

Morphometric and Meristic Characteristics of the Banded Gourami, *Trichogaster fasciata* (Bloch & Schneider, 1801) in a Wetland Ecosystem from Northwestern Bangladesh

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Abstract

This study represents the morphometric and meristic characters of the least concern, *Trichogaster fasciata* (Bloch & Schneider, 1801) including length-weight relationships (LWRs) and length-length relationships (LLRs) using a total of six linear dimensions and various meristic counts from the Gajner *Beel*, a large wetland ecosystem of northwestern Bangladesh. Sums of 324 specimens of *T. fasciata* were occasionally collected from the Gajner *Beel* during the period from July 2017 to June 2018, using different traditional fishing gears. Fin rays were counted with the help of a magnifying glass. Moreover, a total of seven different lengths (e.g., TL, SL, PrDL etc.) were measured using digital slide calipers, and the total body weight (BW) was weighed by an electronic balance with a 0.01 g accuracy for each individual, respectively. Minimum and maximum sizes were 3.1-8.8 cm (Mean \pm SD = 5.78 \pm 1.50) in total length (TL) and 0.81- 13.15 g (Mean \pm SD = 4.90 \pm 3.30) in body weight (BW). All LWRs were highly significant ($p < 0.001$) with r^2 values ≥ 0.960 . Based on the r^2 value, the LWRs by BW vs. TL constitute the finest fitted model among seven equations. In addition, the LLRs also had significance with r^2 values ≥ 0.993 . Based on the r^2 values, the LLRs by TL vs. SL was the best fitted model among six equations. The fin formula of *T. fasciata* is: dorsal, D. XV-XVII/10-14; pectoral, Pc. 9-10; pelvic, Pv. 1; anal, A. XV-XVIII/15-19 and caudal, C. 18-20. This study will contribute to species identification and stock assessment of Gajner *Beel* and the adjacent ecosystems.

Keywords: *Trichogaster fasciata*, Morphometric, Meristic, Fin rays, Gajner *Beel*, Bangladesh

1. Introduction

The Banded gourami, *Trichogaster fasciata* (Bloch & Schneider, 1801) is a freshwater and estuaries tropical labyrinth fish belonging to the family of Osphronemidae (Romero, 2002; Froese and Pauly, 2018). It is an indigenous species and widely distributed throughout the Indian sub-continent: Bangladesh (Rahman, 1989; Menon, 1999), Bhutan (Petr, 1999), India, Nepal and Pakistan (Talwar and Jhingran, 1991; Gupta, 2015). This is well-known as Boro kholisha, Khailsha, Khalisha in Bangladesh, as Kholisha, Kholiana in India and as Katara, Khesara in Nepal (Froese and Pauly, 2018). The banded gourami is a benthopelagic, and generally prefer weedy environments such as estuaries, ponds, large rivers, ditches, and lakes (Menon, 1999). It is a carnivorous hardy fish and breeds in foul water (Bhuiyan, 1964). This species is considered as an important target species for small-scale fishers (Shafi and Quddus, 1982; Rahman, 2005), who use a variety of traditional fishing gears (Kibria and Ahmed, 2005). This fish species is used as a peaceful and beautiful aquarium fish, and traditionally people like its good taste

(Talwar and Jhingran, 2001). Though this species is considered a minor in terms of commercial catches due to its small size, and is mostly captured as a bycatch (Rahman *et al.*, 2018; Hossain *et al.*, 2019; Hossen *et al.*, 2019a), it is regarded as a highly commercial fish species for the aquarium (Froese and Pauly, 2018). The conservational status of *T. fasciata* is listed as least concern both in Bangladesh (IUCN Bangladesh, 2015) and Worldwide (IUCN, 2017).

Morphometric and meristic characteristics are beneficial for species appreciation and classification (Bagenal and Tesch, 1978; Jayaram, 1999; Hossen *et al.*, 2018). Morphometric characters constitute an important part of fisheries' research for comparing life history and morphological trends of fish populations (Hossain *et al.*, 2014, 2016a; Elahi *et al.*, 2017). Morphometric and meristic characteristics, including length-weight relationships (LWRs) (Hossain *et al.*, 2016b; Rahman *et al.*, 2019; Hossen *et al.*, 2019), and length-length relationships (Hossain *et al.*, 2006, 2016c; Hossen *et al.*, 2019) of various threatened species of Bangladesh, are well-documented, but none covers a wide range of linear dimensions. However, a few studies have been conducted

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on *T. fasciata* i.e., length-weight relationships (LWRs) and condition factor (Sarkar *et al.*, 2012; Kalita *et al.*, 2016), biology and fishery (Mitra *et al.*, 2007), morphometric study (Akter *et al.*, 2016), captive breeding (Islam *et al.*, 2017), some aspects of biology (Islam *et al.*, 2016) etc. Therefore, the present study was intended to describe the morphometric and meristic characters of *T. fasciata* in the Gajner Beel, wetland ecosystem in NW Bangladesh via a number of specimens with various sizes over a study period of twelve months.

2. Materials and Methods

2.1. Study Area and Sampling

The current study was performed in the Gajner Beel (Lat. 23° 55' N; Long. 89° 33' E), NW Bangladesh. A total of 324 individuals of *T. fasciata* (Figure 1) were intermittently collected from the fishermen during July 2017 to June 2018. The specimens were caught using various conventional fishing gears, such as cast net (mesh size: 1.0-2.0 cm), gill net (mesh size: 1.5-2.5 cm), and square lift net (about 1.0 cm). The collected specimens were quickly kept in ice in the field, and were stored in the laboratory with a 10 % buffered formalin.



Figure 1. A photo of *Trichogaster fasciata* captured from the Gajner Beel, northwestern Bangladesh

2.2. Meristic Counts

The meristic counts of fin rays of *T. fasciata* in different body parts including dorsal, pectoral, pelvic and caudal fins were observed by a magnifying glass.

2.3. Fish Measurement

Different lengths such as Total length (TL), Standard length (SL), Pre-dorsal length (PrDL), Post-dorsal length (PoDL), Pre pectoral length (PcL), Pre Anal length (PrAnL), and Post Anal length (PoAnL) (Figure 2) were measured using a digital slide calipers. Body weight (BW) was weighed with an electronic balance with a 0.01 g accuracy for each individual, respectively.

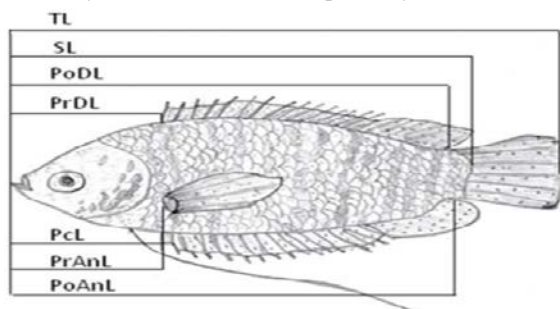


Figure 2. Showing the morphometric measurements of *Trichogaster fasciata* from the Gajner Beel, Northwestern Bangladesh (See Table 1 for abbreviation).

2.4. Growth Patterns

The growth pattern was recognized through LWRs with the equation: $BW = a \times (TL)^b$, where BW is the total body weight (g), and TL is the total length (cm). The parameter a and b were calculated by log-log linear regression analyses: $\ln(W) = \ln(a) + b \times \ln(L)$. Extreme outliers were deleted from the regression analysis according to Froese (2006). Furthermore, the 95 % confidence interval (CI) of a and b and the co-efficient of determination (r^2) were also estimated. In this study, a total of six LLRs were analyzed by linear regression analysis (Hossain *et al.*, 2006). Based on the highest r^2 value, the best model was selected from the various models of both LWRs and LLRs.

2.5. Statistical analysis

Statistical analyses were conducted with GraphPad Prism 6.5 software. All statistical analyses were considered significant at the level of 5 % ($p < 0.05$).

3. Results

The body of *T. fasciata* is elevated and compressed. Its mouth is obliquely directed backwards. The nostrils lie at the anterior superior angle of eyes. Dorsal and abdominal profiles are equally convex. The dorsal is long with its softer portion pointed. Its pectoral extends up to 10 anal spines. Filamentous pelvic extends beyond the base of the caudal which is notched. The dorsal and caudal fins are speckled with orange. The lateral line is interrupted. Scales are present on head, body, and on the base of dorsal and anal fins. Body color is greenish above, dirty white below, pelvic with yellow-white bases and red tips (Figures 1-3).

In the total catch of 324 individuals, BW ranged from 0.81 g to 13.15 g (Mean \pm SD = 4.90 \pm 3.30) and TL varied from 3.1 cm to 8.8 cm (Mean \pm SD = 5.78 \pm 1.50). Standard length (76.47 %) showed the higher proportion of TL (Table 1).

Table 1. Morphometric measurements of the *Trichogaster fasciata* (Bloch & Schneider, 1801) ($n = 324$) captured from the Gajner Beel, Pabna, Bangladesh

Measurements)	Min (cm)	Max (cm)	Mode (cm)	Mean \pm SD	95% CI	% TL
TL (Total length)	3.1	8.8	4.4	5.78 \pm 1.50	5.62 to 5.95	
SL (Standard length)	2.3	6.8	3.4	4.42 \pm 1.13	4.30 to 4.55	76.47
PrDL (Pre-dorsal length)	0.9	2.3	1.1	1.57 \pm 0.37	1.52 to 1.61	27.16
PoDL (Post-dorsal length)	2.1	6.2	3.1	4.08 \pm 1.04	3.96 to 4.19	70.59
PcL (Pre pectoral length)	0.9	2.0	1.1	1.34 \pm 0.29	1.30 to 1.37	23.18
PrAnL (Pre-anal length)	1.0	2.3	1.2	1.54 \pm 0.36	1.50 to 1.58	26.64
PoAnL (Post-anal length)	2.1	6.6	3.3	4.26 \pm 1.09	4.14 to 4.38	73.70
BW (Body weight)	0.81	13.15	1.51	4.90 \pm 3.30	4.54 to 5.26	

Min, minimum; Max, maximum; SD, standard deviation; CI, confidence interval for mean values; TL, total length



Figure 3. Different fins such as (a) Pectoral, (b) Dorsal, (c) Anal and (d) Caudal of *Trichogaster fasciata* from the Gajner Beel, Northwestern Bangladesh

3.1. Fin Formula

All meristic measurements are given in Table 2. The fin formula *T. fasciata* is: dorsal, D. XV-XVII/10-14; pectoral, Pc. 9-10; pelvic fin, Pv. 1; anal, A. XV-XVIII/ 15-19 and caudal, C. 18-20, respectively.

Table 2. Meristic measurements of the *Trichogaster fasciata* (Bloch & Schneider, 1801) ($n = 324$) captured from the Gajner Beel, Pabna, Bangladesh

Meristic data	Numbers	(Spine/ Branch)
Dorsal fin rays	22-24	XV-XVII/10-14
Pectoral fin rays	8-10	9-10
Pelvic fin rays	1	1
Anal fin rays	28-30	XV-XVIII/ 15-19
Caudal fin rays	18-20	18-20

3.2. Growth Pattern

The regression parameters (a and b) of the LWRs, the 95 % Confidence interval (CI) of a and b , the co-efficient of determination (r^2) of *T. fasciata* are given in Table 3 and the regression parameters (a and b) of the LLRs, the 95 % confidence interval (CI) of a and b , the coefficient of determination (r^2) are given in Table 4. All LWRs were highly significant ($p < 0.001$) with r^2 values ≥ 0.997 . Based on the maximum r^2 value, LWR by BW vs. TL constitutes the best fitted model among seven equations. Also, all LLRs, which are shown in Table 4, were highly correlated with the values of $r^2 \geq 0.993$. Based on the maximum r^2 value, LLR by TL vs. SL was the best fitted model among seven equations.

Table 3. Descriptive statistics and estimated parameters of the length-weight relationships of *Trichogaster fasciata* (Bloch & Schneider, 1801) ($n = 324$) captured from the Gajner Beel, Pabna, Bangladesh

Equation	Regression parameters		95% CL of a	95% CI of b	r^2
	a	b			
BW = $a \times TL^b$	0.0356	2.72	0.0345 - 0.0367	2.703 - 2.738	0.997
BW = $a \times SL^b$	0.0685	2.77	0.0656 - 0.0714	2.741 - 2.798	0.991
BW = $a \times PrDL^b$	1.0859	3.00	1.0553 - 1.1173	2.939 - 3.058	0.969
BW = $a \times PoDL^b$	0.0840	2.78	0.0800 - 0.0882	2.749 - 2.819	0.987
BW = $a \times PcL^b$	1.5521	3.34	1.5129 - 1.5924	3.271 - 3.420	0.960
BW = $a \times PrAnL^b$	1.1250	3.03	1.0972 - 1.1535	2.973 - 3.079	0.975
BW = $a \times PoAnL^b$	0.0771	2.76	0.0736 - 0.0809	2.725 - 2.790	0.989

n , sample size; a and b are LWR parameters; CI, confidence intervals; r^2 , coefficient of determination

Table 4. The estimated parameters of the length-length relationships ($y = a + b \times x$) *Trichogaster fasciata* (Bloch & Schneider, 1801) ($n = 324$) captured from the Gajner Beel, Pabna, Bangladesh

Equation	Regression parameters		95% CI of a	95% CI of b	r^2
	a	b			
TL = $a + b \times SL$	-0.0574	1.32	-0.1147 to 9.8802	1.308 - 1.333	0.993
TL = $a + b \times PrDL$	-0.506	4.01	-0.6213 to -0.3913	3.943 - 4.086	0.974
TL = $a + b \times PoDL$	-0.086	1.44	-0.1585 to -0.0144	1.422 - 1.456	0.988
TL = $a + b \times PcL$	-1.154	5.18	-1.3040 to -1.0043	5.066 - 5.285	0.964
TL = $a + b \times PrAnL$	-0.484	4.06	-0.5943 to -0.3745	3.995 - 4.133	0.976
TL = $a + b \times PoAnL$	-0.016	1.36	-0.0835 to 0.0516	1.345 - 1.375	0.990

n , sample size; a , intercept; b , slope; CI, confidence intervals; r^2 , co-efficient of determination

4. Discussion

Information on morphometric and meristic characteristics of *T. fasciata* is very few in literature from Bangladesh and elsewhere. However, the current study reveals the morphometric characteristics of *T. fasciata*, including length-weight relationships using several length

measurements (TL, SL, PcL, etc); length-length relationship and meristic counts.

The LWR is useful in differentiating populations as variations occur in populations of different localities (Le Cren, 1951; Chonder, 1972). In the present study, a total of 324 specimens from small to larger body sizes were sampled; however, the sampling of individuals smaller than 3.1 cm in TL was not possible, which can be

attributed to the selectivity of the fishing gear, but not to their nonappearance on the fishing grounds nor was it because fishermen were not fishing where the smaller sizes present (Rahman *et al.*, 2012; Hossain *et al.*, 2017a; 2017b; Parvin *et al.*, 2018; Azad *et al.*, 2018; Khatun *et al.*, 2019).

In the current study, the observed maximum length of *T. fasciata* was 8.8 cm in TL which is higher than Nitai beel (TL=8.14) (Kalita *et al.*, 2016) and Deepor Beel, India (TL= 8.10) (Borah *et al.*, 2017), but lower than the maximum documented value of 12.5 cm in TL (Menon, 1999) and 9.6 cm TL (Sarkar *et al.*, 2013) from the Ganga River, India. Information on maximum length is necessary for the estimation of growth parameters i.e., asymptotic length and growth co-efficient of fishes, which is significant for fisheries' resource planning and management (Hossain *et al.*, 2018, Khatun *et al.*, 2018). In this study, the total number of fin rays of dorsal fin is XV-XVII/10-14, pectoral fin 9-10, pelvic fin 1, Anal fin XV-XVIII/15-19 and caudal fin 18-20 which is similar to what was reported by Rahman (2005); Talwar & Jhingran (2001) and Shafi & Quddus (1982).

The allometric co-efficient (*b*) values of LWRs may vary between 2.0- 4.0 (Carlander, 1969); however, values ranging from 2.5 to 3.5 are more frequent (Froese, 2006). In the present study, the *b* value was 2.72, which designates a negative allometric growth for *T. fasciata* in the Gajner Beel. Similar findings were also reported by Kalita *et al.* (2016) (*b*= 2.58) from the Nitai Beel and Borah *et al.* (2016) (*b*= 2.78) from the Deepor Beel, India. However, in an earlier study, Hossain *et al.* (2017a) reported a positive allometric growth (*b*= 3.29) in the Gajner Beel, which is inconsistent with what was reported by the current study. The *b* value of the same species may vary from one study to another due to the uses of different fishing gear with different mesh sizes, variations in number of specimen examined (Hossain *et al.*, 2013; Ahamed *et al.*, 2017), and the preservation technique of the samples (Tesch, 1971). Furthermore, such variations between studies may be influenced by the habituated, seasonal variation, sex and the health condition of fishes (Froese, 2006). The results of the present study are useful as baseline data for the species with no previous length-weight relationships as well as for comparisons for future studies; in majority of the cases, the value was not equal to 3.0. This difference was attributed to possible influence of sex and other internal and external factors on growth as described by Le Cren (1951) where generally *b* values equal to 3.0, which indicates that fish grow up isometrically; however, if the values are different from 3.0, this indicates an allometric growth (>3 positive allometry and <3 negative allometry) (Tesch, 1971).

The data of *T. fasciata* were collected over an extended period of time, not representative of any particular season. The LLRs of *T. fasciata* are highly correlated. In spite of the sufficient literature, the current study found the finest model amid equations using different lengths based on the coefficient of determination, which will offer a baseline for comparisons to future studies using any linear dimension.

5. Conclusion

The results of this study would be a tool for fishery managers, fish biologists to identify *T. fasciata* and initiate stock assessment of this least concern species in the wetland ecosystem of Bangladesh and neighboring countries.

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Conflicts of Interest

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

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