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Length-Weight and Morphometric Relationships of the Tank Goby *Glossogobius giuris* (Hamilton, 1822) (Perciformes: Gobiidae) in the Ganges of Northwestern Bangladesh

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Abstract

The present study describes the length-weight (LWR) and morphometric relationships of the tank goby *Glossogobius giuris* (Hamilton, 1822) (Perciformes: Gobiidae), an important small indigenous fish species in the Ganges, northwestern Bangladesh. A total of 266 specimens, 11.30-23.60 cm in total length (TL), were caught using traditional fishing gear from March 2006 to February 2007. The allometric coefficient *b* of the LWR for the combined sexes was close to the isometric value (*b* = 3.068 for TL and *b* = 3.089 for SL, standard length), but with a slight negative allometric growth for males (b = 2.954 for TL, b = 2.953 for SL) and a slight positive allometric growth for females (b = 3.293 for TL, b = 3.166 for SL). The results further indicated that morphometric relationships were highly correlated ($r^2 > 0.712$; $P < 0.001$). To the best of our knowledge, this study presented the first reference on LWR and morphometric relationships for *G. giuris* from Bangladeshi waters. These results will be useful for fishery managers to impose adequate

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regulations for sustainable *G. giuris* fishery management not only in the Ganges of Bangladesh but also in neighbouring countries.

Introduction

The tank goby *Glossogobius giuris* (Hamilton, 1822), a member of the Gobiidae (Perciformes), lives in sea-, brackish- and fresh waters. It is widely distributed in coastal and estuarine waters along the coasts of East Africa, the Red Sea and the Indian subcontinent to China. It is common in inland freshwater bodies in several Asian countries, where it occurs in streams, canals, ditches and ponds with rock, gravel or sand bottoms, feeding on small insects, crustaceans and small fishes (Froese and Pauly 2008). As *G. giuris* is one of the dominant fish species in the Ganges (northwestern Bangladesh), it is an important target species for small-scale fishermen, who use a variety of traditional fishing gears (Craig et al. 2004; Kibria and Ahmed 2005).

Length-weight relationships (LWRs) are useful in fishery management for both applied and basic uses (Pitcher and Hart 1982) to convert length distributions into weights for biomass estimates (Gerritsen and McGrath 2007). The LWRs are needed to estimate weights from lengths because direct weight measurements can be time consuming in the field (Koutrakis and Tsikliras 2003), and its parameters are important in fish biology and can give information on stocks or organism condition at the corporal level (Gonzalez Acosta et al. 2004; Ecoutin et al. 2005). The morphometric (length-length) relationships are also important in fisheries management for comparative growth studies (Moutopoulos and Stergiou 2002). The LWRs are still scarce for most sub-tropical fish species (Hossain et al. 2006a; 2006b).

To the best of our knowledge, there is no previous information on LWRs and morphometric relationships of this species from the Ganges (Craig et al. 2004). Subsequently, the aim of the present paper was to carry out the first complete and comprehensive description of the LWR and morphometric relationships of *G. giuris* from the Ganges, Bangladesh.

Materials and Methods

The present study was conducted in the lower part of the Ganges, northwestern Bangladesh. The Ganges (known as Padma River in Bangladesh) enters Bangladesh from India through the Rajshahi district (Latitude 24° 22' N; Longitude 88° 35' E). A number of commercially important fish species including *G. giuris* are fished by small scale fishermen throughout the year.

The samples for *G. giuris* were collected during daytime on a seasonal basis from the fisherman catch landed at the Rajshahi city, Rajshahi, Bangladesh from March 2006 to February 2007. The fishes were caught by means of the traditional fishing gears *jhaki jal* (cast net), and *dughair* (conical trap) (Kibria and Ahmed 2005). The fresh fish samples were immediately placed in ice, and were fixed in 2% formaldehyde solution upon arrival in the laboratory. The fixed specimens were taken out one by one later to be weighed, measured and sexed. For each individual, total length (TL) standard length (SL), head length (HL), snout length (SnL), body depth (BD), caudal length (CL), caudal peduncle depth (CPD), predorsal length (PrDL), post-dorsal length (PoDL), anus length (AnL), and anal length (AL) were measured to the nearest 0.01 cm using digital slide calipers, and whole body weight (BW) was taken on an electric balance with 0.01 g accuracy.

The weight-length relationship was calculated using the expression:

$$W = aL^b$$

where, W is the body weight (g), L the total length (cm) or the standard length (cm), a the intercept of the regression and b is the regression coefficient (slope).

Parameters a and b of the weight-length relationship were estimated by linear regression analysis based on natural logarithms: $\ln(W) = \ln(a) + b \ln(L)$. Additionally, 95% confidence limits of the parameters a and b and the statistical significance level of r^2 were estimated. The determination coefficient (r^2) was used as an indicator of the quality of the linear regressions (Scherrer 1984). In order to confirm whether b values obtained in the linear regressions were significantly different from the isometric value of ±95% ($\alpha = 0.05$) was applied, expressed by the equation according to Sokal and Rohlf (1987):

$$t_s = (b\text{-}3) / s_b$$

where t_s is the t-test value, *b* the slope and s_b the standard error of the slope (*b*).

The comparison between obtained values of t-test and the respective tabled critical values allowed for the determination of the b values are statistically significant, and their inclusion in the isometric range (*b*=3) or allometric range (negative allometric; b<3 or positive allometric; b>3). Further, the morphometric relationships were made through linear regressions.

Results and discussion

A total of 266 specimens of *G. giuris* were collected during the present study. The absence of small sized fishes (< 8.00 cm SL) was associated with the selectivity of the fishing gear rather than indicating the absence of small sized individuals in the study area.

The sample size (*n*), length range, parameters *a* and *b* of the LWR, 95% confidence intervals of *a* and *b*, the determination coefficient (r^2), t_s and growth type of *G. giuris* are given in table 1. The LWRs indicated negative allometric growth in males, but positive allometric growth in females. The calculated allometric coefficient *b* value are 2.954 for TL and 2.953 for SL in males, and 3.298 for TL and 3.166 for SL in females (Fig. 1). Overall, the *b* value of LWRs for *G. giuris* was close to 3 (b= 3.068 for TL and 3.089 for SL) indicating the isometric growth. Analysis of covariance revealed significant differences between sexes for the slopes (*b*) of the regression lines (P<0.001). All the relationships were highly significant (P<0.001), with r^2 values being greater than 0.945. The sketch drawing of a tank goby *G. giuris* is shown in figure 2, where the dimensions are identified. All morphometric relationships presented in table 2 were highly significant (P< 0.001), with all coefficient of determination values being >0.712, except one (r^2 = 0.332) for SL vs BD.

All allometric coefficients (*b*) estimated in this study were within the expected range of 2.5-3.5, but they can vary between 2 and 4 (Bagenal and Tesch 1978). In general and despite the many variations in fish forms between species, *b* is close to 3, indicating that fish grow isometrically; values significantly different from 3.0 indicate allometric growth (Tesch 1971). The LWR with *b* values significantly different from 3.0 were often associated with narrow size ranges of the specimens examined; such LWR

Table 1. Descriptive statistics and estimated parameters of the length-weight relationships for tank goby *Glossogobius giuris* in the Ganges of the northwestern Bangladesh.

Sex / n	Length (cm)				Weight (g)			Regression parameters		95% Cl of *a*	95% Cl of *b*	r^2	t_s	Growth type
	Type	Min	Max	Mean ± SD	Min	Max	Mean ± SD	*a*	*b*					
M / 124	TL	11.30	23.60	17.96 ± 3.01	11.10	96.50	44.28 ± 21.03	0.008	2.954	0.003 - 0.013	2.774 - 3.283	0.957	-0.399	A -
	SL	8.70	17.50	13.61 ± 2.22	11.10	96.50	44.28 ± 21.03	0.014	2.953	0.007 - 0.023	2.854 - 3.325	0.961	-0.405	A -
F / 142	TL	14.70	22.80	17.63 ± 2.02	25.10	98.20	44.89 ± 18.20	0.003	3.298	0.002 - 0.006	3.102 - 3.525	0.965	2.924	A +
	SL	11.20	17.20	13.47 ± 1.62	25.10	98.20	44.89 ± 18.20	0.011	3.166	0.006 - 0.019	2.981 - 3.396	0.962	1.636	A +
C / 266	TL	11.30	23.60	17.79 ± 2.49	11.10	98.20	44.62 ± 19.35	0.006	3.068	0.003 - 0.009	2.916 - 3.286	0.945	0.041	I
	SL	8.70	17.50	13.53 ± 1.89	11.10	98.20	44.62 ± 19.35	0.013	3.089	0.008 - 0.019	2.955 - 3.262	0.954	0.071	I

M, male; F, female; C, combined; n, sample size; Min, minimum; Max, maximum; SD, standard deviation; *a*, intercept; *b*, slope ; Cl, confidence intervals; r^2, coefficient of determination; t_s , t-test value; A +, positive allometric growth; A -, negative allometric growth; I, isometric growth.

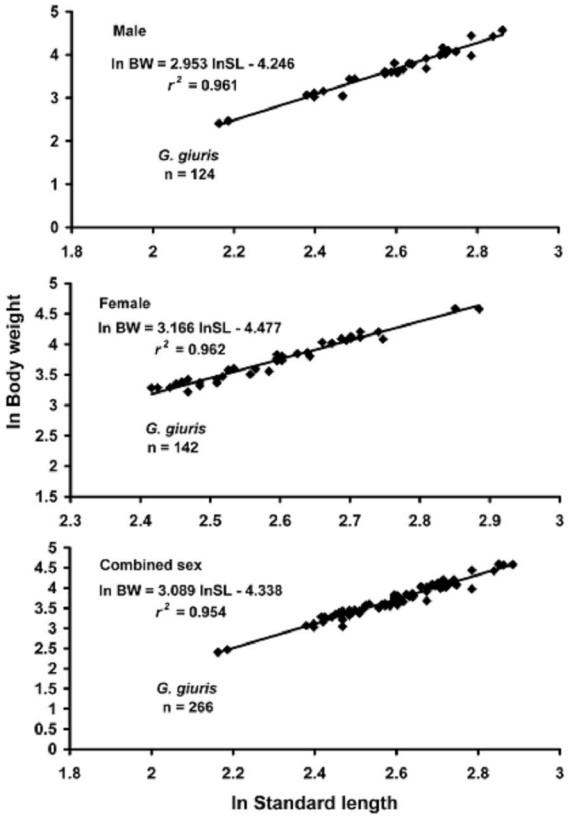

Figure 1. Length-weight relationships (ln BW = ln *a* + *b* ln SL) for a tank goby *Glossogobius giuris* (Hamilton, 1822) in the Ganges of the northwestern Bangladesh during March 2006 to February 2007.

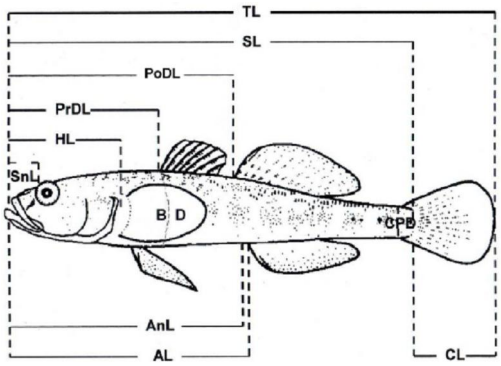

Figure 2. Sketch drawing of a tank goby *Glossogobius giuris* (Hamilton, 1822) where the dimensions are identified.

Table 2. Morphometric relationships of a tank goby *Glossogobius giuris* in the Ganges of the northwestern Bangladesh.

Sex	Equation	n	a	b	95% Cl of a	95% Cl of b	r^2
Male	TL=a+b SL	124	-0.464	1.355	-0.971 to 0.165	1.307-1.394	0.992
	SL=a+b TL	124	0.342	0.737	-0.142 to 0.714	0.716-0.766	0.992
	SL=a+b HL	124	-1.152	3.389	-2.750 to -0.118	3.158-3.725	0.958
	SL=a+b SnL	118	-0.116	8.586	-1.519 to 0.924	7.930-9.481	0.937
	SL=a+b BD	124	1.443	3.076	0.042 to 2.820	2.719-3.455	0.874
	SL=a+b CL	120	2.656	2.067	-0.436 to 6.191	1.476-2.601	0.712
	SL=a+b CPD	121	1.398	6.176	-0.690 to 3.681	5.065-7.234	0.817
	SL=a+bPrDL	117	-0.702	2.636	-2.058 to 0.134	2.486-2.868	0.972
	SL=a+bPoDL	117	0.733	5.247	-1.184 to 2.315	4.623-6.009	0.852
	SL=a+b AnL	120	0.024	1.599	-0.507 to 0.539	1.531-1.664	0.984
	SL=a+b AL	120	0.448	1.719	-0.136 to 1.057	1.638-1.802	0.978
Female	TL=a+b SL	142	0.778	1.252	0.057 to 1.358	1.209-1.305	0.990
	SL=a+b TL	142	-0.621	0.799	-1.136 to -0.054	0.765-0.828	0.990
	SL=a+b HL	142	0.599	2.936	-1.189 to 2.915	2.376-3.355	0.819
	SL=a+b SnL	136	1.857	7.478	0.276 to 2.88	6.871-8.467	0.899
	SL=a+b BD	138	7.836	1.288	1.484 to 9.512	0.889-2.841	0.332
	SL=a+b CL	136	0.741	2.433	-0.777 to 2.200	2.169-2.730	0.790
	SL=a+b CPD	133	0.267	0.386	-0.218 to 0.681	0.356-0.421	0.949
	SL=a+bPrDL	133	-0.692	2.593	-1.893 to 0.468	2.378-2.805	0.948
	SL=a+bPoDL	135	1.061	5.081	-1.153 to 2.427	4.502-5.933	0.830
	SL=a+b AnL	134	0.214	1.687	-0.746 to 1.524	1.510-1.811	0.914
	SL=a+b AL	138	0.501	1.509	-0.875 to 1.769	1.365-1.664	0.948

n, sample size; *a*, intercept; *b*, slope; Cl, confidence intervals; r^2, coefficient of determination; TL, total length; SL, standard length; HL, head length; SnL, snout length; BD, body depth; CL, caudal length; CPD, caudal peduncle depth; PrDL, pre-dorsal length; PoDL, post-dorsal length; AnL, anus length; AL, anal length.

should be used only within the respective size range. The length-weight relationship in fishes can be affected by several factors including habitat, area, seasonal effect, degree of stomach fullness, gonad maturity, sex, health, preservation techniques and differences in the observed length ranges of the specimen caught (Tesch 1971), all of which were not accounted for the present study. Since samples of *G. giuris* were collected over several seasons, the parameters *a* and *b* would be treated as mean annual values. To the best knowledge of the authors, no information dealing with the LWRs or the morphometric relationships of *G. giuris* from this region are available in the literature (Craig et al. 2004). However, in the South African estuaries, results similar to the present study were reported by Harrison (2001) who recorded the isometric growth in *G. giuris*.

This study presents basic information on LWRs and morphometric relationships for the tank goby *G. giuris* that would be useful for fishery managers as well as the sustainable management of its numerous stocks in the region. Moreover, the length-weight relationship estimates for this fish *G. giuris* is only available in FishBase, however, no information on morphometric relationships currently exists and therefore, our results may contribute to this invaluable database. More detailed studies are suggested to provide further specific information on seasonal variation of LWRs, condition factor and gonadosomatic index of the tank goby in the Ganges.

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