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Temporal Variation of Relative Growth Pattern and Condition of *Glossogobius giuris* (Hamilton, 1822) in the Garai River, SW Bangladesh

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Abstract

The present study designates the length-frequency distributions (LFDs), temporal variations of relative growth pattern and relative condition factor (K_R) of the *Glossogobius giuris*, which are evidently lacking in the literature. Sampling was done in the Garai River, southwestern Bangladesh using traditional fishing gears (*Doar* and Cast net) from March 2016 to February 2017. Total length (TL) was measured by digital slide calipers, while individual body weight (BW) was determined using digital electronic balance. A total of 972 specimens (male = 446, female = 526) ranging from 3.4 to 28.0 cm TL and 0.3 to 212.0 g BW were analyzed in this study. The LFDs showed that the $6.99-9.99$ cm TL size group was dominant for both sexes, constituted 46% for males and 41% for females of its population, respectively. The allometric coefficient (*b)* values were 2.89 for males and 2.92 for females, which indicated that the relative growth pattern was negative allometric ($b< 3.00$) in both sexes. The LWRs were significantly different between males and females (ANCOVA, $p < 0.001$). Minimum value of K_R was found in April and maximum value in December for male. For the female, minimum value was found in January and maximum value in December. The K_R were not significantly different between males and females (ANCOVA, p=0.9745). These results will help further studies on the population assessment as well as stock assessment of the *G. giuris*. Furthermore, this research has established a strong base for monitoring the biological changes of this important species due to high fishing pressure, climate changes or other reasons within the Garai River ecosystem or elsewhere.

Keywords: Temporal variations, length-weight relationship, condition factor, *Glossogobius giuris*, Garai River

1. Introduction

The Tank gobi, *Glossogobius giuris* (Hamilton, 1822) (Perciformes: Gobiidae) is broadly distributed in Africa to Oceania, Madagascar to India and the Indian subcontinent to China (Froese and Pauly, 2019). It is commonly known as *Bele, Balia, Bekukor, Bulla, Bakla, Tenk dikkop,* and *Weligouva* in the Bangladesh, India, Malaysia, Nepal, Philippines, South Africa, and Sri Lanka, respectively (Talwar and Jhingran, 1991; Froese and Pauly, 2019). The *G. giuris* is a benthopelagic, amphidromous species, and it inhabits clear to turbid, freshwaters (i.e. rivers streams, canals, ditches and ponds) to estuarine habitats with rock, gravel or sand. This species feeds on small insects, crustaceans and small fishes (Allen, 1991). It is a low fat-high protein fish, and the percentage of moisture, protein, ash, and lipid are about 85%, 15.6%, 2.94% and 1.54%, correspondingly (Islam and Joadder, 2005). The conservation status of this fish has been categorized as least concern (IUCN, 2018).

Size stucture (length-frequency distribution, LFD) represents fundamental information to assess reproductive potential of fish population (Vazzoler, 1996). In riverine fish, the study of the LFD expresses the river health, stock status and fish spawning period (Ranjan *et al.*, 2005) as well as reflects the interaction of the dynamic rate of growth, recruitment and mortality (Neuman and Allen, 2001).

The relationship between length and weight (LWR) − along with condition factors−is useful parameters for the assessment of the well-being of individuals and determines probable variations among different stocks of the same species (King, 2007). Furthermore, condition factor is important for assessing the well-being of the fish and also prediction of future population success by its influence on growth, reproduction, and survival (Richter, 2007).

However, a number of studies have been conducted on different aspects of *G. giuris* including reproduction (Allen, 1991), LWRs, and LLRs in the Ganges River, Bangladesh (Hossain *et al*., 2009a, 2009b), LWRs in the Pampanga River, Philippines, and in the estuaries of South Africa (Harrison, 2001; Garcia, 2010). Therefore, this is the first description on temporal variation of the relative growth pattern and relative condition factor of *G. giuris*

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using monthly data over a one year study period in the Garai River, southwestern Bangladesh.

2. Materials and Methods

2.1. Study site and sampling period

The present study was conducted in the Garai River (a distributary of the Padma River), southwestern region of Bangladesh (Latitude: 23° 32' N; Longitude: 89° 31' E). Monthly samples of *G. giuris* were collected from the fisherman catch landed at the several points (*Mohanagar* Track, *Barokhada Ghat*, *Ganga-Kopotakkho Ghat*, *Ghora Ghat*) of Kushtia during March 2016 to February 2017. This fish is usually caught by different types of nets (gill nets, cast nets, stake nets, lift nets, etc) and traps (*Doar, Kholson* etc). After catching, the samples were immediately preserved with ice on site and then were fixed with 5 % formalin solution.

2.2. Fish measurement

For each individual, total length (TL) was measured to the nearest 0.01 cm using digital slide calipers and whole body weight (BW) was taken on a digital electronic balance with 0.01 g accuracy. All specimens were sexed by gonad observation under a microscope.

2.3. Population structure

The length frequency distribution for *G. giuris* was constructed using 1.0 cm intervals of TL.

2.4. Growth pattern

The LWR was calculated using the expression: $BW = a*(TL)^b$. Parameters *a* and *b* were estimated by linear regression analysis based on natural logarithms: $ln(W) = \ln(a) + b\ ln(L)$. Additionally, 95% confidence limits of *a* and *b*, and the coefficient of determination r^2 were estimated. Based on Froese, (2006), all extreme outliers were excluded from the analyses. A t-test was applied to determine significant differences from the isometric value of $b = 3$ (Sokal and Rohlf, 1987) to characterize the growth patterns to either isometric or (+/-) allometric.

2.5. Condition factor (KR)

The relative condition factor (K_R) for each individual was calculated using the equation of Le Cren (1951): $K_R = W/(a \times L^b)$, where W is the BW, L is the TL, and *a* and *b* are the LWR parameters.

2.6. Statistical analyses

Statistical analyses were done using Microsoft® Excel added in solver, Graph Pad Prism 6.5. Tests for normality of each group were confirmed with the Shapiro-Wilk normality test. The homogeneity of variance was also checked. Where test for normality assumption was not met, the nonparametric Mann-Whitney U test was used to compare TL, BW, K_R between sexes. The Spearman rank test was used to correlate TL and BW with K_R. In addition, analysis of covariance (ANCOVA) was applied to justify the significant differences between sexes for the slopes (*b*) of the regression lines of LWRs. All statistical analyses were considered significant at 5% ($p<0.05$).

3. Results

3.1. Population structure

A total of 972 specimens (male = 446, female = 526) ranging from 3.4 to 28.0 cm TL and 0.3 to 212.0 g BW were analyzed in this study. The minimum and maximum size range of males and females were 3.4 to 28.0 and 3.5 to 27.5 cm in TL, respectively. Additionally, LFDs showed that the 6.99–9.99 cm TL size group was numerically dominant for both sexes, constituted 46% for males and 41% for females of its population (Figure 1). The Mann-Whitney U-test showed no significant differences in the LFDs between sexes (U = 114545, p=0.5280). In addition, BW of females (0.33-210 g; 95% CL = 15.42-19.62 g) was less than males (0.30-212 g; 95% CL=14.88-18.97 g). The differences between the sexes were not statistically significant (Mann-Whitney U=115782, p = 0.7282).

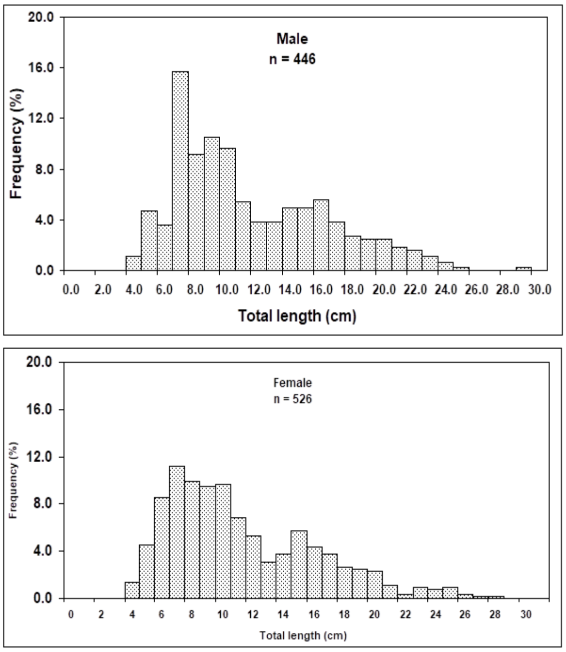

Figure 1.The length-frequency distribution of male and female *Glossogobius giuris* in the Garai (Padma River distributary) River, southwestern Bangladesh

3.2. Relative growth pattern

Monthly length and weight measurements, sample sizes (*n*), regression parameters and 95% confidence limit for *a* and *b* of the LWR, and coefficients of determination (r^2) of *G. giuris* in the Garai River are summarized in Table 1 and 2. The *b* values for TL-BW relationships (Figure 2) indicate positive allometric growth ($b > 3.00$) in January for male and in November for both male and female. Isometric (b=3.00) for female in January and for males in May and September. The *b* values of TL-BW relationships indicate negative allometric growth ($b< 3.00$) for both male and female in February, April, June, October and December (Figure 3).

The overall *b* value for LWR indicates a significantly negative allometric growth (> 3.00) in male (95% CL of *b* = 2.86-2.92) and female (95% CL of *b* = 2.89-2.95). All LWRs were significant ($p < 0.01$) with all r^2 value being ≥ 0.986, and analysis of covariance (ANCOVA) reveals significant difference in LWRs between sexes ($p < 0.0001$).

Table 1. Descriptive statistics on the total length (cm) and body weight (g) measurements of *Glossogobius giuris* (Hamilton, 1822) in the Garai River of southwestern Bangladesh during March 2016 to February 2017

Month	Sex	*n*	TL (cm)				BW (g)			
			Min	Max	Mean ± SD	95% CL	Min	Max	Mean ± SD	95% CI
March	M	33	8.1	28	11.50 ± 4.15	10.03 – 2.98	4.1	212.00	21.39 ± 37.72	8.02–34.77
	F	47	8.1	27.5	12.12 ± 3.82	11.00 – 3.25	4.99	210.00	22.21 ± 32.00	12.82–31.61
April	M	27	7.3	21.1	11.45 ± 3.75	9.97 –12.94	3.90	76.40	17.05± 17.14	10.28–23.84
	F	53	7.9	23.2	11.49 ± 3.35	10.57 – 2.42	4.18	78.32	17.43 ± 15.37	13.20–21.67
May	M	34	4.5	23.8	14.61 ± 5.44	12.71–16.51	0.93	98.71	33.65 ± 26.63	24.36–42.95
	F	46	4.6	24.1	14.41 ± 5.63	12.75–16.09	1.10	140.21	35.13 ± 34.20	24.98–45.29
June	M	40	5.2	19.2	8.29 ± 3.79	7.08–9.50	1.35	59.00	8.55 ± 13.72	4.17–22.95
	F	40	5.1	24.2	7.68 ± 4.39	6.28–9.09	1.16	115.00	9.49 ± 23.63	1.94–17.05
July	M	45	4.7	22.1	11.80± 4.34	10.49–13.10	0.89	1.15	18.57 ± 17.81	13.22-23.92
	F	35	4.9	20.5	10.76 ± 5.21	8.96–12.55	0.91	72.96	18.61 ± 23.57	10.51–26.71
August	M	36	7.1	22.5	14.41 ± 4.00	13.06–15.77	4.57	80.77	27.09 ± 21.01	19.98–34.20
	F	44	7.3	19.8	13.65 ± 3.53	7.30–19.80	3.50	56.40	24.04 ± 16.21	19.09–28.94
September	M	34	12.0	20.0	15.39 ± 1.92	14.80–15.99	12.95	61.04	31.02 ± 11.65	27.43–34.60
	F	37	12.2	19.3	14.94 ± 1.58	14.41–15.46	14.09	60.32	19.63 ± 9.73	26.38–32.87
October	M	39	3.4	20.4	8.17 ± 4.87	6.59–9.75	0.30	23.78	8.23± 12.75	4.09–12.36
	F	41	3.5	17.4	7.03 ± 4.04	5.75–8.30	0.33	34.8	5.39 ± 9.10	2.45–8.26
November	M	32	4.5	9.5	6.93 ± 1.42	6.42–7.44	0.68	6.93	3.26 ± 1.84	2.60–3.93
	F	48	3.7	9.5	6.58 ± 1.30	6.20–6.96	0.40	7.96	2.95 ± 1.70	2.45–3.44
December	M	36	4.6	22.0	8.07 ± 3.97	6.93–9.42	0.63	77.33	8.32 ± 16.62	2.70–13.95
	F	44	4.0	21.5	7.97 ± 3.55	6.89–9.05	1.17	77.45	7.56 ± 14.93	3.02–12.10
January	M	37	6.7	10.9	8.39 ± 1.15	8.00 – 8.78	2.54	12.30	5.77 ± 2.64	4.89–6.65
	F	36	5.8	16.0	9.28 ± 1.90	8.63 – 9.92	1.57	34.84	8.19 ± 6.43	6.02–10.37
February	M	44	4.3	24.7	10.85 ± 5.67	9.13 – 12.58	0.67	115.29	19.04 ± 30.00	9.92–28.17
	F	55	4.6	26.9	12.12 ± 6.30	10.42 –3.83	0.89	146.55	26.80 ± 38.87	16.29–37.31

n, sample size; M, male; F, female; TL, total length (cm) W, body weight (g); min, minimum; max, maximum, SD, standard deviation; CL, confidence limit

Table 2. Descriptive statistics and estimated parameters of the length-weight relationships ($W=a\times TL^b$) of *Glossogobius giuris* (Hamilton, 1822) in the Garai River of southwestern Bangladesh during March 2016 to February 2017

Month	Sex	*n*	Regression parameters				r^2	t_s	GT
			a	*B*	95% CL of *a*	95% CL of *b*			
March	M	33	0.0091	3.01	0.0064 – 0.0130	2.86 – 3.16	0.98	-0.11	I^{ns}
	F	47	0.0106	2.95	0.0076 – 0.0147	2.81 – 3.08	0.97	-0.71	I^{ns}
April	M	27	0.0182	2.71	0.0139 – 0.0237	2.60 – 2.82	0.99	-5.80	$-A^{***}$
	F	53	0.0160	2.78	0.0107 – 0.0239	2.62 – 2.95	0.95	-2.75	$-A^{***}$
May	M	34	0.0161	2.75	0.0129 – 0.0201	2.66 – 2.83	0.99	-6.25	$-A^{***}$
	F	46	0.0128	2.83	0.0100 – 0.0165	2.73 – 2.93	0.98	-3.40	$-A^{***}$
June	M	40	0.0108	2.90	0.0084 – 0.0140	2.78 – 3.03	0.98	-1.66	$-A^{***}$
	F	40	0.0095	2.96	0.0076 – 0.0119	2.85 – 3.07	0.98	-0.80	I^{ns}
July	M	45	0.0100	2.93	0.0075 – 0.1340	2.80 – 3.05	0.98	-1.75	$-A^{***}$
	F	35	0.0074	3.04	0.0052 – 0.0107	2.88 – 3.19	0.97	-0.50	I^{ns}
August	M	36	0.0193	2.65	0.0123 – 0.0301	2.48 – 2.80	0.96	-4.37	$-A^{***}$
	F	44	0.0185	2.69	0.0121 – 0.0284	2.52 – 2.85	0.96	-3.87	$-A^{***}$
September	M	34	0.0070	3.05	0.0043 – 0.0115	2.87 – 3.23	0.96	0.55	I^{ns}
	F	37	0.0094	2.97	0.0050 – 0.0177	2.73 – 3.19	0.95	-0.25	I^{ns}
October	M	39	0.0099	2.89	0.0088 – 0.0112	2.79 – 2.91	0.99	-3.66	$-A^{**}$
	F	41	0.0096	2.88	0.0082 – 0.0112	2.79 – 2.96	0.99	-3.00	$-A^{**}$
November	M	32	0.0071	3.10	0.0049 – 0.0103	2.90 – 3.29	0.97	1.11	$+A^{***}$
	F	48	0.0068	3.16	0.0051 – 0.0092	2.99 – 3.31	0.97	2.28	$+A^{***}$
December	M	36	0.0156	2.74	0.0110 – 0.0221	2.56 – 2.91	0.96	-3.25	$-A^{**}$
	F	44	0.0190	2.65	0.0128 – 0.0283	2.45 – 2.84	0.95	-3.88	$-A^{***}$
January	M	37	0.0055	3.25	0.0033 – 0.0086	3.03 – 3.47	0.96	2.27	$+A^{***}$
	F	36	0.0093	2.99	0.0096 – 0.0131	2.83 – 3.15	0.98	-0.14	I^{ns}
February	M	44	0.0090	2.94	0.0083 – 0.0098	2.90 – 2.97	0.99	-0.50	I^{ns}
	F	55	0.0104	2.90	0.0096 – 0.0113	2.87 – 2.94	0.99	-5	$-A^{***}$

n, sample size; M, male; F, female; *b* are length-weight relationships parameter; CL, confidence limit; r^2, co-efficient of determination; GT, growth type; -A, negative allometric growth; I, isometric growth; +A, positive allometric growth

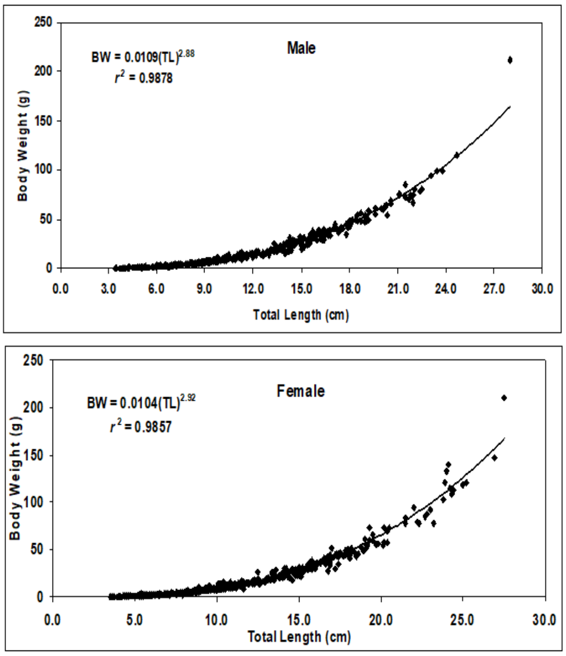

Figure 2. The relationships (BW= aL^b) between body weight (BW) and total length (TL) of the overall male, female of *Glossogobius giuris* in the Garai (Padma River distributary) River, southwestern Bangladesh

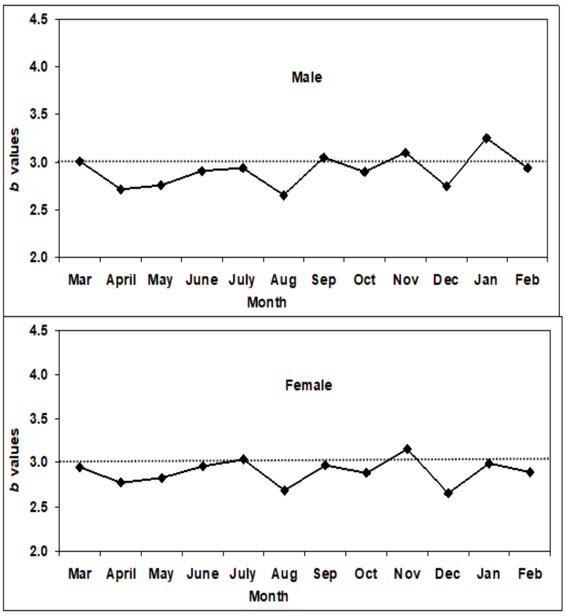

Figure 3. Monthly variations of the *b* values for male and female of *Glossogobius giuris* in the Garai (Padma River distributary) River, southwestern Bangladesh

3.3. Relative condition factor (KR)

The minimum and maximum value of relative condition factor (K_R) for both male and female were 1.00 to 1.01 and 1.00 to 1.03, respectively. The effect of month on the relative condition factor was similar to that of size, where male K_R value decreased from January to the April, and increased from April to the July; then from the July to the October it decreased and increased to the December. For the female K_R, the value increased from January to the April then slightly went down from the April to June and suddenly increased to July then dramatically went down to October then increased to December (Figure 4). The K_R value was almost similar for both male and female which was near about 1 (≤1) in every month. So, the growth rate of *G. giuris* was well balanced throughout the year.

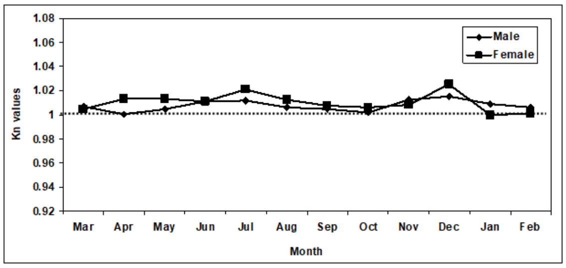

Figure 4. Monthly variations of the Relative condition factor (K_R) for male and female of *Glossogobius giuris* in the Garai (Padma River distributary) River, southwestern Bangladesh

4. Discussion

Information on temporal variation of population structure and growth pattern of *G. giuris* is very limited in literature. In this study, a large number of individuals with different body sizes were collected from the Garai River using traditional fishing gear all over the year to describe the temporal variations in LWRs and condition of this fish

In this study, sampling of individuals smaller than 3.4 cm in TL and 0.3 g in BW was not possible, which can be ascribed to selectivity of fishing gear rather than their absence on the fishing ground or fishermen not fishing where the smaller sizes exist (Azad *et al*., 2018; Hossain *et al*., 2012, 2017a, b; Nawer *et al*., 2017). The LFDs showed that the 6.99–9.99 cm TL size group was numerically dominant for both sexes, constituting 46% and 41% of its population, accordingly, although statistically there were not significantly different. In our works, the maximum TL of *G. giuris* was 28.0 cm, which is much higher than the value of 17.9 cm from the Ganges River, Bangladesh (Hossain *et al*., 2009a); 19.5 cm from Lakes of Agusan Marsh, Philippines (Jumawan and Seronay, 2017) and 17.5 cm from the Hongshui River, Southwest China (Que *et al.*, 2015) but lower than the maximum recorded value of 50.0 cm SL reported from the freshwater fishes of Tanzania (Eccles, 1992) and 25.8 cm in the lower part of the Ganges River, Bangladesh (Hossain *et al.*, 2009a).

The allometric coefficient *b* may differ between 2.0-4.0; however, values ranging from 2.5-3.5 are more common (Carlander, 1969; Froese, 2006). In the present study, the *b* values of LWR remained within the range of 2.89–2.93 (*b*= 2.86–2.92 for males and *b*= 2.89–2.95 for females), which is consistent with the expected range for teleost species (Froese, 2006). In the present study, the overall *b* for the relative growth pattern indicated negative allometric growth (< 3.00) in both males and females. Similar growth pattern (*b* value for male = 2.95 and female = 2.29) were reported by Hossain *et al*. (2009b) for *G. giuris* from Ganges River, northwestern Bangladesh. According to Froese (1998), the growth pattern of *G. giuris* was negative allometric (*b*=2.90). Negative growth pattern was also stated by Que *et al*. (2015) and Islam *et al*. (2017) for this fish from the Hongshui River, southwest China and Brahmaputra River, Bangladesh, respectively. Conversely, isometric growth was detected by Hossain *et al*. (2009a) (*b*=3.03); Garica (2010) (*b*=3.06) and Harrison (2001) (*b*=3.06) while positive allometric growth (*b* = 3.16 & *b*=3.29) was recorded by Hossain *et al*. (2009b) for both male and female *G. giuris* from the Ganges River, Bangladesh. In this present study, December month shows highest K_R value for male 1.02 and female 1.03. This indicates that both males and females are in better condition in the month of December. It is not possible to compare others due to lack of available studies on this aspect. However, the differences in relative growth pattern can be credited due to numerous factors including, habitat availability, seasonal effect and level of stomach fullness (Hossain *et al.*, 2013, 2018), which were not considered in this study.

To sum up, our findings describe the length-frequency distribution, temporal variation of relative growth pattern based on LWR and condition of *G. giuris*. LWRs would be useful in fishery management for both applied and basic use to: (i) estimate weight from length observations; (ii) calculate production and biomass of a fish population; and/or (iii) provide information on stocks or organism condition at the corporal level. The result of this study will provide an important baseline for future studies and would be very effective for stock assessment of *G. giuris* in the Garai River and adjoining ecosystems.

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Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of the present paper.

References

Allen GR. 1991. Field guide to the freshwater fishes of New Guinea. Christensen Research Institute, Madang, Papua New Guinea. 268p.

Azad MAK, Hossain MY, Khatun D, Parvin MF, Nawer F, Rahman O and Hossen MA. 2018. Morphometric Relationships of the Tank goby *Glossogobius giuris* (Hamilton, 1822) in the Gorai River using Multi-linear Dimensions." *Jordan J Biol Sci.*, **11**: 81–85.

Bagenal JB and Tesch FW.1978. Methods for assessment of fish production in freshwaters. Blackwell Scientific publication, Oxford, p. 361.

Carlander KD. 1969. Handbook of freshwater fishery biology. The Iowa State University Press. Ames, IA, **1**:752.

Dall W, Hill BJ, Rothlisberg PC and Staples DJ. 1990. Biology of the Penaeidae. In: Blaxter, J.H.S., Southward, A.J. (Eds.), Advances in Marine Biology. Academic Press, London, UK, 27: 489

Eccles DH. 1992. FAO species identification sheets for fishery purposes. Field guide to the freshwater fishes of Tanzania. Prepared and published with the support of the United Nations Development Programme. FAO, Rome. 145 p.

Froese R and Pauly D. (Eds). 2019. Fish base 2019. World Wide Web electronic publication. Available at: http://www.fishbase.org.

Froese R. 1998. Length-weight relationships for 18 less-studied fish species. *J Appl Ichthyol.*, **14**: 117-118.

Froese R. 2006. Cube law, condition factor and weight-length relationships: History, meta-analysis and recommendations. *J Appl Ichthyol.*, **22**: 241-253.

Garcia LMB. 2010. Species composition and length-weight relationship of fishes in the Candaba wetland on Luzon Island, Philippines. *J Appl Ichthyol.*, **26**: 946-948.

Harrison TD. 2001. Length-weight relationships of fishes from South African estuaries. *J Appl Ichthyol.*, **17**: 46-48.

Hossain MY, Arefin MS, Mohmud MS, Hossain MI, Jewel MAS, Rahman MM, Ahamed F, Ahmed ZF and Ohtomi J. 2013. Length-weight relationships, condition factor, gonadosomatic index-based size at first sexual maturity, spawning season and fecundity of *Aspidoparia morar* (Cyprinidae) in the Jamuna River (Brahmaputra River distributary), northern Bangladesh, *J Appl Ichthyol.*, **29**: 1166-1169

Hossain MY, Hossen MA, Pramanik MNU, Ahmed ZF, Hossain MA and Islam MM. 2016. Length–weight and length–length relationships of three Ambassid fishes from the Ganges River (NW Bangladesh). *J Appl Ichthyol*., **32**: 1279-1281.

Hossain MY, Hossen MA, Khatun D, Nawer F, Parvin MF, Rahman O and Hossain MA. 2017a. Growth, condition, maturity and mortality of the Gangetic Leaffish *Nandus nandus* (Hamilton, 1822) in the Ganges River (Northwestern Bangladesh). *Jordan J Biol Sci.*, **10**: 57–62.

Hossain MY, Hossen MA, Ali MM, Pramanik MNU, Nawer F, Rahman MM, Sharmin S, Khatun D, Bahkali AH, Elgorban AM and Yahya K. 2017b. Life-History traits of the Endangered carp *Botia dario* (Cyprinidae) from the Ganges River in Northwestern Bangladesh. *Pakistan J Zool.*, **49**: 801–809.

Hossain MY, Rahman MM, Bahkali AH, Yahya K, Arefin MS and Hossain MI. 2016. Temporal variations of sex ratio, length-weight relationships and condition factor of *Cabdio morar* (Cyprinidae) in the Jamuna (Brahmaputra River distributary) River, northern Bangladesh. *Pakistan J Zool.*, **48**: 1099–107.

Hossain MY, Pramanik MNU, Hossen MA, Nawer F, Khatun D, Parvin MF, Rahman O, Ahmed ZF and Ahamed F. 2018. "Life-history traits of the Pool barb *Puntius sophore* (Cyprinidae) in different ecosystem of, Bangladesh." *Indian J G Mar Sci.*, **47**: 1446-1454.

Hossain MY, Rahman MM, Miranda R, Leunda PM, Oscoz J, Jewel MAS, Naif A and Ohtomi J. 2012. Size at fist sexual maturity, fecundity, length-weight and length-length relationships of *Puntius sophore* (Cyprinidae) in Bangladeshi waters, *J Appl Ichthyol.*, **28**: 818-822

Hossain MY, Ohtomi J, Ahmed ZF, Ibrahim AHM and Jasmine S. 2009a. Length-weight and morphometric relationships of the tank goby *Glossogobius giuris* (Hamilton, 1822) (Perciformes: Gobiidae) in the Ganges of the northwestern Bangladesh. *Asian Fish Sci.*, **22**: 961-969.

Hossain MY, Jasmine S, Ibrahim AHM, Ahmed ZF, Rahman MM and Ohtomi J. 2009a. Length-weight and length-length relationships of 10 small fish species from the Ganges, Bangladesh. *J Appl Ichthyol.*, **25**:117-119.

Hossen MA, Hossain MY, Ali MM, Pramanik MNU, Nawer F, Islam MA, Hossain MA, Bahkhali AH and Elgorban MA. 2017. Seasonal variations of growth pattern and condition of Paradise threadfin *Polynemus paradiseus* (Polynemidae) from Tetulia River in Southern Bangladesh. *Indian J G Mar Sci.*, **46**: 582–590.

Islam MR, Azom MG, Faridullah M and Mamun M. 2017. Length-weight relationship and condition factor of 13 fish species collected from the Atrai and Brahmaputra rivers, Bangladesh. *J Bio Env Sci.*, **10**: 123-133.

Islam, MN and Joadder MAR. 2005. Seasonal variation of the proximate composition of freshwater Gobi, *Glossogobius giuris* (Hamilton) from the river Padma. *Pakistan J Biol Sci.*, **4**: 532-536.

IUCN. 2018. The IUCN Red List of Threatened Species. Version 2018-2. Downloaded on 19 November 2018.https:// www.iucnredlist.org.

Jumawan JC and Seronay RA. 2017. Length-weight relationships of fishes in eight floodplain lakes of Agusan Marsh, Philippines. *Phil J Sci*., **146**:95-99.

Nawer F, Hossain MY, Hossen MA, Khatun D, Parvin MF, Ohtomi J and Islam MA. 2017. Morphometric relationships of the endangered Ticto barb *Pethia ticto* (Hamilton, 1822) in the Ganges River (NW Bangladesh) through multi-linear dimensions. *Jordan J Biol Sci.,* **10**: 199–203.

Neuman, RM and Allen MS. 2001. Analysis and Interpretation of Freshwater Fisheries Data. Department of Natural Resources Management and Engineering, University of Connecticut.

Que YF, Pan L, Chen F, Xie S, Liao XL and Zhao N. 2015. Length-weight relationships of thirty-seven fish species from the Hongshui River, Southwest China. *J Appl Ichthyol.,* **31**: 804-806.

Ranjan JB, Herwig W, Subodh S and Michael S. 2005. Study of the length frequency distribution of sucker head, *Garra gotyla* (Gray, 1830) in different Rivers and Seasons in Nepal and its Applications. *Kathmandu Uni J Science Eng Tech.,* **1**:1–14.

Richter TJ. 2007. Development and evaluation of standard weight equations for bridgelip sucker and large scale suckers, N Am J Fish Manage., **27**:936-939

Talwar PK and Jhingran AG. 1991. Inland Fishes of India and Adjacent Countries. A.A Balkema, Rotterdam, p.541.

Tesch FW. 1971. Age and Growth. In Methods for Assessment of Fish Production in Fresh Waters, edited by Ricker, W.E. Oxford: Blackwell Scientific Publications, 98-130 pp.

Vazzoler AEAM. 1996. Reproduction Biology of Teleostean Fishes. Theory and Practice. Maringá, EDUEM, Brazilian Society of Ichthyology, 169p.