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Length-Weight Relationship And Condition Factor Of Fourfinger Threadfin (Eleutheronema Tetradactylum, Shaw 1804) In The Shibsa River Estuary, Bangladesh.

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Abstract: The fourfinger threadfin, *Eleutheronema tetradactylum* (Shaw, 1804), is an economically important coastal fish species in Bangladesh, but information on its growth characteristics and body condition in the Shibsa River estuary remains limited. This study investigated the length-weight relationship (LWR) and condition factors of *E. tetradactylum* in the Shibsa River estuary, Bangladesh. A total of 100 individuals were collected from July 2022 to June 2023 with the assistance of local fishermen. Total length (TL) and body weight (BW) were recorded, and the length-weight relationship was estimated using the equation $W=aL^b$. Fulton's condition factor (Kc), relative condition factor (Kn), and relative weight (Wr) were also calculated. The sampled fish ranged from 7.10 to 79.50 cm in TL and 2.17 to 3370.00 g in BW, with mean values of 20.25 ± 15.44 cm and 220.49 ± 570.84 g, respectively. The LWR showed a strong and significant relationship ($BW=0.0057TL^{3.11}$; $R^2=0.998$, $p<0.001$), with a positive allometric growth pattern (b = 3.11). The mean Kc, Kn, and Wr were 0.73±0.08, 1.06±0.09, and 106.34±9.21, respectively. The predominance of smaller individuals in the sample and the Kn and Wr values above unity and 100, respectively, suggest relatively favorable body condition of the sampled fish. These findings provide baseline information on the growth characteristics and condition of *E. tetradactylum* in the Shibsa River estuary and may support future fisheries assessment and management of the species.

Keywords: *Eleutheronema tetradactylum*; length-weight relationship; condition factor; growth pattern; relative weight

1. INTRODUCTION

Eleutheronema tetradactylum, (Shaw, 1804), obtained from the family Polynemidae, is one of the valuable species in southwest coastal region of Bangladesh. This four-finger threadfin, or Indian salmon, which is commonly called "derive" gets its name from its four short filaments on the base of the pectoral fin (Jaferian et al., 2010). It is locally called Sahal or Sahala in West Bengal and Rishi Kuchi or Thailla in Bangladesh (Hena et al., 2011; Karna et al., 2012). Generally, this species is found in coastal shallow water (depth 20-100 m) in the Bay of Bengal of the Indian Ocean (Nesarul et al., 2014). It broadly appears in Pakistan, China, South Africa, Taiwan, Madagascar, Indonesia, Malaysia, Hong Kong, the Philippines, and Thailand (Nesarul et al., 2014). It has high nutritional value, especially the high fatty acid content. For human ingestion it is a potential food source of fatty acids (Xiao and Wang, 2023). In the coastal region, it has significant requirements among the people, and day by day it is burgeoning (Hena et al., 2011). For money-oriented fishing, coastal belt fisheries supply a lucrative amount of profit in the country's economy (Naser et al., 2023). This species has great prospects in the coastal belt for cultural purposes (Hena et al., 2011). Shibsa river estuary in Sundarbans reserve forest, Bangladesh has tremendous ecosystem for supporting hundred of piscines as their

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feeding and nursery ground. Feeding habits, rivals for prey, dwelling place, season, health, sex, environmental degradation, and destructive fishing activities are the impact factors for fish growth patterns (Froese, 2006; Huntingford et al., 2006). Besides, climate change is a most powerful factor for fish biology (Little et al., 2020).

The examination of a fishery dependent on the length-weight relationship (LWRs) and condition factor (CF) is crucial for how it grows, habitat changes, and its overall health condition in the real environment (Pauly and Munro, 1984; Batubara et al., 2019; Batubara et al., 2024). This approach enables a researcher to know the fish capture possibility as well as unsustainable fishing pertaining to growth pattern and condition factor (Batubara et al., 2024). In addition, the growth pattern of fish species is described by LWR data in an ecosystem. Conservation efforts and management strategies of threatened fish species will be effective by LWR data (Nieto-Navarro et al., 2010; Camargo et al., 2018).

Regarding this species, studies like stock assessment (Batubara et al., 2024), length-weight relationship and condition factor (Rahman et al., 2024), morphometric study in the Persian Gulf (Jaferian et al., 2010), growth and survival in brackish water ponds (Hena et al., 2011), breeding biology from the Bay of Bengal (Nesarul et al., 2014), reproductive characteristics in tropical coastal water (Soe et al., 2023), growth estimation (Karna et al., 2012), and the genomics (Qu et al., 2020), were conducted. In contrast, the stock of Sundarbans estuary in Bangladesh regarding length-weight and condition factor are limited thus get necessity of the study.

The present study aimed to investigate the length-weight relationship and condition factor of *E. tetradactylum* in the study area. Specifically, the study on estimated the length–weight relationship, determine the growth pattern based on the regression coefficient (*b*), and evaluation of the condition factor of this species across the size range. The findings are expected to provide baseline information on the growth characteristics and biological condition of *E. tetradactylum*, which may contribute to its fisheries assessment and sustainable management.

2. METHODOLOGY

2.1 Sample collection

A total of 100 individuals was collected from Shibsa river estuary near Paikgacha (22.478432° N, 89.424012° E), Khulna by the help of local fishermen. The study was conducted between July 2022 to June 2023 by random sampling. The collection was kept in an insulated icebox and carried to the fish biology laboratory of Bangladesh Fisheries Research Institute, Brackishwater Station, Paikgacha, Khulna.

2.2 Collection of data

After blotting the excess water with tissue paper total length was taken from the tip of the snout to the end of the caudal fin in centimeters (0.1 accuracy) with a scale, and body weight was estimated by a digital balance (Gulf FZE, EK 3200I) in grams (0.01 g accuracy).

2.3 Growth parameters

The relative growth between total body weight (BW) and body lengths were calculated by LWR using equation (Froese 2006):

$$W=a\times L^{b}$$

Natural logarithm form of this equation is: LogW=loga+blogL.

Where, W = Body weight (g), L is total length in cm, 'a' and 'b' are the parameter, a=intercept and b= slope).

Fulton condition factor (K_c) was calculated by using the Fulton formula:

$$K_c=100\times W/L^{3}$$

Where, W= Weight of fish in gram and L= Total length of fish in centimeter.

The Relative condition factor (K_n) was calculated by using following formula:

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$$K_n = W/aL^b$$

Where, W=Weight of fish in gram and L= Total length of fish in centimeter.

The Relative weight (W_r) was calculated by using following formula:

$$W_r = 100 \times W/W_s$$

Where, W=Weight of fish in gram and W_s=Predicted weight of fish (aL^b).

2.4 Statistical analyses

Statistical analyses, including descriptive statistics, regression analyses, and graphical presentation, were performed using Microsoft Excel 2016 (Microsoft Corporation, Redmond, WA, USA).

3. RESULTS

3.1 Length and body-weight frequency distribution

The total length (TL) of the 100 sampled fish ranged from 5.0 to 80.0 cm (Average= 20.25±15.44), with the highest frequency (61%) recorded in the 5–15 cm length class (Fig. 1 and Table 2). The frequencies in the 16–25, 26–35, and 36–45 cm classes were 12%, 10%, and 11%, respectively, whereas only 3% of individuals occurred in the 46–55 cm class. Two individuals were recorded in the 66–75 cm class and one in the 76–85 cm class, while no individuals occurred in the 56–65 cm class.

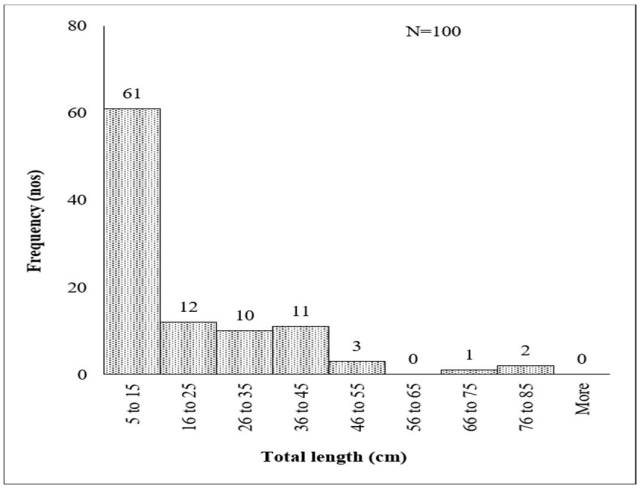


Fig. 1: Length frequency distribution of *E. tetradactylum* in Shibsa river estuary, Bangladesh.

Body weight (BW) ranged from 2.17 to 3370 g (Average= 220.49±570.84) and showed a strongly right-skewed distribution (Fig. 2 and Table 2). The majority of individuals (96%) were concentrated in the 2–1002 g class, while 1% and 1% occurred in the 1003–2002 g and 2003–3002 g classes, respectively. A further 2% of individuals were recorded in the 3003–4002 g class, with no specimens exceeding 4002 g.

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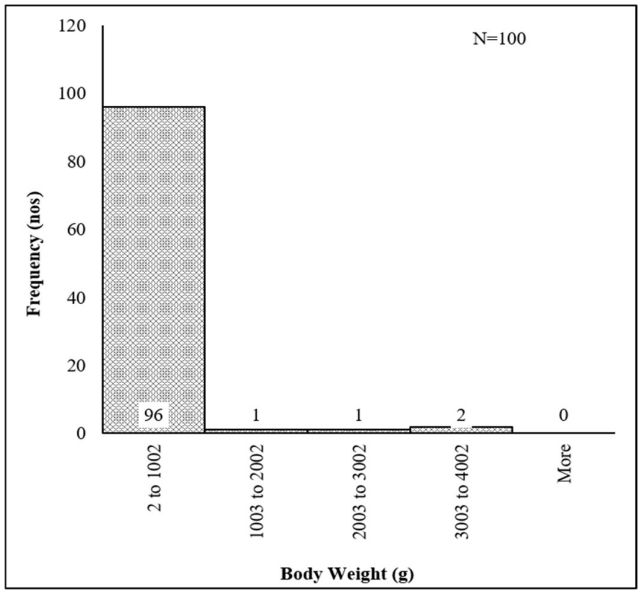


Fig.2: Body weight frequency distribution of *E. tetradactylum* in Shibsa river estuary, Bangladesh.

3.2 Length-weight relationships

The total length (TL) and body weight (BW) of *E. tetradactylum* (N = 100) exhibited a highly significant non-linear relationship expressed by the power equation $BW=0.0057\ TL^{3.11}$ (Log BW=3.11 LogTL -2.27; R^2=0.998, p<0.001; Table 1, Figure 3).

Table 1: Regression analysis with the estimated parameters of the length-weight relationships of *E. tetradactylum* in Shibsa river estuary, Bangladesh.

Equation	N	a	b	R^2	p-value
$BW=0.005TL^{3.11}$	100	0.0057	3.11	0.998	<0.001
LogBW=3.11 LogTL-2.27	100	0.0053	3.11	0.998	<0.001

Where, b = slope of the length–weight relationship; R^2 =coefficient of determination.

The b value indicated the growth pattern was isometric (b=3) or allometric (b≠3); positive allometric (b> 3) and negative allometric (b<3) (Setyohadi and Wiadnya, 2018). Some studies, like Rahman et al. (2024), reported that negative allometric growth (b=2.8) in Sedati; Sidoarjo, Panda et al. (2016) reported that the b value was 3.01 in Chilika Lagoon, India, and Kazemi et al. (2013) reported an isometric growth pattern (b=2.96) in the Persian Gulf and Oman Sea. Different b values were estimated due to different living and non-living components in an ecosystem (Setyohadi and Wiadnya, 2018).

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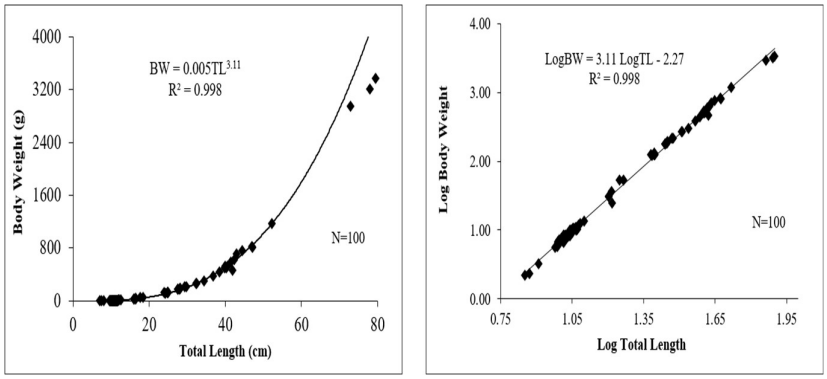


Fig. 3: Scatter plots showing the length-weight relationships of *E. tetradactylum* in Shibsa river estuary, Bangladesh.

3.3 Condition Factor

Average of total length was (20.25±15.44) and body weight (220.49±570.84). Assessment of physiological health revealed a mean Fulton condition factor (K_c=0.73±0.08), while the relative condition factor (K_n=1.06±0.09) and relative weight (W_r=106.34±9.21) (Table 2).

Table 2: Descriptive statistics of total length, body weight, Fulton's condition factor (Kc), relative condition factor (Kn), and relative weight (Wr) of the sampled *E. tetradactylum* Shibsa river estuary, Bangladesh.

Parameter	N	Range	Mean±SD
Total Length (cm)	100	7.10-79.50	20.25±15.44
Body Weight (g)	100	2.17-3370.00	220.49±570.84
K_c (Fulton condition factor)	100	0.54-0.97	0.73±0.08
K_n (Relative condition factor)	100	0.80-1.41	1.06±0.09
W_r (Relative weight)	100	79.61-141.04	106.34±9.21

4. DISCUSSION

The length and weight frequency distribution was comprised with majority in 5–15 cm total length class and 2-1002g body-weight class and sampling mean of TL (20.25±15.44 cm) and BW (220.49±570.84 g). Rahman *et al.* (2024) reported, a higher size class in-term of fork length (29.8±0.28 cm) and comparatively lower body weight (375.6±10.8 g) in Sedati, Sidoarjo and higher FL (37.72±0.36 cm) in Tarakan waters (Tirtadanu and Chodrijah, 2018) Indonesia whereas lower at Bagac river systems (12.07±0.77 cm and 16.22±2.81 g) in Philippines (Corpuz et al., 2023). This dissimilarity may happen due to seasonal variation, geographical location, differences in gear and traps used, sample size and length metrics. The predominance of smaller individuals may indicate recent recruitment and reflect the influence of sampling gear and habitat on size structure.

The estimated slope parameter (b=3.11) deviated above the isometric value of 3.0, indicating positive allometric growth and it gains body mass at a faster rate than length as it matures. In the study for the same species where similarity observed b=3.11 (Karna et al., 2012) in Chilika Lagoon, India, near isometric growth observed (b=2.99) by Batubara et al. (2024) and (b=2.90) Tirtadanu and Chodrijah (2018), negative allometric growth observed by Rahman *et al.* (2024) (b=2.81) and Corpuz *et al.* (2023) (b= 2.67). The similarity with Karna *et al.* (2012) may reflect comparable environmental conditions, population characteristics, or size composition of the sampled fish. These differences may be related to geographical and environmental variation, seasonality, food availability, size range, sex composition, and sampling gear (Gokce et al., 2007).

The relative condition factor K_n (>1) and relative weight W_r (>100) values indicate that the sampled fish were slightly heavier than expected for their length and reference population, respectively, suggesting relatively favorable body condition. The study from Sedati, Sidoarjo, Indonesia and Philippines show similarity in relative condition factors (Rahman et al., 2024; Corpuz et al., 2023) and relative weight (107.78±107.29%) in Persian Gulf (Kazemi et al., 2013). Whereas, Fulton's condition factor was lower and relative weight was aligned with the study of Batubara *et al.* (2024) in Indonesia. K_n values equal 1 denote the balance between prey and predator populations, indicating favorable environmental conditions that support the growth of healthy fish (Ragheb, 2023). The observed similarities and differences in these indices may cause in reproductive cycles, food availability, and environmental and habitat characteristics (Morato et al., 2001).

Appointing a sustainable and environmentally friendly fishing intensity is the most significant steps for the conservation of *E. tetradactylum* stocks in this habitat. The appropriate fish size for catching, net size, the prohibition of destructive fishing gear, marine protected areas (MPAs) designation, and restricted catches during the spawning season are the key techniques (Hard et al., 2008). According to Van-Overzee and Rijnsdorp (2015), the death of fish offspring is caused by fishing activities during the spawning season, which need to prohibit strictly to maintain sustainable fish stocks. For reserving fish habitat and populations, MPAs should established in suitable places where fishing is prohibited and human activities will be restricted (Balmford et al., 2004).

5. CONCLUSIONS

The study established a strong length–weight relationship for *E. tetradactylum* in the Shibsa River estuary, with positive allometric growth (b=3.11; R^2=0.998). The mean K_n (1.06) and W_r (106.34) indicated that sampled individuals were slightly heavier than expected for their length. The predominance of smaller fish suggests that the sampled population was largely composed of smaller size classes, potentially reflecting recruitment and sampling characteristics. These results provide baseline biological information that can contribute to future monitoring, stock assessment, and sustainable management of *E. tetradactylum* in the estuary.

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