

Research Article

Length–Weight Relationships, Condition Factors, and Form Factors of 10 Freshwater Small Indigenous Fish Species in a Wetland Ecosystem of Northwestern Bangladesh

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A total of ten species of freshwater small indigenous fish species (SIFS) were examined in order to study their length–weight relations (LWRs), condition factors (K_R), and form factors ($a_{3,0}$) caught by a small-scale fishery from the Babu Mondoler beel, a wetland ecosystem in northwestern Bangladesh. In addition, the form factor ($a_{3,0}$) was calculated for ten freshwater fish species in worldwide habitats. The samples were collected between June 2021 and May 2022 with various fishing equipment and traps, including box traps, cast nets, and gill nets. The study focused on the following species: *Ailia coila* (Hamilton, 1822), *Amblypharyngodon mola* (Bleeker, 1854), *Channa punctata* (Bloch, 1793), *Channa straita* (Bloch, 1793), *Esomus danricus* (Hamilton, 1822), *Eutropiichthys vacha* (Hamilton, 1822), *Gagata cenia* (Hamilton, 1822), *Labeo catla* (Hamilton, 1822), *Lepidocephalichthys guntea* (Hamilton, 1822), and *Macrognathus aculeatus* (Bloch, 1786). Total length (TL) was strongly correlated with body weight (BW) ($p < 0.001$). The slope b was between 2.55 and 3.38, with 7 species experiencing negative allometric growth, 1 species experiencing positive allometric growth, and 2 species experiencing isometric growth. The mean relative condition factor (K_R) ranged from 0.9746 ± 0.0870 (*Channa punctata*) to a maximum of 1.0344 ± 0.2101 (*Ailia coila*) as a benchmark of the well-being of individuals of the various species in the same ecosystem. In our studied ecosystem, we observed a form factor ($a_{3,0}$) ranging from 0.0025 to 0.0151. The results on LWRs, condition factors, and form factors are important baseline data for monitoring the status of fish populations, detecting environmental stress, and sustainable management. Therefore, habitat action is required to reduce the growth-affecting stressors on these SIFS.

Keywords: condition factor; conservation; form factor; length–weight relations; small-scale fishery; sustainable management

1. Introduction

The small indigenous fish species (SIFS) substantially contribute to overall fish consumption, varying their maximum length from 5 to 25 cm [1]. In Bangladesh, there is a wide variety of aquatic biodiversity, which includes 260 native species of bony fish that are found in freshwater and are

appropriate for human consumption. These species belong to 145 genera and 55 families, as highlighted in the study by Craig et al. [2]. The unique natural characteristics of SIFS, including their size, habitat preferences, life history traits, and ecological roles, define how these factors contribute to their varying degrees of vulnerability to overfishing, habitat disturbance, and other forms of misuse by fisheries.

Bangladesh's aquatic fauna, however, is increasingly at risk from pollution, overfishing, and environmental destruction [3]. Cannibalistic behavior by species such as *Channa striata* and predatory species such as *Notopterus chitala* and *Wallago attu* are major causes of SIFS loss. Since SIFS are becoming more difficult to locate in markets and less common in natural water bodies, they are now prohibitively costly for rural people. Research indicates that at peak production seasons in rural Bangladesh, 50%–80% of the fish ingested were SIFS [4]. Due to their complete consumption and provision of vital minerals, including calcium, iron, vitamin A, and zinc [1], SIFS were important to Bangladeshi rural people's diets. They also gave individuals who lived close to wetland habitats a source of income. Rural people believe that growing SIFS is less lucrative than growing Indian major carps [4]. However, no major management or research efforts have focused on these species in our studied wetland habitat. *A. coila* is classified as near threatened (NT) by the IUCN Red List of Threatened Species [5], signifying that it is experiencing notable conservation challenges or exploitation for fisheries purposes.

Length–weight relationships (LWRs) are frequently utilized in the estimation of an organism's weight based on its corresponding length. These relationships are particularly valuable in the evaluation of fish populations and stocks, as they offer valuable observations regarding the developmental trends of various types of fish and the achievement of an ideal state of growth [6, 7]. In addition, LWRs serve as valuable tools for evaluating the relative health of individuals within definite stocks or among distinct stocks of the identical species [8]. For instance, the LWR of a particular species is commonly employed to measure the average weight for an unfamiliar length category and to modify length observations into weight measurements, thereby offering a measure of the biomass [9]. The exponent b derived from the LWR serves as a crucial parameter for comprehending the structure of a fish population [9].

Relative condition factor (K_R) serves as a significant biological indicator, providing crucial insights into various aspects such as growth, sexual maturity, food availability, sex ratio, and age of species [10]. Moreover, by analyzing the form factor ($a_{3,0}$), researchers may evaluate and compare the differences in the morphology of the body between various groups or species. This procedure can shed light on any differences in morphology and adaptation [9].

This research was conducted in a wetland ecosystem of Bangladesh, which supports the diverse fisheries, communities, and livelihoods of thousands of fishers. In the realm of scientific research, no literature is currently available that specifically focuses on the LWRs, condition factor (K_R), and form factor ($a_{3,0}$) of the 10 reported species within the studied habitat of Bangladesh. These estimates will serve as a valuable reference for future studies on population parameters, ultimately providing crucial baseline information for evaluating population status in subsequent research endeavors. Therefore, this study aims to provide information on the growth patterns, condition factors (K_R), and form factors of ten SIFS that are found in freshwater environments within a wetland ecosystem in the northwestern region of Bangladesh.

2. Materials and Methods

2.1. Sampling Site. Fish samples were systematically amassed from the Babu Mondoler beel, a wetland ecosystem connected to the Ganges lower basin situated in northwestern Bangladesh at coordinates 24°28'51.20" N latitude and 88°14'45.38" E longitude, as depicted in Figure 1. Between June 2021 and May 2022, samples were procured from the catches of local fishermen, employing diverse fishing gears and traps, including gill net, cast net, and box trap. The total length (TL) of the fish specimens was calculated using digital slide calipers (Mitutoyo, Japan) to the closest 0.1 cm, and their weight was measured by an electronic weighing machine (Sartorius, Germany) with a determinacy of 0.01 g.

2.2. LWRs. To ascertain the relationships within LWRs: $W = aL^b$, as formulated by Cren [6], was applied. In this equation, W denotes body weight (BW) (g), L signifies TL (cm), and a and b represent the intercept and slope, respectively. $\ln(W) = \ln(a) + b \ln(L)$ is the transformed equation that was used to estimate the parameters a and b . The application of the equation involved utilizing a simple linear regression model, which was employed to log-transform the data for more accurate analysis. A t-test was conducted to determine whether the slope b was significantly different from the isometric value of 3. Furthermore, the determination of the 95% confidence interval (CI) for the parameters (a and b) was also conducted, along with the coefficients of determination (r^2), using the methodologies outlined by Froese [9].

2.3. Relative Condition Factor. The relative condition factor (K_R) was determined for each fish species using the following formula: $K_R = W/(aL^b)$, where W is the BW (g) and L is the TL (cm), and a and b are the parameters of LWR [6].

2.4. Form Factor. The calculation of the form factor ($a_{3,0}$) for each individual of a particular species was conducted utilizing the equation provided by Froese [9], which can be expressed as follows: $a_{3,0} = 10^{\log a - s(b-3)}$. In this equation, the variables a and b represent the regression parameters of the LWRs, while the value of s , which is equal to 1.358, denotes the regression slope of the logarithm of a versus b . In addition, the a and b parameters from LWR are used to estimate the form factor in worldwide habitats.

2.5. Statistical Analysis. The LWR was performed in R (V4.5.0). Data was read by using dplyr and readxl packages, upon which it was log transformed and fitted in a power function, with the help of linear regression. Models were also important, which was affirmed by ANOVA (model: $F = 48.72$; $p < 0.001$). Student's t -test comparison was performed to determine whether or not b of each species is statistically different from the predictions provided by isometric growth ($b = 3$). As a statistically significant difference of b between 3 implies either a positive or a negative allometric growth ($p < 0.05$), an isometric growth would be

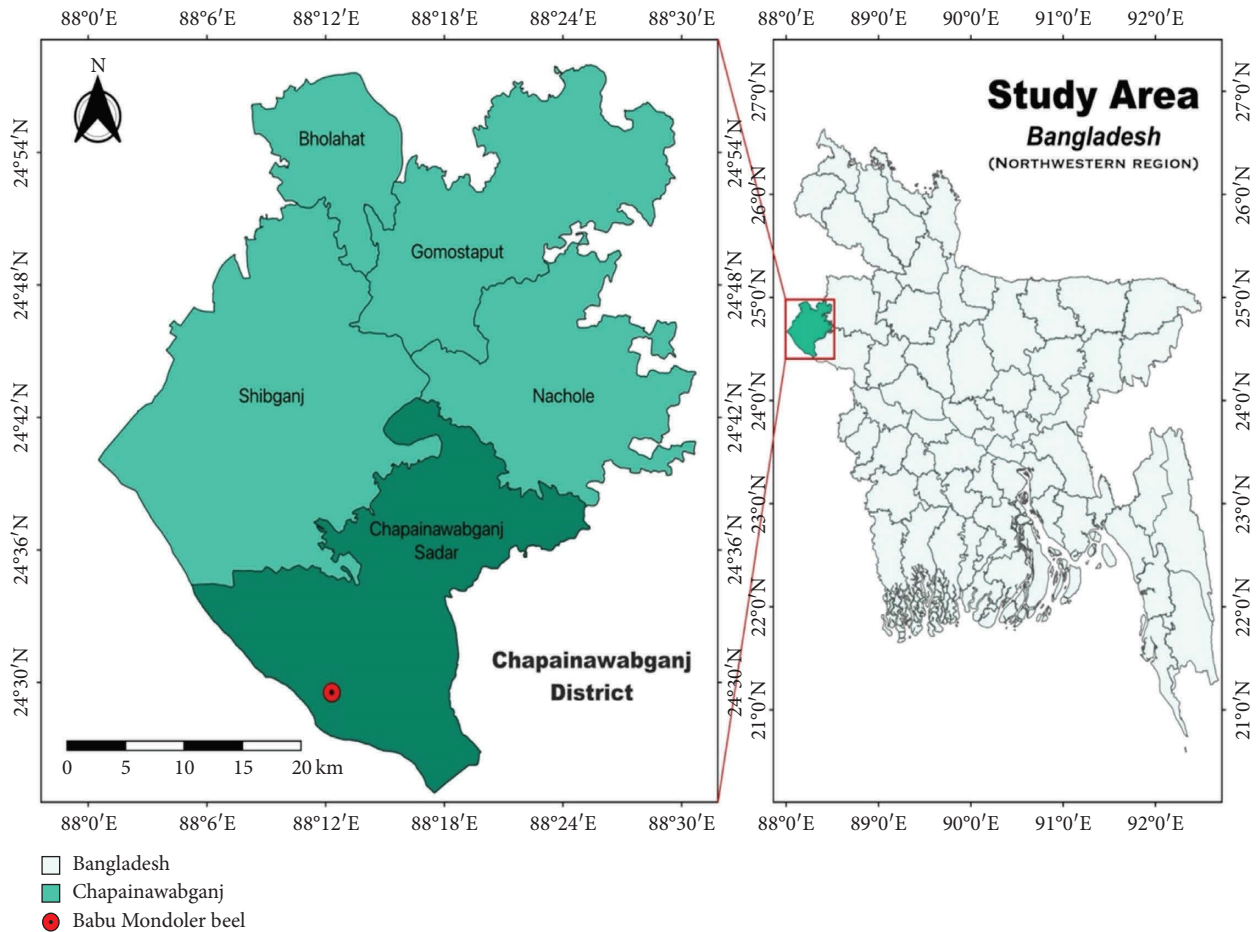


FIGURE 1: Map of the study site (Babu Mondoler beel, northwestern Bangladesh) where the sampling point was marked by a red point ($24^{\circ}28'51.20''N$ latitude and $88^{\circ}14'45.38''E$ longitude).

given when b is not statistically differentiated from 3 ($p < 0.05$). Assumptions were made to test normality (Shapiro–Wilk, $p = 0.21$). Data were extracted (broom) and plotted (ggplot2, RColorBrewer).

3. Results

The total number of individuals ($n = 3057$), which constituted at least 10 freshwater fish species (belonging to 7 families), was evaluated through LWRs (Table 1). The logarithmic relationship between TL and BW of ten freshwater fish species is shown in Figure 2. The value of the slope (b) was between 2.55 (2.46–2.65) and 3.38 (3.28–3.47), whereas the value of the intercept (a) varied between 0.0046 and 0.0236, indicating species-specific differences in the growth patterns (Figures 3 and 4). The detailed overview of the LWR parameters, such as the regression coefficients a and b , and the coefficient of determination (r^2), is available in Table 1. The all-species significant positive relationship between TL and BW ($p < 0.001$) supported the validity and applicability of the obtained models. Among the 10 species, we observed an isometric growth pattern in *A. mola* and *C. striata*, and a positive allometric growth pattern in *L. guntea*. In addition, we found that the allometric growth pattern of *A. coila*,

C. punctata, *E. danricus*, *E. vacha*, *L. catla*, *L. guntea*, *G. cenia*, and *M. aculeatus* was negative. Furthermore, the values of a extended from 0.0046 to 0.0236 for LWRs.

In the Babu Mondoler beel, northwestern Bangladesh, the minimum and maximum K_R values for various species were determined to be 0.6287 and 1.8860 for *A. coila*, 0.8604 and 1.1727 for *A. mola*, 0.7388 and 1.1709 for *C. punctata*, 0.8011 and 1.4144 for *C. striata*, 0.8411 and 1.1879 for *E. danricus*, 0.8090 and 1.2199 for *E. vacha*, 0.6887 and 1.9208 for *L. catla*, 0.7200 and 1.2866 for *G. cenia*, 0.6976 and 1.3109 for *L. guntea*, and 0.8208 and 1.3213 for *M. aculeatus* (Table 2).

In our studied ecosystem, the counted form factor ($a_{3,0}$) was recorded as 0.0025 for *A. coila*, 0.0117 for *A. mola*, 0.0111 for *C. punctata*, 0.0088 for *C. striata*, 0.0042 for *E. danricus*, 0.0068 for *E. vacha*, 0.0070 for *G. cenia*, 0.0102 for *L. catla*, 0.0151 for *L. guntea*, and 0.0034 for *M. aculeatus*, respectively (Table 3).

4. Discussion

Information on the reported ten species is quite scarce in the literature from the mentioned wetland. Our results add to the growing evidence for LWRs, condition factors (K_R), and

TABLE 1: Descriptive statistics of length–weight relationships and growth patterns of 10 freshwater SIFS sampled in the Babu Mondoler beel, northwestern Bangladesh.

Species	n	TL (cm)	BW (g)	a	95% CL of a	b	95% CL of b	r^2	GT
<i>Ailia coila</i>	308	4.2–14.7	0.42–9.98	0.0105	0.0087 to 0.0126	2.55	2.46 to 2.65	0.902	A–
<i>Amblypharyngodon mola</i>	322	3.3–5.9	0.36–2.25	0.0088	0.0077 to 0.0098	3.09	3.01 to 3.16	0.954	I
<i>Channa punctata</i>	303	8.0–19.7	6.23–91.1	0.0161	0.0133 to 0.0193	2.88	2.81 to 2.95	0.955	A–
<i>Channa striata</i>	304	18.9–36.2	55.34–442.5	0.0088	0.0066 to 0.0115	3.00	2.91 to 3.08	0.942	I
<i>Esomus danricus</i>	306	3.2–5.4	0.27–1.16	0.0129	0.0116 to 0.0142	2.64	2.58 to 2.71	0.950	A–
<i>Eutropiichthys vacha</i>	302	8–15.7	5.29–32.23	0.0236	0.0202 to 0.0274	2.60	2.54 to 2.66	0.957	A–
<i>Labeo catla</i>	291	5.5–16.9	1.8–60.68	0.0135	0.0114 to 0.0158	2.91	2.84 to 2.98	0.959	A–
<i>Gagata cenia</i>	286	4.3–8.7	0.84–7.87	0.0178	0.0152–0.0208	2.81	2.73–2.90	0.936	A–
<i>Lepidocephalichthys guntea</i>	315	3.7–8.5	0.4–6.74	0.0046	0.0038 to 0.0053	3.38	3.28 to 3.47	0.942	A+
<i>Macrognathus aculeatus</i>	320	8.2–21.6	2.21–33.97	0.0054	0.0044 to 0.0065	2.85	2.78 to 2.93	0.950	A–

Note: n , sample size; a , intercept; b , slope; CL, confidence limit for mean values; r^2 , coefficient of determination; I, isometric; A+, positive allometric; A–, negative allometric.

Abbreviations: BW, body weight; GT, growth type; TL, total length.

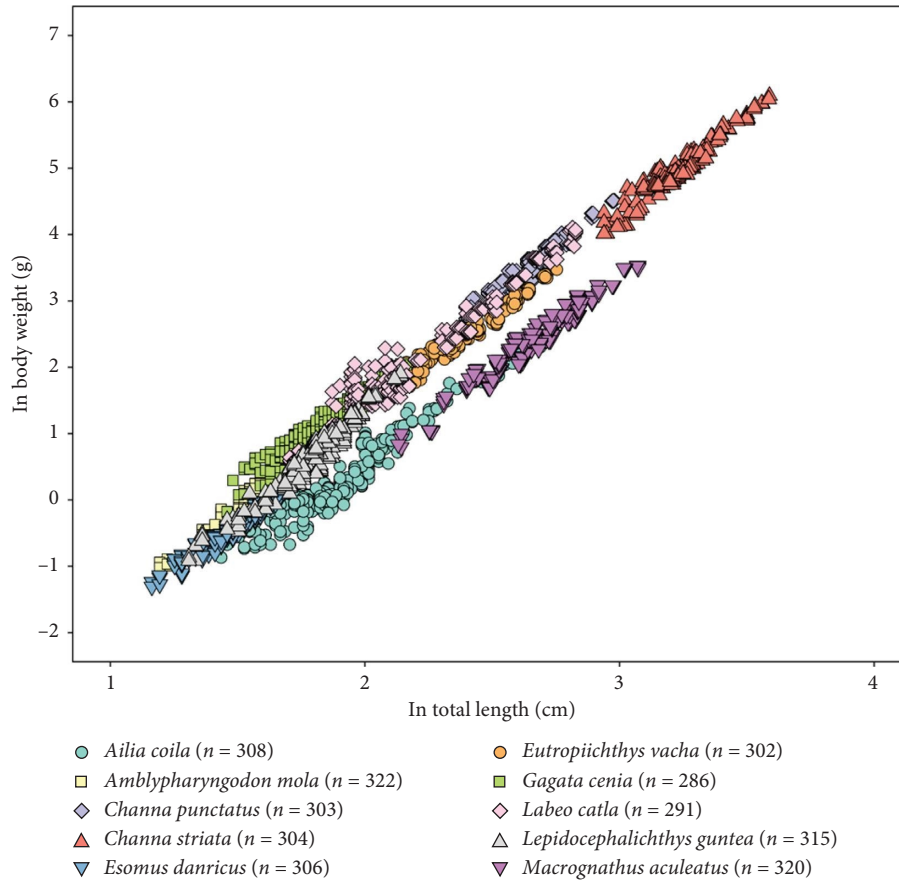


FIGURE 2: Logarithmic relationship between total length (cm) and body weight (g) of 10 freshwater SIFS in the Babu Mondoler beel, northwestern Bangladesh.

form factors ($a_{3,0}$) of ten SIFS from the studied ecosystem of Bangladesh. The data collected on the ten species of freshwater fish span a prolonged timeframe and are not confined to any single season. Hence, the average yearly values rather than seasonal changes should be considered when comparing these statistics. The absence of sex-specific data may affect growth and condition parameters, together

with the possibility of sample bias resulting from gear selectivity and habitat-specific capture efficiency [11]. The longest *M. aculeatus* measured in this research was 21.6 cm; this is quite similar to the longest recorded TL that was 21.8 cm in the Mathabhanga River [12]. This resemblance implies that the growth capacity of *M. aculeatus* remains constant across various aquatic environments in

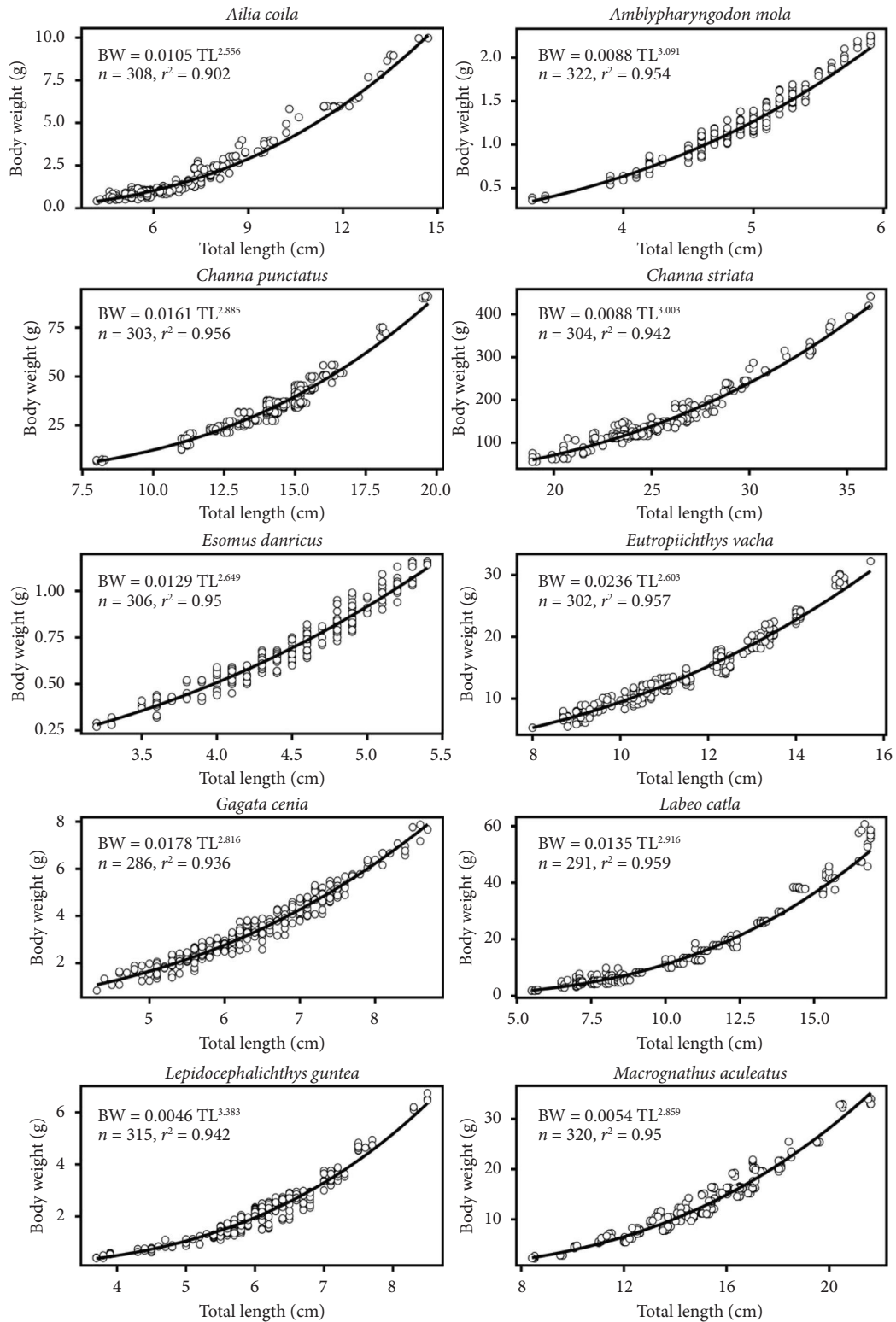


FIGURE 3: Relationship between body weight (g) and total length (cm) of 10 freshwater small indigenous fish species (SIFS) in the Babu Mondoler beel, northwestern Bangladesh.

Bangladesh. However, in the environment that we examined, the smallest *E. danricus* was measured to be 3.2 cm in length, whereas in the Ganges River, it was determined to be 3.0 cm [13].

The LWRs indicated that the *b* (allometric coefficient) values in our current research ranged from 2.55 to 3.38, which is acceptable within the standard range (2.0–4.0) established by Carlander [14] and Froese [9]. The growth

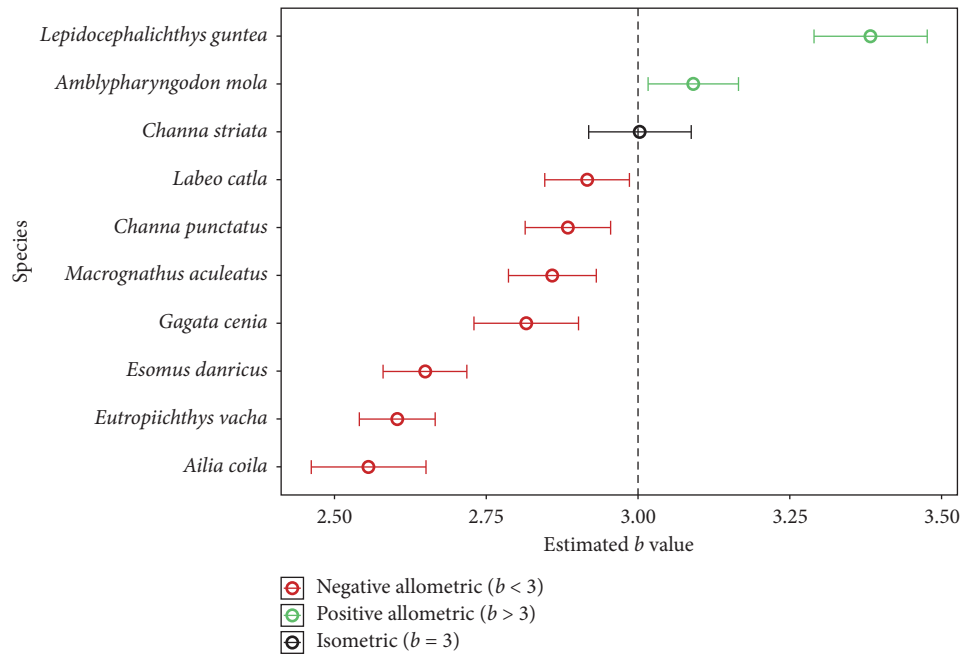


FIGURE 4: Estimated b values of 10 freshwater SIFS in the Babu Mondoler beel, northwestern Bangladesh.

TABLE 2: Relative condition factor of 10 freshwater SIFS sampled in the Babu Mondoler beel, northwestern Bangladesh.

Species	n	Relative condition factor (K_R)			
		Minimum	Maximum	Mean \pm SD	95% CL
<i>Ailia coila</i>	308	0.6287	1.8860	1.0344 ± 0.2101	1.0108–1.0580
<i>Amblypharyngodon mola</i>	322	0.8604	1.1727	0.9989 ± 0.0693	0.9913–1.0065
<i>Channa punctata</i>	303	0.7388	1.1709	0.9746 ± 0.0870	0.9647–0.9844
<i>Channa striata</i>	304	0.8011	1.4144	1.0128 ± 0.1010	1.0014–1.0242
<i>Esomus danricus</i>	306	0.8411	1.1879	1.0155 ± 0.0697	1.0077–1.0234
<i>Eutropiichthys vacha</i>	302	0.8090	1.2199	1.0118 ± 0.0813	1.0026–1.0210
<i>Labeo catla</i>	291	0.6887	1.9208	1.0300 ± 0.1961	1.0075–1.0527
<i>Gagata cenia</i>	286	0.7200	1.2866	1.0175 ± 0.1025	1.0056–1.0295
<i>Lepidocephalichthys guntea</i>	315	0.6976	1.3109	1.0030 ± 0.1185	0.9899–1.0162
<i>Macrognathus aculeatus</i>	320	0.8208	1.3213	1.0253 ± 0.1193	1.0122–1.0385

Note: n , sample size; CL, confidence limit for mean values. Abbreviation: SD, standard deviation.

pattern showed both negative and positive allometric growth, with a value below 3 suggesting limited development in some dimensions and a value over 3 suggesting significant acceleration in particular parameters such as body depth, organ mass, fat accumulation, and skeletal development. These two patterns together signify the intricate and dynamic characteristics of the whole development process [15]. The variations in regression slope values (b) are often attributed to factors such as sample size, sex, gonadal maturity, nutrition, habitat, and season, underscoring the complex array of forces affecting these parameters [16]. This research indicates that b values were consistently below 3 ($b < 3.0$) for the seven fish species, implying negative allometric growth, characterized by a relatively sluggish growth rate and reduced BW. This may represent an adaptation to enhance swimming efficiency or to address issues such as food scarcity. The positive allometric growth seen in one species signifies a more substantial rise in weight relative to length,

maybe indicating a more energy-efficient development strategy or a specialized ecological niche. Isometric growth seen in two species indicates a proportional rise in length and weight, suggesting constant environmental circumstances or minimal ecological stresses. Species in beels exhibit adaptations to distinct microhabitats, feeding behaviors, swimming patterns, and ecological niches that vary even within confined spatial regions. Bottom-dwelling species typically exploit detritus and benthic food sources, demonstrating adaptations such as reduced mobility and specialized respiratory or feeding mechanisms that are advantageous in low-oxygen environments commonly present near substrates. In contrast, pelagic or more active foragers may possess adaptations that enhance mobility and facilitate opportunistic feeding on plankton or free-swimming prey. The behavioral and ecological differences result in variations in growth dynamics and life history traits among species [17]. According to earlier research, the b values for *A. coila*,

TABLE 3: The calculated form factor ($a_{3,0}$) of 10 freshwater SIFS from the Babu Mondoler beel, northwestern Bangladesh, and worldwide water bodies.

Water bodies/country	Sex	Regression parameters		References	Calculated $a_{3,0}$
		a	b		
<i>Ailia coila</i>					
Babu Mondoler beel, northwestern Bangladesh	Unsexed	0.0060	2.76	Present study	0.0025
Ganges basin, Jharkhand, India	Unsexed	0.0012	3.42	Sandhya et al. [38]	0.0045
<i>Amblypharyngodon mola</i>					
Babu Mondoler beel, northwestern Bangladesh	Unsexed	0.0088	3.09	Present study	0.0117
Panchet Reservoir, India	Unsexed	0.0120	2.95	Sandhya et al. [38]	0.0103
Hirakud Reservoir, India	Unsexed	0.0130	2.82	Karna et al. [41]	0.0074
Wetlands of Dishoi and Neamatighat, India	Male	0.0395	2.38	Devi and Das [42]	0.0057
Atrai River, Bangladesh	Unsexed	0.0090	3.06	Islam et al. [39]	0.0109
South 24 Parganas, India	Unsexed	0.0030	3.57	Pal et al. [30]	0.0178
Garjan beel, Assam, India	Male	0.0053	3.30	Baishya et al. [43]	0.0135
Garjan beel, Assam, India	Female	0.0033	3.61	Baishya et al. [43]	0.0222
Mathabhanga River, Bangladesh	Mixed	0.0055	3.39	Hossain et al. [12]	0.0186
<i>Channa punctata</i>					
Babu Mondoler beel, northwestern Bangladesh	Unsexed	0.0161	2.88	Present study	0.0111
Panchet Reservoir, India	Unsexed	0.0103	3.02	Sandhya et al. [38]	0.0110
Hirakud Reservoir, India	Unsexed	0.0117	2.98	Karna et al. [41]	0.0110
Vellar River, India	Female	0.0282	2.77	Haniffa et al. [44]	0.0137
Thamirabarani River, India	Mixed	0.0105	2.99	Haniffa et al. [44]	0.0102
Mathabhanga River, Bangladesh	Mixed	0.0126	3.03	Hossain et al. [12]	0.0138
<i>Channa striata</i>					
Babu Mondoler beel, northwestern Bangladesh	Unsexed	0.0088	3.00	Present study	0.0088
Chalakudy River, India	Unsexed	0.0140	2.68	Renjithkumar et al. [45]	0.0051
Agusan Marsh, Philippines	Unsexed	0.0170	2.89	Jumawan and Seronay [46]	0.0121
Lubuk Lampam floodplains, South Sumatera, Indonesia	Mixed	0.0132	2.87	Fahmi et al. [47]	0.0088
Pearl River, China	Unsexed	0.0100	2.99	Li [48]	0.0097
Chi River, Thailand	Unsexed	0.0111	2.94	Satrawaha and pilasamorn [49]	0.0092
<i>Esomus danricus</i>					
Babu Mondoler beel, northwestern Bangladesh	Unsexed	0.0129	2.64	Present study	0.0042
Ranganadi River, Lakhimpur district, India	Unsexed	0.0095	2.95	Kaushik and Bordoloi [23]	0.0081
Ganges river, Bangladesh	Unsexed	0.0066	3.06	Hossain et al. [13]	0.0033
<i>Eutropiichthys vacha</i>					
Babu Mondoler beel, northwestern Bangladesh	Unsexed	0.0236	2.60	Present study	0.0068
River Ganga, India	Unsexed	0.0100	3.03	Ray et al. [50]	0.0110
Atrai River, Bangladesh	Unsexed	0.0110	2.82	Islam et al. [39]	0.0063
Ken River, India	Unsexed	0.0112	2.93	Dubey et al. [51]	0.0090
<i>Gagata cenia</i>					
Babu Mondoler beel, northwestern Bangladesh	Unsexed	0.0060	3.05	Present study	0.0070
Basantar River, India	Unsexed	0.0036	3.15	Sharma et al. [52]	0.0058
Payra River, Southern Bangladesh	Unsexed	0.0035	3.17	Nahar et al. [53]	0.0060
<i>Labeo catla</i>					
Babu Mondoler beel, northwestern Bangladesh	Unsexed	0.00135	2.91	Present study	0.0102
Sylhet Basin, Bangladesh	Unsexed	0.0135	2.99	Haroon et al. [54]	0.0131
Kapati Lake, Bangladesh	Unsexed	0.0037	3.35	Ahmed and Saha [55]	0.0111
Harike River, India	Unsexed	0.0065	3.23	Johal and Tandon [56]	0.0133
<i>Lepidocephalichthys guntea</i>					
Babu Mondoler beel, northwestern Bangladesh	Unsexed	0.0046	3.38	Present study	0.0151
Atrai River, Bangladesh	Unsexed	0.0090	3.01	Islam et al. [39]	0.0093
<i>Macrognathus aculeatus</i>					
Babu Mondoler beel, northwestern Bangladesh	Unsexed	0.0054	2.85	Present study	0.0034
Hongshui River, China	Unsexed	0.0042	3.05	He et al. [26]	0.0049
Yellow River, China	Unsexed	0.0019	3.09	Qin et al. [57]	0.0025
Mathabhanga River, Bangladesh	Unsexed	0.0052	2.86	Hossain et al. [12]	0.0034

Note: a , intercept; b , slope; $a_{3,0}$, form factor.

A. mola, *C. punctata*, *C. striata*, *E. danricus*, *E. vacha*, *G. cenia*, *L. catla*, *L. guntea*, and *M. aculeatus* were 3.18 [18], 3.18 [19], 3.03 [20], 2.15 [21], 2.50 [13], 3.05 [22], 2.92 [23], 3.29 [24], 3.20 [25], and 3.05 [26], respectively. The different trends in growth patterns witnessed in the examined species can be associated with a number of ecological influences, including food availability, inter- and intraspecific competition, water quality variables, and predation intensity, which can introduce influences in the amount of energy directed to growth [27]. Therefore, in terms of updating FishBase, the current *b* values may be supplementary to the previously researched *b* values [28].

Relative condition factor (K_R) is an effective measure to evaluate the state of separate fish, the prosperity of their habitat, and food supplements [29]. In this study, K_R values among the ten fresh fish species were based on 0.9746 ± 0.0870 in *C. punctata* and 1.0344 ± 0.2101 in *A. coila*, which showed a minor interspecific variation in the body conditions. It is noteworthy that the K_R value of the vast majority of species was around or slightly bigger than 1.0, which could imply that sampled individuals were in fairly good condition compared to their predicted weight based on their corresponding LWR. Relatively high K_R values (1.0344 ± 0.2101 , and 1.0300 ± 0.1961) of *A. coila* and *L. catla* possibly indicate the presence of favorable feeding habitats or reduction of interspecific competition of these habitats. On the contrary, *C. punctata* had the lowest condition factor (0.9746 ± 0.0870), which could be due to environmental pressures, food limitation, or even the species nature that has impacts on growth performance. The smaller standard deviations, i.e., *A. mola* (SD = 0.0693) and *E. danricus* (SD = 0.0697), which are relatively lower compared to others, indicate the homogenized condition in different individuals, which may either be due to steady microhabitats or regular food consumption. In general, the relative values of the condition factors confirm that the investigated aquatic ecosystem favors the overall health and growth of the fish communities in it, but only at the community scale, since there are slight species differences that suggest that habitat patchiness and trophic niche, as well as intraspecific interactions, are not favored. More research that combines environmental factors and feeding ecology may improve current knowledge of such trends. According to prior research, the mean K_R values for the species *A. coila*, *A. mola*, *C. punctata*, *C. striata*, *E. danricus*, *E. vacha*, *G. cenia*, *L. catla*, and *L. guntea* were determined as follows: 0.9905 [18], 0.85 [30], 1.004 [31], 0.005 [32], 0.645 [33], 1.070 [34], 1.0219 [35], 1.200 [36], and 0.747 [37], respectively. However, no specific references were found that provide a comparison for *M. aculeatus*.

The study of form factor values from various aquatic habitats indicates notable disparities in body shape. This research reveals that *A. coila* exhibits a lower form factor value of 0.0025 in the current water body, in contrast to 0.0045 recorded in Jharkhand, India [38], suggesting a slight increase in BW in a different location. *L. guntea* has a maximum form factor of 0.0151 in the present water body, which is superior to the 0.0093 recorded in the Atrai River in

Bangladesh [39], indicating a tendency towards a more robust body morphology in the latter. The increased form factor in the turbid waters could be the manifestation of adaptive morphological strategies in the context of benthic feeding efficiency that may substitute a lower visual foraging context. This is consistent with wider trends of phenotypic plasticity of fish in visually limited environments. The discrepancies in form factor across various water bodies presumably indicate the impact of environmental variables such as water flow, substrate type, and habitat availability, which may induce morphological modifications in response to local circumstances [40]. The results support the prospect that form factor is a variable characteristic influenced by geographical locations, elucidating the species' ecological and adaptive variety.

5. Conclusion

This study offers essential insights into LWRs, condition factors (K_R), and form factors for a thorough analysis of 10 different freshwater SIFS from the Babu Mondoler beel, a wetland ecosystem in northwestern Bangladesh. Given the observation that 7 fish species in the wetland ecosystem exhibit a negative allometric growth pattern, which suggests environmental stress, it is advisable to undertake an investigation to pinpoint specific stressors such as water quality degradation, pollution, or habitat destruction. Investigating the food web and nutrient cycling will provide insights into how restricted food sources influence fish growth. Furthermore, examining the physiological and behavioral adaptations of fish species in reaction to these stressors can yield important insights into their coping strategies. Continuous observation of the ecosystem will document shifts in fish populations and evaluate the success of conservation initiatives. The findings of our current research serve as important baseline information that can be used to monitor the population of fish, environmental stress, as well as in the conservation of SIFS.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Ethics Statement

The fish specimens utilized in this study were deceased at the time of acquisition from the fishermen. Consequently, no specific animal rights or welfare considerations were noted during the fieldwork.

Disclosure

All authors read and approved the final manuscript.

Conflicts of Interest

The authors declare no conflicts of interest.

Author Contributions

Tariq-Al Kasif: conceptualization, data analysis, methodology, and writing—original draft. Md. Mizanur Rahman: data analysis and data curation. Imran Bin Younos: data curation, data analysis, and visualization. Md. Rajib Sharker: review and editing. Mohammad Shadiqur Rahman: review and editing. Md. Fakhru Islam: review and editing and supervision.

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