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## Length-weight relationship, length-length relationship and condition factor of *Labeo bata* (Hamilton, 1822) from central Brahmaputra valley of Assam

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**Abstract**

The present study was carried out to establish the relationship of total length and total weight, the relationship of total length (TL), standard length (SL), and fork length (FL) and also condition factor of native fish species *Labeo bata* from Kolong River of central Brahmaputra valley of Assam. A total of 334 specimens were collected for this present study from May 2018 to April 2019. The length-weight relationship (LWR) was calculated separately with male, female, and pooled data and growth was shown negative allometric ( $b < 3$ ). The length-length relationship (LLR) showed a linear significant relationship between total length and standard length, total length and fork length and standard length and fork length. Information on the length-weight relationship, length-length relationship and condition factor of *Labeo bata* from central Brahmaputra valley are quite limited. There is no such information of LWRs, LLRs, and condition factor of this fish species from this area so this result which would be helpful for scientific and sustainable management of Indian minor carp fisheries in the Kolong River of central Brahmaputra valley of Assam.

**Keywords:** Length-weight relationship, length-length relationship, condition factor, *Labeo bata*, Kolong river

**Introduction**

The mighty river Brahmaputra with 41 important tributaries covering about 640 km in the state. River Kolong-Kopili is an important south bank tributary draining the central Brahmaputra in Assam showing the presence of 141 finfish species belonging to 84 genera and 29 families<sup>[1]</sup>. Kolong, a tributary of river Brahmaputra with a total length of about 250 km, originates from a place near Jakhalabandha (Nagaon district, Assam) in between two hills viz. Hatimura and Barjhap at latitude 26°36'3"N and longitude 93°5'7" E. This river meets Kopili, a major south bank tributary of the Brahmaputra near Jagibhakatgaon and finally drains into the Brahmaputra at Kajalimukh<sup>[19]</sup>.

*Labeo bata* is a commercially important freshwater minor carp (locally known as Bhangon, Bhang, and Bata carp) of the Indian subcontinent. It belongs to the family Cyprinidae under the order Cypriniformes. *L. bata* is distributed throughout the Indian subcontinent including Bangladesh, Pakistan, Nepal, and Myanmar<sup>[28, 5]</sup>. *L. bata* is a freshwater medium-sized Indian minor carp, normally attains a length of 25 cm in a pond and 30-50cm in large tanks, reservoirs, and rivers and it is predominantly a bottom feeder<sup>[4]</sup>.

In nature, every living organism inherits growth as an integral part of their life history and also concerning growth dynamics, length-weight relationship and the length-length relationship of any fish species is a significant biological parameter in aquaculture to assess the stock variation, growth rate determination, and appearance of maturity with the time of spawning<sup>[3]</sup>. Length-weight and length-length relationship parameters are also affected by a series of factors including season, habitat, gonad maturity, sex, diet, stomach fullness, health, and preservation techniques<sup>[6]</sup>.

The condition factor (K) is an index reflecting interactions among biotic and abiotic factors in the physiological condition of the fishes. It shows the well-being of the population during various life cycle stages [14]. The present study is an attempt to provide basic information on the growth of *L. bata* based on length-weight relationship and length-length relationship studies. Basic information on the length-weight and length-length relationship for *L. bata* that will be helpful for future studies. Not much information is available in this aspect from the central Brahmaputra valley of Assam and the present study is a maiden attempt in this region of this species and the results obtained from it may contribute significantly to our knowledge of this least concern fish species as per [2].

**Materials and Methods**

Fish samples were collected monthly from May 2018 to April 2019 from the Kolong River of the Nagaon district, Assam. A total of 334 specimens of species *L. bata* were collected for observation of length-weight, length-length relationships, and condition factor. Fish specimens were caught using gills nets, cast nets, and seine nets of varying mesh sizes from 25-40 mm from different landing centres of Kolong River. The collected fishes were packed in iceboxes and brought to the laboratory for further observation. In the laboratory body measurement of fish, specimens were taken. Total length (TL), Standard length (SL), and Fork length (FL) of specimens were measured to the nearest 1 mm by scale, and body weight (BW) was measured with a digital weighing machine with the precision of 0.1 mg using Sartorius BSA224S-CW electronic balance.

The length-weight equations were computed, separately for males, females, and sexes combined. After removing all the outliers following [7], the length-weight relationship was estimated by using cube law given by [12].

$$W = a L^b$$

The length-weight relationship of each fish species was worked out using the logarithmic transformation of cube law

to arrive at a linear relationship.

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

Where W is the weight of the fish in grams (g), L is the total length of fish in centre meters (cm), ‘a’ and ‘b’ are intercept and slope of the regression line, respectively. To test for possible significant differences in both slope and intercept, analysis of co-variance was followed. The relationship between total length (TL) and Standard length (SL), Standard length (SL), and Fork length (FL) and Total length (TL) was established using linear regression analysis of  $TL = a + b \times SL$ , respectively. The condition factor was given by [22] and is calculated by the following formula:

$$K=100W/L^3$$

Where K = condition factor,  
L = total length (cm) and  
W = total weight (g).

**Results**

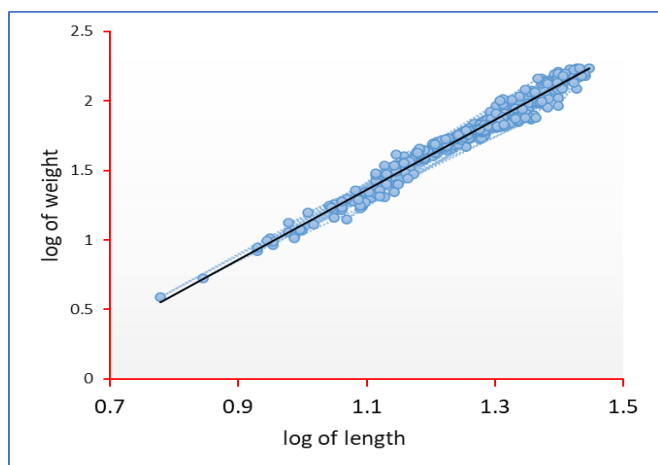
The length-weight relationship for the fish species was found to be significant at 1% and 5% level. The ‘b’ value of *L. bata* was found to be 2.93 (Table 1). Studies on the length-length relationship showed that the relationship between total length (TL), Standard length (SL), and Fork length (FL) was found to be linear for all cases and significant ( $p \leq 0.01$ ) (Table 2). The condition factor (K) for *L. bata* is found  $1.089 \pm 0.150$  for males,  $1.016 \pm 0.071$  for females, and pooled data  $1.061 \pm 0.070$  (Table 3). The month-wise condition factor (K) was also observed and revealed that the highest K value was found in June 2018 (1.223) and lowest in December 2018 (0.973) (Table 4). The regression coefficients, when calculated using the methods of least squares for male, female, and sexes combined of *L. bata* in size range 8.5cm- 28.0 cm gave the following equations:

Male:  $\text{Log } W = 0.136 + 2.979 \text{ Log } L$  ( $r^2 = 0.965$ )  
 Female:  $\text{Log } W = 0.139 + 2.945 \text{ Log } L$  ( $r^2 = 0.965$ )  
 Pooled:  $\text{Log } W = 0.142 + 2.936 \text{ Log } L$  ( $r^2 = 0.967$ )

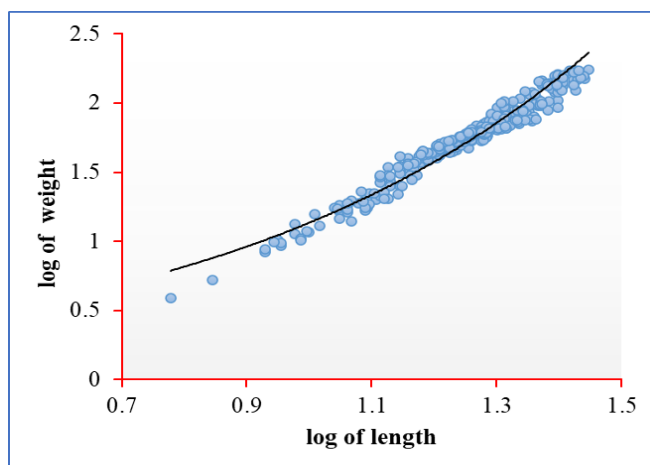
**Table 1:** Descriptive statistics and estimated length-weight relationship parameters for *L. bata* during the experimental period.

Species	N	Length range (cm)	Regression Parameters				
			a	95% confidence level of a	b	95% confidence level of b	r <sup>2</sup>
<i>Labeo bata</i>	334	8.50-28.00	0.14	0.13-0.15	2.93	2.87-2.99	0.96

N: sample size; a: intercept; b: slope; r<sup>2</sup>: coefficient of determination



**Fig 1:** Logarithmic relationship between length and weight of pooled data *L. bata* (linear).



**Fig 2:** Logarithmic relationship between length and weight of pooled data *L. bata* (exponential).

**Table 2:** Estimation of length-length relationship between Total length (TL), Standard length (SL), and Fork length (FL) for *L. bata* from May 2018 to April 2019.

Fish species	N	TL = a + b SL			SL = a + b FL			FL = a + b TL		
		a	b	r <sup>2</sup>	a	b	r <sup>2</sup>	a	b	r <sup>2</sup>
<i>Labeo bata</i>		0.132	0.933	0.965	0.813	1.020	0.991	0.271	0.956	0.963

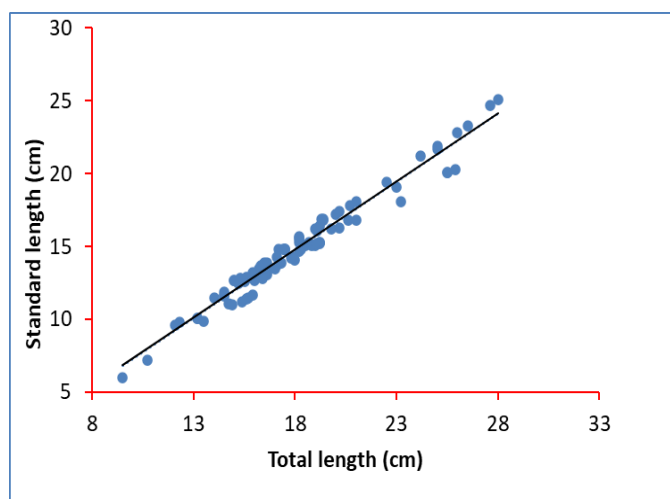
N: sample size; TL: total length; SL: standard length, FL: fork length; a: intercept; b: slope; r<sup>2</sup>: coefficient of determination.

**Table 3:** Value of 'K' range and Mean Standard deviation of condition factor 'K'.

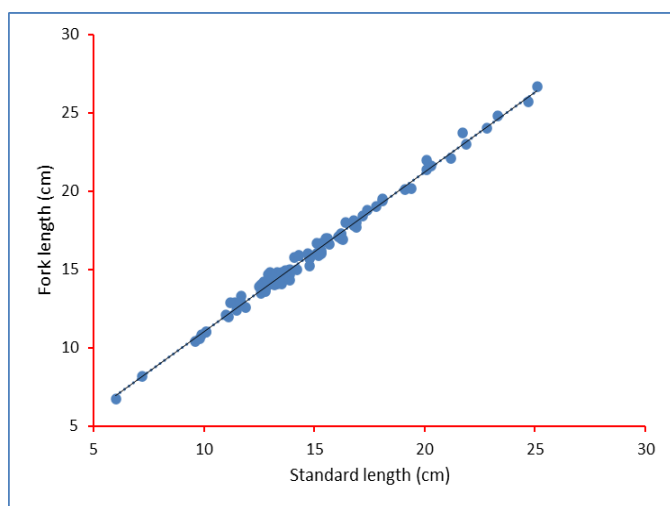
Species	Sex	'K' range	Mean SD of 'K'
<i>Labeo bata</i>	Male (n=131)	0.85-1.31	1.08±0.15
	Female (n=203)	0.93-1.15	1.01± 0.07
	Pooled (n=334)	0.97-1.22	1.06± 0.07

**Table 4:** Month-wise condition factors (K) for pooled data of *L. bata*

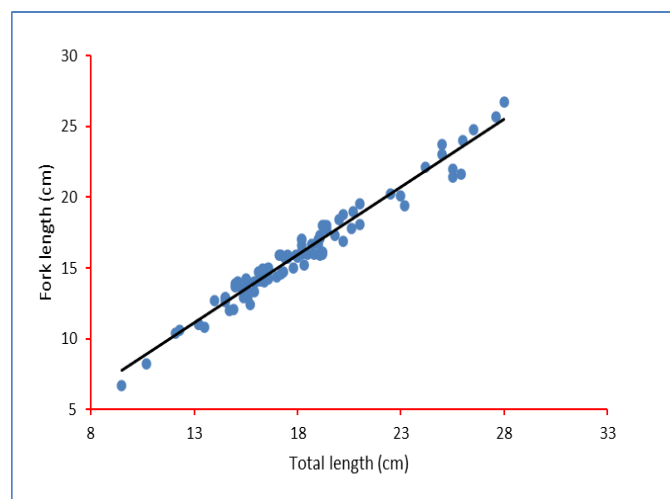
Months	No. of Males	No. of Females	Condition Factor (K)
May, 2018	12	21	1.12
Jun, 2018	14	13	1.22
Jul, 2018	11	12	1.11
Aug, 2018	9	15	1.11
Sept, 2018	10	16	1.03
Oct, 2018	9	14	1.01
Nov, 2018	10	17	0.97
Dec, 2018	9	14	0.97
Jan, 2019	13	21	1.02
Feb, 2019	12	20	1.03
Mar, 2019	12	20	1.03
Apr, 2019	10	21	1.07



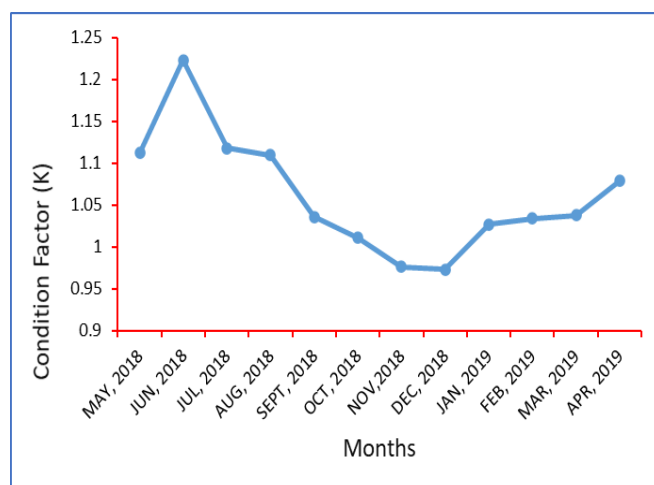
**Fig 3:** Length-length relationship between total length and the standard length of *L. bata* (linear).



**Fig 4:** Length-length relationship between standard length and a fork length of *L. bata* (linear)



**Fig 5:** Length-length relationship between total length and a fork length of *L. bata* (linear).



**Fig 6:** Month-wise Condition Factors for Pooled Data of *L. bata*

**Discussion**

Attempts are being made to study the length-weight relationship and length-length relationship and also condition factor of tropical freshwater fish from central Brahmaputra valley, Assam [19]. Information on length-weight and the length-length relationship of *L. bata* is quite limited from the Brahmaputra basin and no such information was found for these species from Kolong River, Assam. In the present investigation, the exponential form of the equation derived for the length-weight relationship of *L. bata* was found to be  $W = 0.142 L^{2.936}$   $r^2 = 0.96$ . The respective linear relationship could be expressed as  $\text{Log } W = 0.14 + 2.93 \text{ Log } L$ . The length-length relationship was found to be linear ( $P < 0.01$ ). This study represents the first reference on length-length relationship for *L. bata* based on the data on FishBase [7]. A total of 154 specimens of *L. bata* from Deepor Beel were collected for the estimation of length-weight relationship and

relative condition factor, which indicate that the value of 'b' in both the sexes is derivate from 3.0, which is a constant for an ideal fish<sup>[3]</sup>. The relative condition factor in both the sexes indicate the good general condition of the fish which are more or less similar in both males and females. Length-weight relationship and relative condition studied from Kulia Beel, Nadia district of West Bengal of two carps such as *L. bata* and *L. rohita*, and the length-weight relationship was recorded  $W = 0.0171 L^{2.904}$  and monthly mean  $K_n$  values varied from 0.907 to 1.076<sup>[25]</sup>. From Taunsa Barrage, River Indus, Pakistan, collected a sample of *L. gonius* for analysis of the length-weight relationship, length-length relationship, and condition factor and revealed that LWRs ( $W = -2.403 L^{3.29}$ ), LLRs, and condition factor ( $K = 0.98 \pm 0.06$ ) relationships were found significantly correlated<sup>[17]</sup>. A negative allometric growth pattern was also found from Lower Anicut, Tamil Nadu of *C. reba* fish species where 'b' value was found to be 2.363<sup>[13]</sup>. And the similar result was also found from Govindgarh Lake, Rewa (M.P), where the 'b' value was 2.97 in *L. rohita*<sup>[23]</sup>. The 'b' value of *L. rohita* was found 2.695 in males and 2.664 in females<sup>[22]</sup>. For the present study, the 'b' value was found to be in the expected range of 2.5- 3.5<sup>[7]</sup>. However, this deviation of b value was might be a habitat of fish, maturity stages, sex diet, growth phase, stomach fullness, and seasonality<sup>[7]</sup>. The length-length relationship is important in the fisheries management for cooperative growth studies<sup>[15]</sup>. Variation in Length-length relationships of the same species from across different locations may be attributed to varying ecological conditions and variation in the physiological of the animals or a combination of both<sup>[12]</sup>. In the present study, the K values of *L. bata* varied from  $1.08 \pm 1.5$  for males,  $1.016 \pm 0.071$  for females, and  $1.061 \pm 0.070$  for pooled data. Condition factor or 'K' is important in understanding the life cycle of fish species, thus contributing to the management of the species and maintain the equilibrium in the ecosystem<sup>[11]</sup>. Fishes sufficiently fed would have 'K'  $\geq 1$  but when undernourished 'K' is less than 1<sup>[18]</sup>. The condition factor values of *L. rohita* for the different length-groups ranged between 1.27 and 1.63 which signifies that the environmental suitability of the reservoir Udaisagar for good growth of fish<sup>[24]</sup>. An experiment worked done on Indian major carps in Gujarat, India, and reported average condition factor values for *C. catla* ( $1.34 \pm 0.05$ ), *L. rohita* ( $1.230 \pm 0.022$ ), and *C. mrigala* ( $1.00 \pm 0.012$ )<sup>[27]</sup>. From River Ganga in Allahabad, found that condition factor values were highest in *L. rohita* ( $1.75 \pm 0.32$ ) and lowest in *L. calbasu* ( $1.06 \pm 0.09$ )<sup>[20]</sup>. The condition factor (K) for *L. calbasu* varied from  $0.79-1.81 \pm 0.150$  in River Chenab, Pakistan<sup>[18]</sup>. The condition factor ranged from 0.65 to 1.05 (mean  $SD = 0.87 \pm 0.09$ ) in males and 0.67 to 1.79 (mean  $SD = 1.14 \pm 0.30$ ) in females of *C. reba*<sup>[9]</sup>. In later studied,<sup>[16]</sup> the condition factor recorded for *L. rohita* (1.41), *L. calbasu* (1.83), *L. gonius* (1.51), *L. boggut* (1.55), *L. dyochelius* (1.02), *C. catla* (1.45), *C. mrigala* (1.05) and *C. reba* (0.84) in Indus River, Pakistan. There is a little information regarding LWRs, LLRs, and condition factor of tropical water fish *L. bata* in central Brahmaputra valley, Assam. The information generated in the present study can be helpful and needful in future studies and also in the sustainable management of this resource.

## Conclusion

From the present investigations, it can be concluded that *L. bata* growth in weight is almost proportional to the cube of its

length. Length-length parameters were found linear and significant. In the case of Condition factor ( $K_n$ ), it also shows positive influence with increasing length or weight. From the present study, we can use the study of fish population dynamics, comparison of body forms of different fish groups, the pattern of growth of fish life history between regions, and morphological comparisons between different fish populations from different habitats.

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