrptive statistics and regression parameters of log body weight (W, g) with different morphometrics for *Labeo boga*

Correlation equations	Parameters		95% CI of 'a'	95% CI of 'b'	r	r^2
	a	b				
LogTL =a+bLog Wet-wt.	1.148	0.321	1.118	0.280	0.933***	0.870
LogSL =a+bLog Wet-wt.	1.036	0.353	1.011	0.320	0.963***	0.928
LogFL =a+bLog Wet-wt.	1.077	0.339	1.052	0.306	0.959***	0.920
LogK =a+bLog Wet-wt.	-1.445	0.036	-1.537	-0.085	0.097^{ns}	0.009
LogHL=a+bLog Wet-wt.	0.300	0.359	0.220	0.253	0.743***	0.552
LogBG=a+ bLog Wet-wt.	0.855	0.336	0.805	0.269	0.854***	0.731
LogDFL=a+bLog Wet-wt.	0.434	0.303	0.378	0.228	0.796***	0.634
LogPtFL=a+bLog Wet-wt.	0.299	0.381	0.230	0.288	0.803***	0.645
LogAFL=a+bLog Wet-wt.	0.220	0.391	0.149	0.297	0.806***	0.649
LogCPL=a+bLog Wet-wt.	0.554	0.292	0.460	0.166	0.606***	0.367
LogBD=a+b Log Wet-wt.	0.554	0.336	0.504	0.269	0.854***	0.731
LogED=a+bLog Wet-wt.	-0.294	0.285	-0.367	0.188	0.696***	0.485

DISCUSSION

With the increase in fish body length, morphometric parameters revealed a proportionally positive increase. A highly positive relation was observed in case of different morphometric parameters with the length.For*Labeoboga*, a strong correlation (r = 0.974, r =0.973, r=0.931) was observed among total length vs standard length, total length vs fin length, and total length vs weight, while the moderate correlation was observed between caudal peduncle length with total length, head length, and eye diameter. However, no weak and non-negative relationship was observed. Thispositive correlation is in accordance with the other studies reported in literature (**Naeem*et al*., 2011; Ujjania*et al*., 2012; Pervaiz*et al*., 2012; Masood*et al*., 2022**).

The estimation of "b" value from the weight length relation was found to be within the usual ranges from 2.5 to 3.5, which is consistent with the findings of **Carlander (1969);**

Froese (2006); Azam & Naeem (2021). Understanding of the growth pattern of fish is accomplished by analysis of the regression coefficient among the fish total length and body weight. In present study, the 'b' value was 2.71 exhibit negative allometricpattern for growth. It is important to noted difference in the "b" value as influenced by a different variables, including age, location, biological parameters, pH, DO, and time (**Bagenal, 1978;Muchlisin*et al*., 2010**), as well as the availability of food (**Ishtiaq&Naeem, 2016**).According to **Hile&Jobes(1941**)and **Le Cren(1951**), the variability in 'b' value in similar or different specie is related to the feeding habit and sex.

In future, Ichthyologists might compare the morphometric relationships of *Labeoboga* using the findings of the current study, and compare the results of current study with the morphometric parameters of *Labeoboga* inhabiting at different locations.

CONCLUSION

In the present study, 48 samples of *Labeo boga* were examine with some morphometrics characters. Condition factor showed a weak positive correlation for both total length(r=0.266) and weight of the fish (r=0.094). A high positive correlation was observed in case of different morphometric parameters with body total length. Consequently, fish breeders may use the current data to improve the *Labeoboga* species, and ichthyologists can use the result of this study to compare the morphometric relationships of *Labeoboga*inhabiting at different locations worldwide.

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