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Full Length Research Article

Length-weight Relationship and Condition Factor of *Lepidocephalichthys guntea* from Fulkalmi Khal in Nadia District, India

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Abstract

A small indigenous species is the peppered loach, *Lepidocephalichthys guntea*. Between January 2021 and December 2021, a total of 261 *L. guntae* specimens (5.28 - 10.72 cm, 1.05 - 9.88 g) were procured for this investigation from the Fulkalmi "khal" of the Nadia district. There is a significant correlation between the relevant length-weight characteristics, with r^2 values in the three categories nearing 1. Regression analysis showed that female species experienced positive allometric growth whereas male and combination species experienced negative allometric development. The b values are 2.3145 for male, 3.835 for female, and 2.8787 for the combined group. The male and combined groups' values of the Fulton's (K) and modified(K) condition factors were closer to 1, indicating that the *L. guntea* population in the Fulkalmi "khal" is in good health. The results of the current study will be beneficial in creating future management plans for the small indigenous species *L. guntae* in the Fulkalmi "khal" and other comparable bodies of water.

***Key words*:** Length-weight relationship, *Lepidocephalichthys guntea*, Fulkalmi khal, Condition factor

Fishery biology places great emphasis on the length-weight relationship study because it has a variety of applications and allows for the assessment of a number of crucial biological factors, including general health, the state of maturation and spawning, fecundity, and others, using the condition factor from this relationship [1]. Length-weight relationship (LWR) is important in bioecological studies of fish because it helps understand growth trends and general wellness in a fish population. LWR varies with environmental conditions of the aquatic habitat. Studies on LWR in fishes provide crucial conclusions on fish biology and develop a mathematical relation to calculate a fish's average weight from its length [2-3]. Fish weight directly affects how big of fish should be harvested for the highest sustainable supply. The increase in fish weight is typically thought to follow the fictitious cube law. The link between a fish's length and weight changes based on the habitat in which it lives. This relationship serves three functions: it clarifies the mathematical relationship between the two variables so that, if one is known, the other can be computed; it identifies the relative condition that can be used to assess the general wellbeing and type of growth, such as isometric or allometric growth; and it calculates the potential yield per recruit in the study of fish population dynamics [4]. Fish length-weight information is a valuable standard output of sampling programs [5]. These data are required to calculate growth rates, age structures, length distributions, and other crucial aspects of fish population dynamics [6]. Comparisons of the physical characteristics and life histories of populations living in various locations can also be made using length-weight connections [7-8] .The length-weight relationship is one of the most widely used analyses of fisheries data [9]. In fish, the growth pattern typically follows the cube law [10-11]. When a fish grows isometrically, the relationship between them is valid. The exponential value in these circumstances must be precisely 3. But in practice, the actual relationship between length and weight may deviate from the optimal value due to environmental factors or fish circumstances [1].

Lepidocephalichthys guntea (Fig 5) are commonly found on the bottoms of streams, marshes, flooded fields, and lakes in the Brahmaputra and Ganges stream systems in North India, Bangladesh, and Nepal [12]. These species can be found in the Ganga, Jalangi, Kangsabati, and Silabati rivers in West Bengal. In the wild, they continue to be partially buried in mud or sand, under fallen leafs, under macrophytes and algae. They are regarded as having both gastronomic and aesthetic value. *Lepidocephalichthys guntea* length-weight research in India is scarce. [13] studied *L. guntea* from Nepal's Pathri Khola. [14] studied length-weight connections of *L. guntea* from Bangladesh's Padma River. [15] studied *L. goalparensis* in Kukurmara, Kamrup district, Assam. [16] examined length-weight and relative *L. guntea* condition factor from Assam's Ghati Beel. [17] investigated *L. guntea* from the Atrai and Bangladesh's Brahmaputra. [18] studied length-weight relationship form Kangsabati river. However, there is no data

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available on the length-weight relationship of *L. guntea* collected from small khals in the state of West Bengal. As a result, the Fulkalmi khal, located in the Nadia district of West Bengal, India, has been chosen as the location for the present inquiry on the length-weight relationship of the *Lepidocephalichthys guntea* species.

Fig 1 Map of the collection center (Fulkalmi "khal") of the species

MATERIALS AND METHODS

Study area and sample collection

In terms of commercial relevance, traditional fishing in the Fulkalmi Khal utilizing traditional gear "Ghuni" is regarded as s significant fishery. "Khal" are medium size 1.5 – 2.5 km long closed waterbody. The sample species were gathered from Fulkalmi khal (23°33'01.0"N 88°36'55.2"E) as well as from a nearby low-lying rice field (Fig 1). The majority of the species were captured using "Ghuni" traps, also known as "Betti" locally. Over the course of the investigation's 12-month study period, 261 specimens in total were sampled randomly (January 2021 to December 2021). Fish body weights were determined using a digital weighing balance to the nearest 0.1 gram, and lengths were determined using a varnier calliper scale to the nearest 0.1 centimeter (Fig 6-7). The sizes ranged from 5.8 cm to 10.72 cm in length and from 1.05 to 9.88 g in weight. Male, female, and combination of female and male were the three groups assigned to the species. A key phenetic property known as " laminar circuli " was used to differentiate the male and female species of this species. The seventh and eight pectoral fin ray fused to form the structure. This character is only found in males of the species and is absent in females of the same species.

Estimation of length-weight relationship (LWR) and condition factors (K)

[1] proposed a non-linear equation in the form of $W = aL^b$ as; Log W = b Log L + Log a where, W = total fish weight in gram; L = total fish length in centimeters; a = regression curve intercept; b = regression coefficient/growth coefficient, that explains the link between the length (L) and weight (W) of fish. The condition of the fish was determined by applying the Fulton's condition factor equation, which reads as follows: $K = (W / L^3) \times 100$ and Modified condition factor equation, $K= (W/L^b) \times 100$, where W = total fish weight in gram; L = total fish length in centimeters and b = regression coefficient/growth coefficient [1].

Data analysis

The statistical analysis was carried out with the assistance of the computer program MS Excel-2016, and SPSS version 20 was utilized in order to determine which differences between the values of length-weight and condition factor were significant and which were not. The accuracy of a linear regression's prediction can be quantified using a statistic called the coefficient of determination (r^2) (a value close to 1 means a better model).

RESULTS AND DISCUSSION

No previous research has been done to collect any information on the biology of the Fulkalmi khal's native flora and fauna, particularly its smaller species. In the present study 161 of the 261 specimens were female, making up 61.68% of the total, while 100 were male, making up 38.31%. The proportion of male to female individuals was 1:1.61, according to the sex ratio. The χ^2 test revealed ($P < 0.05$) that there was a statistically significant deviation in the sex ratio from the 1:1 ratio that was anticipated. This observation demonstrated that the collected male and female distribution of *L. guntea* in the Fulkalmi khal's natural water was significantly more female than male. [19-22] discovered outcomes similar to these results. The total length of the females ranged from 5.8 cm to 10.72 cm, with 8.06 cm being the mean value and 1.14 cm being the standard deviation. The total length of the males ranged from 5.28 cm to 7.3 cm, with a mean of 6.16 cm and a standard deviation of 0.47 cm. The total length of the combined group varied from 5.28 to 10.72 centimeters, with a mean of 7.77 centimeters and a standard deviation of 1.31 centimeters. The mean total weight of females was 4.02 ± 2.24 g, whereas the mean total weight of men was 0.81 ± 1.98 g, and the mean weight of the combined group was 3.24 ± 2.03 g. (Table 1). The results of the t-test indicated that there was a statistically significant difference ($P < 0.05$) between the sexes in terms of overall total length and total weight. The most common measurement among all of the samples was 10.72 centimeters.

Table 1 The length and weight measurements of *Lepidocephalichthys guntea*

Category	Number of samples	Total length in cm			Total weight in gm		
		Min.	Max.	Mean SD	Min.	Max.	Mean SD
Male	100	5.28	7.3	6.16 ± 0.47	1.05	2.75	1.98 ± 0.35
Female	161	5.8	10.72	8.06 ± 1.14	1.05	9.88	4.02 ± 2.24
Combination of male and female	261	5.28	10.72	7.77 ± 1.31	1.05	9.88	3.24 ± 2.03

†Min.: Minimum, Max.: Maximum, SD: Standard deviation

The b values of the length-weight relationship indicated negative allometric growth for males (b=2.3145, $W = 0.2155203\ L^{2.3145}$) and the combined group (b=2.8787, $W = 0.13163794\ L^{2.8787}$), whereas females showed positive allometric growth (b=3.834, $W = 0.05398225\ L^{3.834}$) (Table 2-3). According to the finding presented here, the value of 'b' suggests that as length increases, weight increases more than it does in the case of females, whereas weight falls as length increases in the case of males and combined group. As a result of the current research, it has been determined that females, in

contrast to males, experience a gain in weight due to the tremendous development of their gonads. This discovery was also corroborated by the results of the earlier examination [13], [16], [18]. In point of fact, the value of 'b' is lower for males, which may be because males expend more energy on the growth of their gonads than on the development of their somatic bodies [23]. The negative allometric growth that was detected in males, which was an interesting finding, may have been caused by a loss of energy during the breeding activity [24]. The degree to which the value of b varies depends on a sexual orientation [25], the phases of gonad development, particularly those of the ovary, have an effect on a body weight [26-27] feeding behaviors [1], a species's several subpopulations [28] and state of maturity of the species [29]. This difference between the sexes was significant ($P < 0.05$), and the results were found to be gender-specific. The calculated parameters of the length-weight relationship are presented in (Table 2), which can be found here. In (Table 3), the length-weight relationship was presented in the form of $W = a L^b$. (Fig 2-4) provides an estimation of the length-weight connection for both females and males, as well as for both sexes together. The b values for females, males, and both sexes were considerably different from 3.0 ($P < 0.05$), which signify differences were statistically significant (Table 2). (Table 3) provides, in addition to the findings of the current investigation, a comparison of previously published length-weight relationship parameters for *L. guntea* from a variety of geographic locations. [13-18] all obtained results of "b" value, that were consistent with those of the present study (2022). Female species among the three categories exhibit a high relationship between length and weight with a r^2 value of 0.97, whilst male and combined species exhibit a r^2 value of 0.89 and 0.90, respectively. Other researcher [13], [14], [16] and [18] also reported similar result (Table 5).

Table 2 Descriptive statistics of regression parameter of the species

Category	Regression parameters					
	a	b	t-test value of b	Multiple R	R Square	Adjusted R square
Male	0.2155203	2.3145	(P<0.05)	0.94	0.89	0.89
Female	0.05398225	3.834	(P<0.05)	0.98	0.97	0.97
Combination of male and female	0.13163794	2.8787	(P<0.05)	0.95	0.90	0.90

†a: intercept, b: slope, R: coefficient correlation

Table 3 Descriptive logarithmic and parabolic equations of the species

Category	Logarithmic equations	Correlation coefficient	Parabolic equations
Male	Log W = - 0.66651 + 2.3145 log TL	0.89	$W = 0.2155203\ L^{2.3145}$
Female	Log W = -1.26775 + 3.834 log TL	0.97	$W = 0.05398225\ L^{3.834}$
Combination of male and female	Log W = -0.88062 + 2.8787 log TL	0.90	$W = 0.13163794\ L^{2.8787}$

†TL: Total length, W: Weight, L: Length

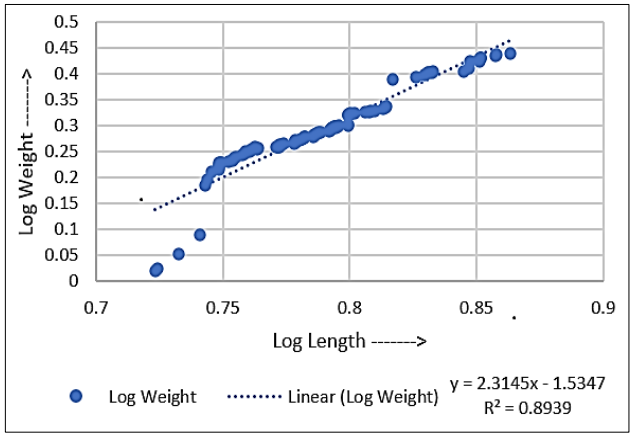

Fig 2 Length-weight relationship of male species (Log value)

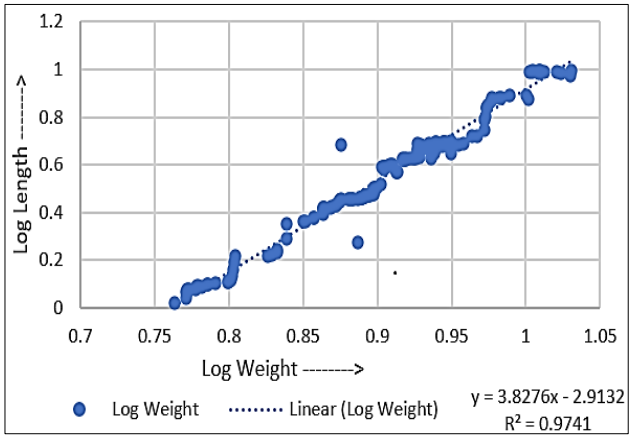

Fig 3 Length-weight relationship of female species (Log value)

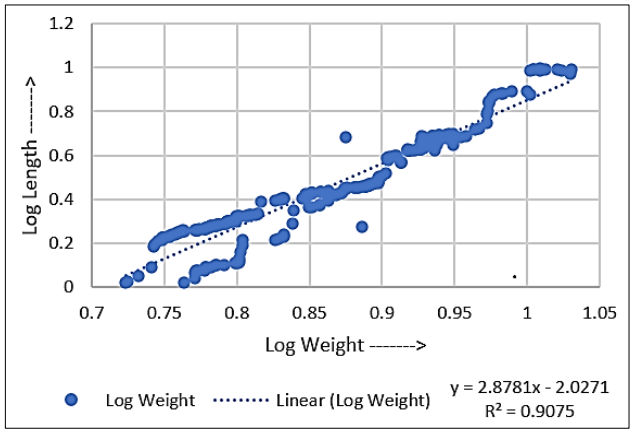

Fig 4 Length-weight relationship of combined species (Log value)

Fig 5 *Lepidocephalichthys guntea*

Table 4 Descriptive condition factor of the species

Category	Condition factors (K)					
	Condition factor (Fulton, 1904)			Modified condition factor (Le Cren, 1951)		
	Min.	Max.	Mean SD	Min.	Max.	Mean SD
Male	0.706	0.959	0.843 ± 0.06	2.223	3.148	2.924 ± 0.16
Female	0.411	1.143	0.688 ± 0.10	0.075	0.212	0.121 ± 0.01
Combination of male and female	0.411	1.143	0.747 ± 0.11	0.527	1.460	0.950 ± 0.14

†Min.: Minimum, Max.: Maximum, SD: Standard deviation

Table 5 Comparison of previous and present fiending of length-weight relationship

Authors	Geographical region	r^2 value			b value		
Dhakal and Subba (2003)	Pathri Khola, Morang District	Male	:	0.8591	Male	:	2.6298
		Female	:	0.9153	Female	:	3.1814
		Juvenile	:	0.8290	Juvenile	:	4.5776
		Combined	:	0.8678	Combined	:	3.2176
Hossain (2010)	Padma River	Overall	:	0.946	Overall	:	3.640
Gohain and Deka (2017)	Assam's Ghati Beel	Male	:	0.92	Male	:	2.66
		Female	:	0.93	Female	:	3.76
		Combined	:	0.91	Combined	:	3.02
Islam (2017)	Brahmaputra River	Overall	:	0.967	Overall	:	3.014
Mandal and Mandal (2021)	Kangsabati River	Male	:	0.838	Male	:	2.749
		Female	:	0.808	Female	:	3.4526
		Combined	:	0.859	Combined	:	2.8155
Present study (2022)	Fulkalmi Khal	Male	:	0.89	Male	:	2.3145
		Female	:	0.97	Female	:	3.834
		Combined	:	0.90	Combined	:	2.8787

Fig 6 Length measurment

Fig 7 Measurements of weight

In the current research, the Fulton condition factor (CF) value was calculated to be 0.843 ± 0.06 for males, 0.688 ± 0.10 for females, and 0.747 ± 0.11 for both sexes combined. Between males and females of *L. guntea*, there were discernible differences ($P < 0.05$) in the Fulton condition factor values. Modified condition factor (CF) value was calculated to be 2.924 ± 0.16 for males, 0.121 ± 0.01 for females, and 0.950 ± 0.14 for both sexes combined (Table 4). The Modified condition factor values of *L. guntea* showed significant differences ($P < 0.05$) depending on the gender of the subject. The value of the condition factor, or K, is one of the factors that determines whether or not fish are healthy in any natural aqua-habitat. According to [1], a value of 'K' that was closer to 1 suggested that the fish's overall condition was satisfactory. According to the findings of this study, male and mixed species demonstrate better overall health in comparison to female species in the natural water body under investigation (Fulkalmi khal, Nadia district). Regarding the availability of this species over the past few years, a phenetic study was conducted by mouth interviewing 127 residents of three villages in the Nadia district named Fulkalmi, Madhupur, and Pipragachi. The majority of locals (86%) said that there has been a decrease in the population of the species as compared to its historical availability. It's possible that the problem is caused by agricultural runoff that goes straight into the waterbody. Because of the extensive use of pesticides and herbicides in agricultural production. In light of this, an investigation of the impact of pesticides and herbicides on the biodiversity of this water body ought to be carried out in near future.

CONCLUSION

As a result of the current data, it can be said that *Lepidocephalichthys guntea*'s length-weight relationship somewhat departed from the isometric growth pattern (b=3) and did not obey the cube law. Males and combined group "b" values were found to be below 3, indicating a negative allometric growth rate, whereas females' "b" values were found to be greater than 1, indicating a positive allometric growth rate.

The "r" value for the association between length and weight showed that it was positive in each group. The fact that the "K" value was closer to the ideal value suggested that the species was doing well in its native environments. Additionally, it offers background data on the length-weight relation as well as the condition factor of *L. guntea*. It is imperative that urgent action be taken into consideration in order to conserve this species in their native habitat by the implementation of an artificial breeding program, as the population of this species is steadily declining.

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Conflicts of interest

We declare that we have no conflict of interest.

Ethics approval

To the best of our knowledge, we have obtained all required permissions and followed all applicable international, national, and/or institutional norms for the sampling, care, and experimental use of fishes in this investigation.

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