

# Morphometric Relationships of the Endangered Ticto barb *Pethia ticto* (Hamilton, 1822) in the Ganges River (NW Bangladesh) through Multi-Linear Dimensions

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## Abstract

The present study illustrates the morphometric relationships including Length-Weight Relationships (LWRs) and Length-Length Relationships (LLRs) using a total of 13 linear dimensions and meristic characters of the threatened ticto barb *Pethia ticto* (Hamilton, 1822) in the Ganges River through multi-linear dimensions. A sum of 100 specimen of *P. ticto* was sampled occasionally from the Ganges River during July 2014 to October 2015, using various traditional fishing gears (e.g., cast, gill, and square lift net). Counts of fin rays and scales (including lateral line scale) were done by a magnifying glass. Additionally, here total 14 different morphometric lengths were assessed to 0.1 cm, and Body Weight (BW) was measured to the nearest 0.1 g for each individual. The fin formula of *P. ticto* is: dorsal, D. 10–11 (ii/8-9); pectoral, P<sub>1</sub>. 12 (ii/10); pelvic, P<sub>2</sub>. 8- 9 (ii/6-7); anal, A. 7-8 (ii/5-6); and caudal, C. 20–24 (iv /16–20), respectively. Total Length (TL) was recorded as minimum (4.9 cm) and maximum (9.5 cm), whereas Body Weight (BW) was varied from 1.5-12.9 g. All LWRs were highly significant ( $p < 0.001$ ) with  $r^2$  values  $\geq 0.987$ . Based on  $r^2$  value, LWR by BW vs. TL was the best-fitted model among 14 equations. In addition, the LLRs had also significance with  $r^2$  values  $\geq 0.986$ . According to  $r^2$  values, LLR by TL vs. FL was the best-fitted model among 13 equations. The present study is very effective for species recognition in the Ganges River, NW Bangladesh and in other river systems in its vicinity.

**Keywords:** Bangladesh; *Pethia ticto*; morphometric and meristic characters, Ganges River.

## 1. Introduction

The ticto barb, *Pethia ticto* (Hamilton 1822), is a fresh- and brackish-water subtropical, small-indigenous fish belonging to the family Cyprinidae. It is found in still, shallow waters and rivers, frequently with muddy bottoms (Bisht & Das 1981). *P. ticto* is a native species of the Asian countries, i.e., Bangladesh, India, Myanmar, Nepal, Pakistan, Sri-Lanka and Thailand (Talwar & Jhingran 1991). This species is a commercially important target species for small-scale fishers in Bangladesh, and elsewhere in Asia, who apply a variety of traditional fishing gears (Rahman 1989). It is also the most favored aquarium fish among barb species in Asian countries (Froese & Pauly 2016). *P. ticto* is a considerable source

of animal protein and micro-nutrients in the diet of rural small-scale farmers (Roos *et al.*, 2007). It is vulnerable in Bangladesh (IUCN Bangladesh, 2015); lower risk but near threatened in India (Balasundaram *et al.*, 2000; Sarkar *et al.*, 2010); threatened in Sri-Lanka (IUCN Sri-Lanka 2000).

Morphometric and meristic characteristics are helpful for species recognition and classification (Begenal & Tesch 1978; Jayaram 1999, Hossen *et al.*, 2016). Furthermore, morphometric characters play a vital role in fisheries research, as it is used for comparing life history and morphological trends of populations across regions (Hossain *et al.*, 2017a, 2016a; Elahi *et al.*, 2017). Morphometric and meristic characteristics, including Length-Weight Relationships (LWRs) (Hossain *et al.*,

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2016b, 2017b), and length-length relationships (Hossain *et al.*, 2006, 2016c) of many threatened species of Bangladesh, are well documented, but none covers a large quantity of linear dimensions. However, only a few conservation studies including LLR and LWR have been done on the ticto barb (Hossain *et al.*, 2009a, 2009b, 2014, 2015a; Hossain, 2010, 2014; Kaushik & Bordoloi, 2015). Therefore, the present study illustrates the morphometric and meristic traits of *P. ticto* from the Ganges River, northwestern (NW) Bangladesh using a number of specimens with a wide variety of body sizes.

## 2. Material and Methods

A total of 100 individuals of *P. ticto* (see Figure 1) was collected occasionally from the Ganges River (24°22' N; 88°35' E; known as the Padma River in Bangladesh) during July 2014 to October 2015 using various types of traditional fishing gears that include cast net (mesh size ranges: 1.5 - 2.5 cm), gill net (mesh size ranges: 1.5–2.0 cm), and square lift net (mesh size: ~2.0 cm). The fresh samples were instantly chilled in ice on site and fixed with 10% buffered formalin upon arrival in the laboratory, where all morphometric and meristic features were computed according to Froese & Pauly (2016).



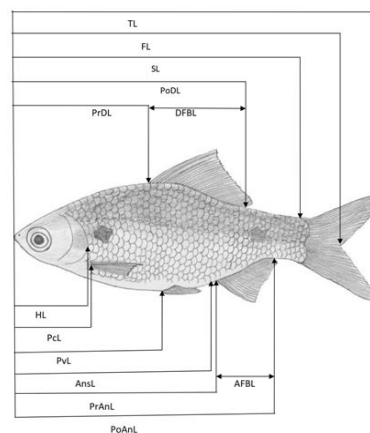
**Figure 1.** Photo of *Pethia ticto*, collected from the Ganges River, northwestern Bangladesh on 5 June 2015

The total number of the fin rays and scales in different body parts (including the lateral line) was counted by using magnifying glass. Body Weight (BW) of each individual was weighed using an electronic balance and different linear dimensions, i.e., lengths (see Table 1 and Figure 2) were measured with digital slide calipers to the nearest 0.1 g and 0.1 cm accuracy, respectively. The LWR was calculated with the equation:  $W = a \times L^b$ , where  $W$  is the Body Weight (BW) and  $L$  is the 14 different lengths in cm. The parameters  $a$  and  $b$  were calculated through linear regression analyses depends on natural logarithms:  $\ln(W) = \ln(a) + b \ln(L)$ . Moreover, 95% confidence limit (CL) of  $a$  and  $b$  and the co-efficient of determination ( $r^2$ ) were estimated. Extreme outliers were excluded from the regression analyses. A t-test was used to verify whether  $b$  values obtained in the linear regressions were significantly dissimilar from the isometric value ( $b = 3$ ), (Sokal & Rohlf 1987). In the present study, 13 LLRs were analyzed by linear regression analysis (Hossain *et al.*, 2006). The best model for both LWRs and LLRs was selected depending on the highest value of determination  $r^2$ . Statistical analyses were carried out with Graph Pad Prism 6.5 software. All statistical analyses were significant at 5% ( $p < 0.05$ ).

**Table 1.** Morphometric measurements of the *Pethia ticto* (Hamilton, 1822) ( $n = 100$ ) captured from the Ganges River, northwestern Bangladesh.

Measurements	Min (cm)	Max (cm)	Mean $\pm$ SD	Mode	95% CL	%TL
TL (Total length)	4.9	9.5	7.69 $\pm$ 1.08	8.3	7.48-7.90	
BW (Body weight)	1.5	12.9	7.06 $\pm$ 2.88	4.8	6.49-7.63	91.9
FL (Fork length)	4.2	8.5	6.82 $\pm$ 1.03	7.7	6.61-7.02	88.6
SL (Standard length)	3.6	7.5	5.88 $\pm$ 0.93	6.5	5.69-6.06	76.5
HL (Head length)	0.8	1.9	1.48 $\pm$ 0.26	1.7	1.43-1.53	19.3
PcL (Pectoral length)	0.9	1.8	1.42 $\pm$ 0.22	1.6	1.38-1.46	18.5
PvL (Pelvic length)	1.7	3.5	2.76 $\pm$ 0.41	3.1	2.68-2.84	35.9
PrDL (Pre Dorsal length)	1.7	3.6	2.89 $\pm$ 0.40	3.2	2.81-2.97	37.6
PoDL (Post Dorsal length)	2.4	4.9	3.90 $\pm$ 0.57	4.3	3.79-4.01	50.7
DFBL (Dorsal fin base length)	0.7	1.3	1.01 $\pm$ 0.18	1.1	0.97-1.04	13.1
PrAnL (Pre Anal length)	2.7	5.2	4.20 $\pm$ 0.58	4.7	4.08-4.31	54.6
PoAnL (Post Anal Length)	3.1	6	4.80 $\pm$ 0.70	5.4	4.67-4.94	62.5
AFBL (Anal fin base length)	0.4	0.8	0.61 $\pm$ 0.12	0.7	0.58-0.63	7.9
AnsL (Anus length)	2.5	5.1	4.02 $\pm$ 0.63	4.5	3.89-4.14	52.3
BD (Body depth)	1.4	3.2	2.4 $\pm$ 0.41	2.7	2.32-2.48	31.2

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



**Figure 2.** Showing the morphometric measurements of *Pethia ticto* from the Ganges River, Northwestern Bangladesh

### 3. Results

The body of *P. ticto* is elongated, strongly compressed, and silvery with two black spots (one above the pectoral fin and the other on the central point of the caudal peduncle). The mouth is small and terminal, with no barbel.

There are about 25-29 scales in the lateral line, 4.5-6.5 scales above the lateral line, and 6.5-7.5 scales beneath the lateral line. In addition, 9-10 pre-dorsal scales were found. All morphometric and meristic measurements are given in Table 1 & 2. The fin formula of *P. ticto* is dorsal, D. 10-11 (ii/8-9); pectoral, P<sub>1</sub>. 12 (ii/10); pelvic, P<sub>2</sub>. 8- 9 (ii/6-7); anal, A. 7-8 (ii/5-6); and caudal, C. 20-24 (iv /16-20), respectively. In the present study, TL was varied from 4.9-9.5 cm (mean ± SD = 7.69 ±1.08) and BW was ranged from 1.5-12.9 g (mean ± SD = 7.06 ±2.88). Fork length (88.6%) and standard length (76.5%) showed higher proportion of TL (Table 1).

The regression parameters (*a* and *b*), their 95% confidence intervals, coefficients of determination (*r*<sup>2</sup>) for LWRs, of *P. ticto* are given in Table 3. All LWRs were highly significant (*p* < 0.001) with *r*<sup>2</sup> values ≥ 0.904. Based on *r*<sup>2</sup> value, LWR by BW vs. TL was the best fitted model among 14 equations. LLRs, which are shown in Table 4, were also highly correlated with *r*<sup>2</sup> values ≥ 0.902. Based on maximum values of *r*<sup>2</sup>, LLR by TL vs. FL was the best-fitted model among 13 equations.

**Table 2.** Meristic characters of *Pethia ticto* (Hamilton, 1822) (*n* = 100) captured from the Ganges River, northwestern Bangladesh.

Meristic data	Numbers	(Unbranched /Branched)
Dorsal fin rays	10-11	(ii/8-9)
Pectoral fin rays	12	(ii/10)
Pelvic fin rays	8-9	(ii/6-7)
Anal fin rays	7-8	(ii/5-6)
Caudal fin rays	20-24	(iv/16-20)
Lateral line scale	25-29	
Scale upper the lateral line to base of dorsal fin	4.5-6.5	
Scale below the lateral line to pelvic fin	6.5-7.5	
Pre-dorsal scale	9-10	

Unbranched, single fin ray; Branched, upper portion of fin is divided into several rays

**Table 3.** Descriptive statistics and estimated parameters of the length-weight relationships of *Pethia ticto* (Hamilton, 1822) (*n* = 100) from the Ganges River, northwestern Bangladesh.

Equation	<i>a</i>	<i>b</i>	95% CI of <i>a</i>	95% CI of <i>b</i>	<i>r</i> <sup>2</sup>
BW= <i>a</i> × TL <sup><i>b</i></sup>	0.0086	3.26	0.0074-0.0101	3.18-3.33	0.987
BW= <i>a</i> × FL <sup><i>b</i></sup>	0.0208	3.00	0.0179-0.0241	2.95-3.08	0.984
BW= <i>a</i> × SL <sup><i>b</i></sup>	0.0416	2.86	0.0352-0.0492	2.77-2.96	0.973
BW= <i>a</i> × HL <sup><i>b</i></sup>	2.4798	2.51	2.3319-2.6371	2.37-2.66	0.922
BW= <i>a</i> × PcL <sup><i>b</i></sup>	2.3879	2.90	2.2879-2.4922	2.79-3.02	0.963
BW= <i>a</i> × PvL <sup><i>b</i></sup>	0.2838	3.10	0.2540-0.3172	2.99-3.21	0.970
BW= <i>a</i> × PrDL <sup><i>b</i></sup>	0.0219	3.24	0.1860-0.2413	3.12-3.36	0.966
BW= <i>a</i> × PoDFL <sup><i>b</i></sup>	0.0941	3.13	0.0835-0.1060	3.04-3.21	0.981
BW= <i>a</i> × DFBL <sup><i>b</i></sup>	6.5258	2.52	6.3417-6.7153	2.37-2.68	0.912
BW= <i>a</i> × PrAnL <sup><i>b</i></sup>	0.0574	3.31	0.0512-0.0644	3.23-3.39	0.985
BW= <i>a</i> × PoAnL <sup><i>b</i></sup>	0.0469	3.15	0.0416-0.0530	3.07-3.23	0.985
BW= <i>a</i> × AnFBL <sup><i>b</i></sup>	19.7283	2.18	18.2198-21.3618	2.03-2.32	0.904
BW= <i>a</i> × AnsL <sup><i>b</i></sup>	0.1148	2.92	0.1025-0.1285	2.83-3.00	0.981
BW= <i>a</i> × BD <sup><i>b</i></sup>	0.6669	2.63	0.6074-0.7323	2.52-2.73	0.961

See Table 1 for abbreviations; *n*, sample size; *a* and *b* are LWR parameters; CI, confidence intervals; *r*<sup>2</sup>, coefficient of determination

**Table 4.** The estimated parameters of the length-length relationships ( $y = a + b \times x$ ) *Pethia ticto* of (Hamilton 1822), ( $n = 100$ ) from the Ganges River, northwestern Bangladesh.

Equation	Regression parameters		95% CI of $a$	95% CI of $b$	$r^2$
	$a$	$b$			
TL = $a + b \times$ FL	0.6124	1.039	0.4413- 0.7835	1.014- 1.063	0.986
TL = $a + b \times$ SL	0.9867	1.140	0.7480- 1.2253	1.100- 1.180	0.970
TL = $a + b \times$ HL	1.6581	4.076	1.3392- 1.9770	3.863- 4.288	0.937
TL = $a + b \times$ PcL	0.8854	4.789	0.6469- 1.1238	4.623- 4.954	0.971
TL = $a + b \times$ PvL	0.4491	2.620	0.1990- 0.6992	2.530- 2.710	0.972
TL = $a + b \times$ PrDL	0.0040	2.659	-0.2601- 0.2680	2.568- 2.750	0.972
TL = $a + b \times$ PoDL	0.3716	1.877	0.1426- 0.6010	1.819- 1.936	0.977
TL = $a + b \times$ DFBL	1.8145	5.835	1.4208- 2.2083	5.450- 6.220	0.902
TL = $a + b \times$ PrAnL	-0.0704	1.850	-0.2503- 0.1094	1.807- 1.892	0.985
TL = $a + b \times$ PoAnL	0.3108	1.536	0.1520- 0.4695	1.503- 1.569	0.984
TL = $a + b \times$ AnFBL	2.6094	8.356	2.3025- 2.9162	7.861- 8.851	0.920
TL = $a + b \times$ AnsL	0.8704	1.697	0.6826- 1.0582	1.651- 1.743	0.982
TL = $a + b \times$ BD	1.5067	2.576	1.2787- 1.7348	2.483- 2.670	0.985

See Table 1 for abbreviations;  $n$ , sample size;  $a$ , intercept;  $b$ , slope; CI, confidence intervals;  $r^2$ , co-efficient of determination

#### 4. Discussion

There are very few studies on morphometric and meristic characters of *P.ticto* (Talwar & Jhingran 1991; Hossain *et al.*, 2009a; Kaushik & Bordoloi, 2015). In the present study, we found 25-29 scales in the lateral line, 10-11 dorsal fin rays, 12 pectoral fin rays, 7-8 anal fin rays and 8-9 pelvic fin rays were observed, which was dissimilar to the studies done by Talwar & Jhingran (1991).

A total of 100 individuals collected for the present study comprised various body sizes (4.9 – 9.5). However, during this study, absence of *P. ticto* smaller than 4.9 cm TL may be attributed either to the fishermen who did not catch the smaller size due to low market price or to the selectivity of fishing gears (Hossain *et al.*, 2012a, 2016d, 2017c). In the present study, maximum length recorded (9.5 cm) is lower than the maximum length (TL= 10.0 cm) reported by Talwar & Jhingran (1991). Maximum length helps to estimate the growth parameters, i.e., asymptotic length, growth coefficient, vital for fisheries resource planning and management (Ahmed *et al.*, 2012).

The allometric co-efficient ( $b$ ) values of LWRs ranging from 2.5 to 3.5 are more common (Froese, 2006). In the present study, most of the  $b$  values were in the limit of 2.5–3.5, which is similar to Hossain *et al.* (2009a) who estimated the  $b$  value as 2.92 for *P. ticto*, though some were within the range of 2.0–4.0. However,  $b$  values may vary in the same species due to one or more factors, these include growth differences among organs, genders, and preservation methods, additionally differences in the physiology and the examined length series of the specimens collected (Tesch, 1971; Hossain *et al.*, 2012b, 2015b), which were not considered in this study. In addition, all the LLRs were highly correlated. Due to lack of literature data, it restrains to compare our results with other findings except the study by Kaushik and Bordoloi (2015). However, the present study found the best model among equations using different lengths based on coefficient of determination, which will offer baseline for comparisons with future studies using any linear dimension.

The present study should be a valuable tool for fishery managers to identify *P. ticto* and initiate stock assessment of the existing stocks of this threatened species in the Ganges River, NW Bangladesh and other subtropical countries. Also, these results will impart valuable information for the FishBase and providing an important baseline for future studies within the Ganges River and surrounding 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.

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