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# Length-Weight, Length-Length relationships and condition factor of the endangered yellowtail catfish *Pangasius pangasius* collected from the Meghna River Estuary, Bangladesh

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**ABSTRACT**

The current study was conducted to assess the length-weight relationship (LWR), length-length relationship (LLR), and condition factor of the yellowtail catfish *Pangasius pangasius* at its juvenile and matured stages. A total of 274 juvenile (8.80-20.20 cm) and 38 (68.50-105.90 cm) matured individuals were collected from the Meghna River Estuary (MRE) in Bangladesh from March to December 2020. The total length (TL) and standard length (SL) of collected samples were measured through digital slide calipers (for juvenile) and measurement tape (for adults). Individual fish weight (W) was determined using a digital balance. The length-frequency distribution of *P. pangasius* showed unimodal for the juvenile stage and bimodal for adult stages. The regression coefficient '*b*' obtained from LWR was recorded as 2.25 for juveniles and 3.15 for adults, with a significant positive correlation (r = 0.88 and 0.96, respectively, $p$ <0.01). Highly positive relationships were observed between total length (TL) and standard length (SL) of the species at both juvenile and adult stages (r = 0.96 and 0.98, respectively, $p$ <0.01), recording regression equations as TL = 0.67 + 1.21 SL and TL = 11.46 + 0.99 SL, respectively. The regression analysis of all LWR and LLR were significant ($p$ <0.01). Fulton's condition factor was found lower at the juvenile stage (0.81±0.21) and higher at the adult stage (1.21±0.14). However, this work form provides the first attempt to document the growth pattern of juvenile and adult *P. pangasius* from the MRE, which might be useful for the policymakers to make effective management plans to conserve the natural stock of the species.

## INTRODUCTION

The yellowtail catfish *Pangasius pangasius* (**Hamilton, 1822**) is one of the most commercially essential and nutritious riverine fish with high protein (26.06%) and fat (14.79%) contents in its flesh **(Islam *et al.*, 2012; Monalisa *et al.*, 2013)**. In Bangladesh, this species is locally named "deshipangus" and is granted with a very high market price (nearly 5 – 10 times higher than *P. hypophthalmus*) for its gorgeous and delicious. This

species is a carnivorous and voracious fish, occurring in high estuary as juveniles, moving to brackish water as sub-adults and finally as adults reaching river mouths and inshore areas **(Nima *et al.*, 2018)**. *Pangasius pangasius* is available in the South- East Asian countries including Bangladesh, India, Pakistan, Myanmar, Malaya-peninsula, Indonesia, Vietnam, Java and Thailand **(Talwar & Jhingran, 1991; Tripathi 1996; Chondar, 1999)**.

Although *P. pangasius* was abundant previously in the rivers and estuaries of Bangladesh, serious declines in its population and abundance have been observed in recent years **(Hossain *et al.*, 2009)** and is now only found in the Padma and Meghna River system in Bangladesh. It is inferred that the natural population of the species has witnessed a decline of about 50% in the last 20 years **(IUCN, 2015)** due to various factors, such as over exploitation, habitat degradation, water pollution, destruction of the breeding grounds and the lack of proper management **(Gupta, 2016)**. Among different causes for this decine, 'Chai fishing' ('Chai' is a very big cylindrical shaped fishing trap, tapering little at both ends, made with bamboo splits and used for indiscriminate killing of catfish fingerlings mainly *Pangasius* fingerlings) is highly considered. Every year, a huge number of juvenile pangus (< 30 cm) are captured indiscriminately using 'Chai' in the MRE **(Nima *et al.*, 2018)**. Due to the drastic declination of *P. pangasius* in natural water bodies, it has been categorized as "endangered" in Bangladesh and vulnerable to extinction from the natural sources **(IUCN, 2015)**. Thus, an appropriate conservation step is urgently required to save the species, and an adequate information on the species biology is a prerequisite for making any conservation strategy to attain its effective implementation.

The length frequency (LFD) distribution of any fish is important to know the status of size structure and stock assessment of that fish population in nature **(Sparre *et al.*, 1989)**. The study of the length-weight relationship (LWR), length-length relationship (LLR) and condition factor (K) of fish is crucial for fishery assessment studies, providing information on fish growth and fitness in the riverine ecosystem. It has been widely implemented as a standard method to yield basic biological information that can be applied worldwide for fishery management **(Le Cren, 1951)**. LWR, LLR along with condition factor (K) are radical external traits for measuring the health condition of fish species **(Nehemia *et al.*, 2012; Mortuza & Al-Misned, 2013)**, which is greatly influenced by the age and life stage of fish **(Mazumder *et al.*, 2016)**.

Though few studies have been conducted on LWR and the condition factor of adult *P. pangasius* **(Yusof *et al.*, 2011; Deka & Gohain, 2015**; **Mortuza & Al-Misned, 2015)**, no work has investigated the largest habitat Meghna River Estuary (MRE). After Hilsa, riverine catfishes (*P. pangasius*, *Sperata aor*, *Bagarius bagarius* and *Rita rita*) constitute the highest proportion (29%) of production in volume (**Pramanik *et al.*, 2017**) in the MRE. Furthermore, the prospective knowledge on its early life stages is scarce; though in some species, individual fish characteristics during the juvenile stage form a critical

factor in predicting the probability of surviving to adult-hood **(Evans *et al.*, 2014)**. Therefore, the present study was organized to determine the LWR, LLR and the condition factor (K) of *P. pangasius*, at its both juvenile and adult stages, to clarify its pattern of growth and general well-being in the MRE. In addition, this work was managed to introduce baseline information on this species for the management and conservation practices related to it.

## MATERIALS AND METHODS

A total of 274 juveniles of *P. pangasius* were collected through direct purchasing from the 'chai' fishing in Chandpur (23°14′38″ N; 90°38′09″ E), Laksmipur (22°57′17″ N; 90°37′43″ E) and Bhola (22°20′38″ N; 90°59′12″ E) during the period from March to December 2020. Matured *P. pangasius* is rarely to caught and 38 fish were collected from the local fishers of the afore-mentioned districts during the study period. The collected samples were kept in polystyrene box, with ample crushed ice and were immediately transported to the laboratory. The total length (TL) and standard length (SL) of juvenile and adult fish were measured with a digital slide calipers having ±0.01mm accuracy (EAGems-B00Z5KETD4) and a measurement tape nearest to 0.1 cm, respectively. Individual weight (W) of juvenile and adult fish were also taken through two different digital balance, with ±0.01g (Shimadzu UX320G) and ±1.0 g accuracy (BH-124), respectively.

Length frequency distribution (LFD) of *P. pangasius* was used in this study through multiple length frequency data sets on the basis of TL of all individuals. LFD values were aggregated into 1 cm (juvenile) and 3 cm (adult) interval length class to estimate the pattern of this fish in different cohorts. LFDs for each cohort were conducted by histogram.

The length-weight relationship (LWR) was calculated using the conventional formula of **Le Cren (1951)** as follows:

$$W = aL^b$$

Where; W= weight of fish (g), L= total length (cm), a= intercept of the regression and b= regression coefficient. Parameters a and b were obtained from log transformed equation **(Froese, 2006)**. The log transformed data represent the least square linear regression equation.

$$\text{Log } W = \text{Log } a + b \text{ Log } L$$

The growth is determined isometric when b value is equivalent to three, otherwise allometric growth is concluded, which may be either positive (if, $b>3$) or negative (if, $b<3$) **(Nehemia *et al.*, 2012)**.

The length-length relationship (LLR) was determined by the method of least squares to fit a simple linear regression model as follows **(Alam *et al.*, 2012)**.

$$Y = p + qX$$

Where; Y= total length (cm), X= standard length (cm), p= proportionality constant and q= regression coefficient.

The condition factor (K) was calculated using the following formula **(Fulton, 1904)** to estimate the degree of the wellbeing of fish:

$$K = 100 \times (W/L^3)$$

Where; K= Condition factor, W= Weight of fish (g) and L= Total length of fish (cm).

**Statistical analysis:**

Statistical analysis was performed using SPSS version 20.0 statistical software package (IBM®) at 0.01 significant level, while relevant graphs and tables were prepared using Microsoft Excel® (2010). Data were presented as arithmetic mean ± standard deviation if otherwise not mentioned.

## RESULTS

The total length of juvenile and adult *P. pangasius* ranged from 8.80 - 20.20 cm and 68.50 - 105.90 cm, respectively, and weight ranged from 7.13 - 62.84 g and 3500 - 12078 g, respectively. The length-frequency distribution (LFD) of *P. pangasius* varied between juvenile and adult stages, where juvenile stage showed unimodal distribution; whereas, adults showed bimodal distribution. The highest frequency was obtained in 13.80 cm size group of juveniles accounted for 50 individuals (Fig. 1a) and 77.50 cm size group of adults accounted for 8 individuals (Fig. 1b).

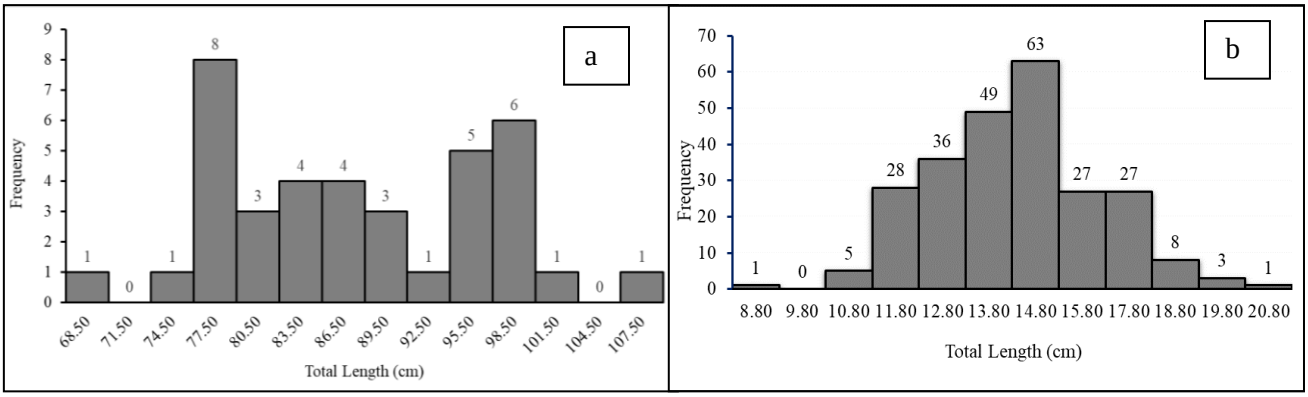


**Fig. 1.** Histograms showing **(a)** length frequency distribution of juvenile and **(b)** adult *P. pangasius*

LWR parameters, with their descriptive statistics for juvenile and adult species, are presented in Table (1). The total length and weight of the species for both juvenile and adult were highly positively correlated (r = 0.88 and 0.96, respectively, $p < 0.01$). LWR revealed the allometric growth pattern of the species owing to the regression coefficient '*b*' = 2.25 of juvenile and 3.15 for adult (Table 1). The obtained values were transformed into parabolic form and the equation was found as $W=0.057L^{2.25}$ for juvenile (Fig. 2a) and $W=0.006L^{3.15}$ for adult (Fig. 2b). The regression analysis of all LWR were significant ($p < 0.01$).

**Table 1.** Descriptive statistics and estimated parameters of length-weight relationship (LWR) and length-length relationship (LLR, TL against SL) for juvenile and adult *P. pangasius* in the Meghna River Estuary (MRE), Bangladesh

| Life stage | | TL (cm) | | W (g) | | LWR parameters | | | | | LLR parameters | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | n | Min | Max | Min | Max | a | $aCL_{95\%}$ | b | $bCL_{95\%}$ | $r^2$ | p | q | $r^2$ |
| Juvenile | 274 | 8.80 | 20.20 | 7.13 | 62.84 | -1.24 | -1.42 - (-1.05) | 2.25 | 2.09 – 2.41 | 0.74 | 0.67 | 1.21 | 0.93 |
| Adult | 38 | 68.50 | 105.90 | 3500 | 12078 | -2.22 | -2.91 -(-1.53) | 3.15 | 2.80 – 3.51 | 0.90 | 11.46 | 0.99 | 0.97 |

Abbreviations: a, intercept of LWR; b, slope of LWR; CL, confidence limits; n, number of individuals; p, intercept of LLR; q, slope of LLR; $r^2$, coefficient of determination.

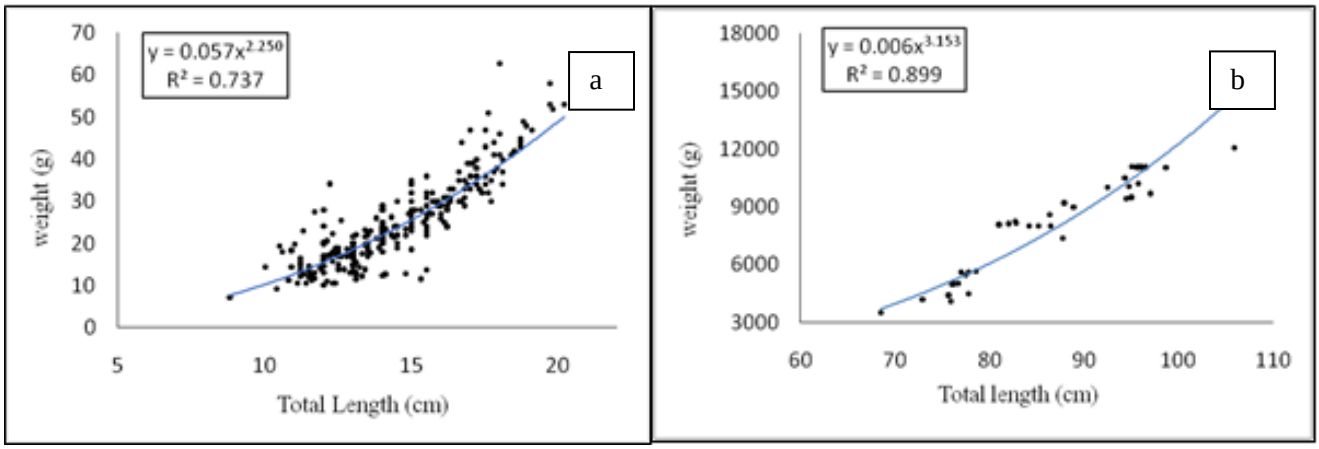


**Figure 2:** Histograms showing parabolic relationship between total length and weight of (a) juvenile and (b) adult *P. pangasius*

Morphometric relationship of TL vs SL was estimated by linear regression equation, where the established equations were TL = 0.67 + 1.21 SL for juvenile and TL = 11.46 + 0.99 SL for adult; with all coefficient of determination ($r^2$) value being greater than 0.9 (Table 1). The regression analysis of all LLR were significant ($p$ <0.01).

The condition factor (K) is an indicator of general well-being of the fish, based on hypothesis that heavier fish for a given length are in better condition **(Bagenal & Tesch, 1978**). In the present study, the 'K' value in juvenile fish ranged from 0.32 to 1.88, with an average of 0.81±0.21; whereas in adult, fish ranged from 0.94 to 1.52 with an average of 1.21±0.14.

## DISCUSSION

*P. pangasius* is a very high demanded fish in Bangladesh, which ultimately forces higher or indiscriminates fishing pressure on the species **(Nima *et al.*, 2018)**. Although the species was abundant once in the riverine habitats of Bangladesh, yet the wild

population of the species is nowadays facing a great threat of extinction. To the best of our knowledge, informative data on the LFD, LWR, LLR and condition factor (K) of this fish are not available for its juvenile stage, and this assumption applies also to the adult stage in the MRE. However, this is the first attempt to detect the growth pattern and general well-being of this species for both juvenile and adult stages from the MRE.

In the present study, 274 juvenile and 38 adult specimens were considered for Length frequency distribution (LFD). The LFD of juvenile and adult *P. pangasius* did not have equal intervals due to different size groups, in addition to the adults showig bimodal distribution. The bimodal distribution of the species might be associated with different cohorts as the samples were collected from its natural habitat; natural population do not exist in ideal size range due to the number of environmental factors including rainfall, temperature, food availability and pollution of the habitat etc. **(Adebiyi *et al.*, 2013)**.

The total length and weight of the collected fish samples were considered to determine the growth pattern of *P. pangasius* in the MRE. It was observed that the LWR parameter '*b*' varied in juvenile and adult stages. The value of regression coefficient '*b*' in LWR remains constant at 3 for an ideal fish living in an ideal condition **(Le Cren, 1951)**. However under natural condition, the differences in the '*b*' value could be attributed to several factors including seasonality, habitat, gonad maturation, feeding intensity, age, sex and geographic region **(Mazumder *et al.*, 2016; Mushtaq *et al.*, 2018)**. In the present study, the '*b*' value of the juvenile pangus (2.25) indicates that the fish becomes less rotund with the increase of the length and reversely for the adult pangus, which is very common phenomenon among fish. In early life stage, they grow much in length compared to weight. The result of the present study is comparable with the findings of **Yusof *et al.*, (2011), Deka and Gohain (2015)** and **Mortuza and Al-Misned (2015)** who reported that, the '*b*' values of the same species were 3.43, >3 and 2.72, respectively. **Deka and Gohain (2015)** and **Mortuza and Al-Misned (2015)** studied the adult *P. pangasius* (total length 41.1-78 cm and 117.7 cm; weight 3.00-2.10 kg, and 16.00 kg, respectively) and observed the positive allometric growth pattern of the species. On the other hand, **Yusof *et al.* (2011)** worked on comparatively small sized *P. pangasius* (total length and weight were 31.0-38.0 cm and 230.0-535.0 g, respectively) and recorded the negative allometric growth pattern. Consequently, it can safely be assumed that the observed variation of exponential '*b*' value in the same species is associated with the age of the species. In addition, the correlation coefficient value of LWR of juvenile and adult *P. pangasius* was high (r = 0.88 and 0.96, respectively, $p < 0.01$), indicating high degree of relationship in growth performance. The LLR is very significant in fisheries management for comparative growth studies **(Moutopoulos & Stergiou, 2002)**. Results of LLR showed that TL-SL is highly correlated in both juvenile and adult stages of *P. pangasius* (r = 0.96 and 0.98, respectively).

The condition factor (K) is an important quantitative parameter to determine the relative degree of robustness and nourishment in fish **(Mortuza & Al-Misned, 2013)**; it

can be used as an index to assess the status of the aquatic ecosystem in which the fish lives **(Barnham, 1998)**. In the present study, Fulton's condition factor (K) was used to assess the overall health condition of *P. pangasius* at its juvenile and adult life stages. The observed 'K' value was 0.81 ± 0.21 at its juvenile stage and 1.21 ± 0.14 at its adult stage. The lower 'K' value in juvenile stage and higher 'K' value in adult stage might be associated with the age of fish, since age and maturity stage of fish extremely influences the value of condition factor **(De Silva & Silva, 1979; Hoda, 1987; Narejo *et al.*, 2002)**. The 'K' value of a population not only depends on species physiology, but also on environmental elements, such as temperature, rainfall, salinity, nutrient availability and oxygen concentration among others **(Khristenko & Kotovska, 2017**). The higher K value in adult stage indicates the good health condition of *P. pangasius* in the environment of MRE. Therefore, it can be concluded that MRE, still able to provide enough food and other environmental conditions to proliferate the species and over-exploitation, might be the main cause of threating the species towards extinction. The present study provides the fundamental knowledge that could have conservation implications and might attract the fish biologist and policy makers.

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