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Morphometric characters and length-weight relationship of Bele, (*Glossogobius giuris*) from Mithamoin haor, Kissorgonj, Bangladesh

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Abstract

Different morphometric characters such as total length (TL), standard length (SL), head length (HL), eye diameter (ED), body depth (BD), pre-orbital length (POL) were measured on *Glossogobius giuris* collected from Mithamoin haor showed that percentage growth value of SL, BD, HL, ED and POL were higher in female. A linear relationship was found between total length and morphometric characters and these also showed significant positive correlation ($p<0.001$) between dependent and independent variables. The length-weight relationships of *G. giuris* were calculated for males, females. The relationship was analyzed using the formula $W=aL^b$ after transform into straight-line equitation. The equation obtained for male was; Log W = 2.757 Log TL – 1.757; for female; Log W = 2.843 Log TL – 1.868. The regression coefficients (b) between males and females did not show any significant difference ($p>0.05$) while b value significantly deviated from the expected cube value of 3 in case of male only thus indicating negative allometry. However, relative condition factor (Kn) of *G. giuris* computed for female was 1.009 ± 0.124 and for male was 1.016 ± 0.199, which suggest the specimen were healthy and in good condition. All this variation between male and female may be due to spawning cycle or other physiological activities or environmental factors.

Keywords: Morphometric characters, Length-weight relationship, Condition factor, Glossogobius giuris

Introduction

Bangladesh is now occupied 6th position among top ten aquaculture producing countries of the world (FAO, 2010). Carps, tilapia and pangus are being now extensively used as commercially important aquaculture species in the country. However, these species are now genetically eroded due to inbreeding, introgressive hybridization as well as poor brood stock management. Besides this there are many indigenous species which have high commercial values are left untouched and farmers also are now searching new potential aquaculture species. In this circumstances *G. guiris* may play role for enhancement of fish production as well as upliftment of socioeconomic condition in the country. The freshwater gobi, *G. giuris* is tastier and nutritive, has potential fishery in southern and northeastern region of Bangladesh. *G. giuris* is also very important food fish, especially to the low-middle class and poor people, because of being comparatively cheaper but sometimes very expensive to them (Islam, 2004). Therefore, it could be included in the aquaculture programme along with carps, pangus, tilapia etc. Studies on morphometric measurements and statistical relationships of fishes are imperative for both fishery biology (Sparre *et al* 1989; Mustafa & Brooks 2008) and taxonomy studies (Tandon *et al* 1993; Simon *et al* 2010a). Length-weight relationship is an important tool in fish biology, physiology, ecology, fisheries assessment and fish conservation. These studies are used as a tool for fish conservation in several parts of the world providing information on the condition, growth pattern, ontogenic changes and in fish population dynamics (Oscoz *et al* 2005; Simon *et al* 2009). Length-weight relationship is also useful for the conversion of growth-in-length equations to growth-in-weight for use in stock assessment models and to estimate stock biomass from limited sample sizes (Binohlan and Pauly 1998; Koutrakis and Tsikliras 2003; Valle *et al* 2003; Ecoutin *et al* 2005; Özaydin and Taskavak 2007; Simon and Mazlan 2008; Simon *et al* 2009; Ndome *et al.* 2012).

Fish are said to be isometric growth when length when length increases in equal proportions with body weight for constant specific gravity. The regression co-efficient for isometric growth is ‘3’ and values greater or lesser than ‘3’ indicate allometric growth. Le Cren (1951) proposed relative condition factor (Kn) in preference to ‘K’ as the former considers all the variations like those associated with food and feeding, sexual maturity etc., while the latter does so only if the exponent value is equal to 3. Thus ‘k’ factor measures the variations from an ideal fish, which holds the cube law while ‘Kn’ measures the individual deviations from the expected weight derived from the length-weight relationship.

However, very limited information is available so far on the length-weight relationship and condition factor of *G. giuris* and therefore, the present study was undertaken to establish the pattern of growth and general condition of this fish species from the natural waters for direct use in fishery assessment. This work would also contribute to the existing knowledge by acting as a baseline data for carrying out research especially on taxonomy, racial study, morphology and genetic diversity of other fish species in Bangladesh.

Material and Methods

A total of 87 specimens of *G. girius* (Male 40, female 47) were collected from Baila chor of Kissorgonj district from March to July, 2012. The specimens mopped on filter paper to remove water from their body surfaces and were classified according to sex. Total length (TL), standard length (SL), head length (HL), eye diameter (ED), body depth (BD), pre-orbital length (POL) of the fish were measured to the nearest cm using measuring board and scale. The fishes were weighed on electric balance (ZSA 120, Scientech, USA) having 0.0001 g precision. The morphometric characters SL, BD, HL etc are expressed as percent to total length of the fish as done by Carlender and Smith (1954) and Hile (1948). Regression of various body parts against TL of the fish were drawn by least square method.

The data so generated were subjected to statistical analysis by fitting length-weight relationship following Le Cren (1951). Length - weight relationship can be expressed as $W = aL^b$, the logarithmic transformation of which gives the linear equation

$LogW = loga + b\ logL$

Where W = Weight in gram, L= length in cm, a = a constant being the initial growth index, and b = growth coefficient.

Constant 'a' represents the point at which the regression line intercepts the y-axis and 'b' the slope of the regression line. The relationship between length and weight was determined for males and females separately by transforming the values of both variables to logarithamatic values and fitting a straight line by the method of least squares. The significance of regression was tested by ANOVA. The regression coefficients for male and female were compared using Students ‘t’ test (Zar, 1974) to establish the variations in the 'b' values, if any, between them. Bailey's t-test (Snedecor and Cochran, 1967) was employed to find out whether 'b' value significantly deviated from the expected cube value of 3 [t = (b-3)/Sb], where b = regression coefficient and Sb = Standard error of 'b'. The t-test (Snedecor and Cochran, 1697) on 'r' values reveals whether significant correlation exists between length and weight. Relative condition factor (Kn) as per Le Cren (1951) is expressed as follows:

$Kn = W / W'$
Where W = observed weight,
W'= calculated weight derived from length weight relationship.

Results and Discussion

A total of 87 specimens ranging from 10.2-25.1 cm TL (total length) and 8.16-119.84 g body weight (BW) were used for the studies of morphometric characteristics. The main morphometric data are presented in Table 1. Body of *G. giuris* is elongated, anteriorly cylindrical, posteriorly compressed. Head pointed depressed, lower jaw longer; Maxilla extends to below anterior part of eye. Lips thick, teeth villiform in jaws, outer and inner rows enlarged caninoid in front in both jaws. Toungue bilobate. Similar nature of phenomenon also observed by Islam (2004).

The SL of male and female fish was 79.34 % and 79.88 % of the total length, respectively. The HL, ED, BD and POL were found to be 24.70, 15.55, 3.28 and 8.55% of the total length of the male fish, respectively. For female fish the HL, ED, BD and POL also found to be 24.98, 15.92, 3.63 and 8.74% of the total length, respectively (Table 1). In both cases TL shows a linear relationship with various morphometric characters (Fig.1). All the measurements are positively correlated with TL. These results show consistency with the findings of Khumar and Siddiqui (1991) and Tiwari and Qureshi (2003).

Table 1. Morphometric measurements of the *G. giuris* specimens (n= 87) collected from haor region of Kissorgonj, Bangladesh

Measurement	Male Fish						Female Fish					
	TL	SL	HL	BD	ED	POL	TL	SL	HL	BD	ED	POL
Average	16.80	13.33	4.15	2.61	0.55	1.44	17.58	14.05	4.39	2.80	0.64	1.54
STDV	3.97	2.96	1.01	0.75	0.18	0.34	2.81	2.27	0.74	0.60	0.19	0.34
Max	25.1	19.2	6.2	4.1	1.3	2.2	22.9	18	5.8	4.9	1.3	2.5
Min	10.2	8.5	2.2	13	0.3	0.9	11.7	9.2	2.9	1.6	0.3	1
% TL		**79.34**	**24.70**	**15.55**	**3.28**	**8.55**		**79.88**	**24.98**	**15.92**	**3.63**	**8.74**

Different morphometric characters of male and female indicated that percentage growth value of SL, BD, HL, ED and POL were slightly higher in female. Thus it may infer that female shows slightly faster linear growth of the above mentioned body parts than the male of *G. giuris*. The values of growth percentage of different morphometric characters with total length showed heterogeneity though they were statistically not significant. This heterogeneity of morphometric characters may be due to difference in physiological activities in the male and female fish. These results are consistent with the results found in *Puntius sarana* by Kumar and Siddiqui (1991).

Table 2. Analysis of regression of body measurement of *G. giuris*

Body parts	Residuals			Variations due to deviation from individuals regression		Calculated "F"
	DF	SS	MS	DF	MS	
SL	87	30.410	0.350	1	983.374	2813.314
HL	87	173.063	1.989	1	840.721	422.636
BD	87	433.522	4.983	1	580.262	116.448
ED	87	846.205	9.726	1	167.579	17.229
POL	87	375.415	4.315	1	638.370	147.938

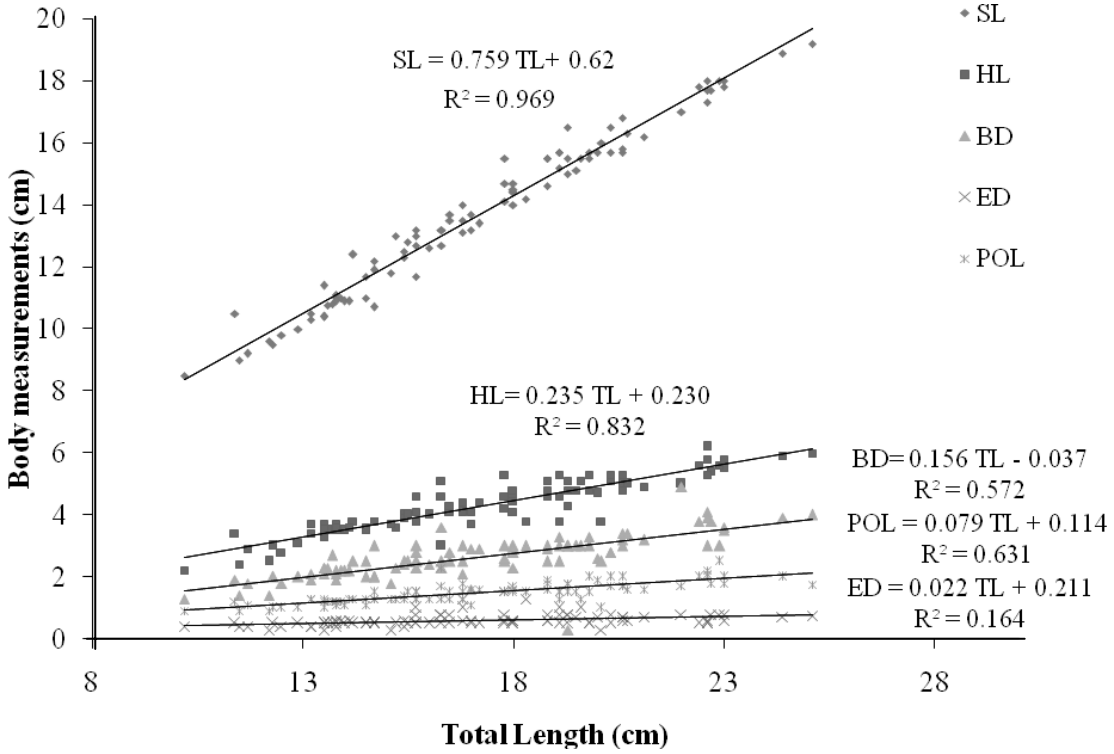


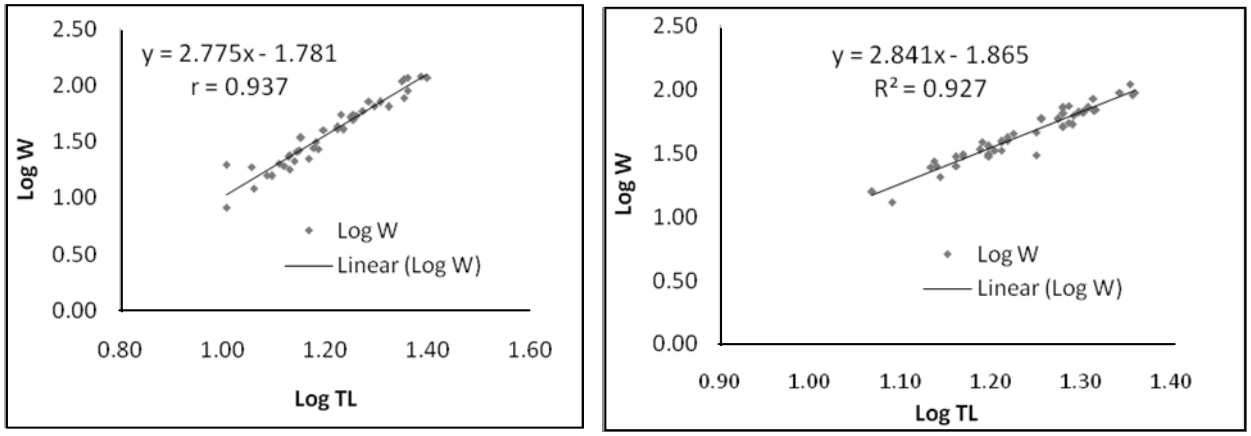
Fig. 1. Relative growth of body measurements on TL (pool) of *G. giuris*

All the morphometric characters examined exhibit a significant positive correlation ($p<0.01$) between dependent and independent variables, but the level of significance vary with features indicate that different organs grow differently. Among them the total length and standard length ($r= 0.98$); total length and head length ($r= 0.91$) show significant relationship. Thus the increase of total length synchronized with different degree of the increase to the various factors.

The minimum relationship between total length and different parameters (Body depth, pre orbital length and orbital length) might be due to the least changes in the growth of parameters over the fish size. The minimum relationship between total length and pre orbital length or orbital length might be due to the least growth changes in the eye, over the fish size. In all teleost fishes, the eyes continue to grow throughout the life without any obvious changes in visual capability (Fernald, 1985).

Analysis depicted a strong homogeneity of regression on different body parts on total length between male and female fish and it was found insignificant (Table 1 and 2). This indicates that there was no difference statistically in growth rates of different morphometric characters.

The ratio of standard length to total length, head length to total length, eye diameter to head length, head length to standard length, body depth to total length, body depth to standard length and pre-orbital length to head length were measured. We found standard length 1.26 ± 0.04 in total, head 3.23 ± 0.3 in standard length, 4.05 ± 0.37 in total length. Body depth 5.20 ± .075 in standard and 6.52 ± 0.90 in total length. Eyes 7.25 ± 1.6 in head. These results are consistent with the result of Hoese, (1986).



A B

Fig. 2. Logarithmic relationship between total length and body weight of (A) male and (B) Female, *G. giuris*

The length-weight relationship of males and females were not significantly different. The regression equation is expressed as –

Log W (male) = 2.775 Log TL – 1.7581

Log W (Female) = 2.841 Log TL – 1.865

The 95% confidence limits of 'b' values were:

Male: 2.540 to 3.01

Female: 2.601 to 3.081

The correlation coefficient 'r' between log length and log weight was found to be 0.968 in males, 0.963 in females. The't' test on 'r' values showed the existence of good relationship between length and weight ($p< 0.01$). The results of ANOVA on the length-weight regressions were found to be highly significant ($p< 0.01$) in both the sexes based on the coefficient of determination (r^2) (Croxton, 1953). Pair-wise comparison between males and females were carried out using Students 't' test and revealed that no significant difference between 'b' values of males and females ($t= 0.385$; $p> 0.05$).

The results of Bailey's 't' test revealed significant departure of 'b' value from the hypothetical value of '3' in males. While no significant difference could be noticed in females. The't' test arrived at, 2.1 in males manifested the significant departure of 'b' value from 3 ($p< 0.05$). In females'' value was 1.3 which was non-significant. In the present study the exponential value (b) in the length-weight equation was found to be 2.775 and 2.841 for male and female, respectively, shows slight variation and indicate negative allometric growth, based on Begenal and Tesch (1978) criteria of 3. Allen (1938) suggested that the value of 'n' in an ideal fish is 3, that is, it should agree with the cube law' ($W = aL^3$). But according to Hile (1936) and Martin (1949) the value of 'b' generally ranges between 2.4 and 4.0. Tesch (1968) reported that value of (b) might be in between 2.0 and 4.0. On the other hand, various studies conducted by Beverton and Holt (1957), and Cinco (1982) have suggested that the value of 'b' is usually almost 3. However, a variation in (b) value may occur due to species variation, difference in environmental factors, sex variation etc (Joadder, 2009).

The slope value of regression line less than '3' has been reported in *Tor tor* (Malhotra, 1982), *Labeo dero* (Malhotra & Chauhan, 1984), *Hilsa ilisha* (Quddus *et al*., 1984 and Mia, 1984), Labeo *dyocheilus* (Malhotra, 1985) and *Cyprinus carpio communis* (Sunil, 2000), Gudusia chapra (Narejo *et al*., 2000) and *Glossogobius giuris* of Atrai River (Joadder, 2009). These reports collaborate with the present findings on the length-weight relationship in *G. giuris*, in which significant departure of 'b' value from the isometric value of 3 was noticed in respects of sexes.

Le Cren (1951) reported that females are heavier than males of the same length probably because of difference in fatness and gonadal development. While discussing the seasonal effect on length-weight relationship of *Clarias batrachus*. Mitra and Naser (1987) found that higher metabolic activity with spawning season lowered the 'b' value while less metabolic activities, accumulation of fat, weight of gonad etc, during the prespawing period increased the values. The higher regression coefficient in female *G. giuris* may be attributed to the higher fat accumulation, less metabolic activity and higher gonadal weight when compared to its male counterpart.

Fluctuations in the condition factor of many fishes were observed in relation to their reproductive cycle (Neelakantan and Pai, 1985; Narejo *et al*, 2002), feeding rhythm or physic-chemical factors of environment, age, physiological state of fish or some other unknown factors (Kurup and Samuel, 1987; Kurup, 1990; Kalita and Jayabalabn, 1997). Since weight of fish is a function between length and growth, the value of 'kn' varies with respect to sex, maturity, developmental changes, gear selectivity, season and even time of day (Le Cren 1951).

Table 3. Mean relative condition factor (Kn) for different size groups of *G. giuris* from Mithamoin haor of Kissorgonj, Bangladesh

Size group (cm)	Male					Female			
	No. fish	Observed weight (g)	Calculated weight (g)	K_n		No. fish	Observed weight (g)	Calculated weight (g)	K_n
10-12	4	12.92	12.54	1.193		1	15.68	14.75	1.063
12-14	9	20.68	21.73	0.931		5	22.19	22.08	0.994
14-16	7	30.32	30.32	0.988		10	31.79	31.49	1.013
16-18	7	47.72	45.88	1.045		9	41.43	42.18	0.986
18-20	4	61.06	59.25	1.059		12	62.08	60.31	1.033
20-22	2	71.68	74.49	0.912		7	74.62	74.79	0.996
22-24	5	101.11	96.02	1.054		3	97.77	97.34	1.005
24-26	2	118.74	121.70	0.977					
Average (±SD) Kn males = 1.0165 ± 0.199; Average (±SD) Kn Females = 1.009 ± 0.124									

The relative condition factor (Kn) for all fish samples was determined individually and presented as 2 cm interval of total size group (Table 3). The values of Kn shows fluctuation in all size groups of both for males and females, however, when t-test applied on data of Kn for males and females was found that the values are statistically non-significant ($p>0.005$). In the present study sex-wise analysis of 'Kn' values revealed that the mean 'Kn' value in females (1.0090) was to some extent lower than that of males (1.0165). These results coincide with the results of Joadder (2009), observed in *G. giuris* from Atria River, Bangladesh.

According to Le Cren (1951), 'Kn' greater than 1 indicated good general condition of fish. Pandey and Sharma (1997) studied the condition of four exotic carps and only the common carp, *Cyprinus carpio communis* was found to have value above 1 (1.0109). Pandy and Sharma, (1998) reported high 'Kn' values for *Labeo rohita* (1.0129) and *C. catla* (1.0007) and low values for *Cirrhinus mrigala* (0.9967). Studies on relative condition factor (Kn) of *Schizopyge esocinus* revealed that the fluctuations in 'Kn' values can be attributed to spawning cycle as well as feeding intensity (Dar *et al*., 2012)

It can be concluded that in *G. giuris* females gain weight at faster rate in relation to its length when compared to males. Females of *G. giuris* followed isometric pattern of growth whereas, males showed negative allometry. The study also revealed that in *G. giuris*, though the condition of fish is more related to gonadosomatic index, there exists some relationship between relative condition factor and gastrosomatic index and other environmental and physiological factors

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