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Length-Weight relationship and relative condition factor of *Labeo bata* (Hamilton, 1822) from Deepor beel, a Ramsar site of Assam, India

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Abstract
The present study deals with the length-weight relationship, relative condition factor of a fish species *Labeo bata* (Hamilton, 1822) of Deepar Beel (wetland) of Assam. The fish is separated into male and female to calculate length-weight relationship and relative condition factor separately. The growth performance of length-weight relationship are found high in both the sexes since the correlation coefficient 'r' exhibits high degree of relationship where positive allometric growth is shown by male and negative by female. The positive allometric growth in male may be due to higher feeding proficiencies and better environmental condition whereas negative allometric growth in female may be the result of loss of energy due to gonad development during breeding season of the present study. The present findings also indicate that the value of 'b' in both the sexes is deviated from 3.0, which is a constant for an ideal fish. The Kn value in both the sexes indicate good general condition of the fish which are more or less similar in both male and female.

Keywords: Length-Weight relationship, relative condition factor, *Labeo bata*

1. Introduction
In nature, every living organism inherits growth as an integral part of their life-history. In relation to growth dynamics, length-weight 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. Growth is accompanied with increase of length and weight or both because growth is considered as a function of length and weight. In an ideal environment, isometric growth pattern of fish follows the Cube Law ($W=L^3$), but in natural environment due to many factors the cube law may be deviated and therefore, the length-weight relationship is calculated modifying the Cube Law by Le Cren (1951) [11] and is expressed as $W = a L^b$ where W=weight of the fish (grams) and L= length of fish (cm).

2. Materials and Methods
A total number of 154 (male = 74 and females = 80) individual of various age of live samples of *Labeo bata* were collected randomly from Deepar Beel (Wetland) located at $91^0 36^/$-$91^0 42^/$ East longitude and $26^0 6^/$ to $26^0 09^/$ North latitude from April, 2015 – August, 2015. Total length of the fishes were measured with digital slide caliper from tip of the snout to tip of the caudal fin and body weight were measured nearest to 0.01 g with the help of standard digital balance (Systronic make) individually. The length – weight relationships were estimated following the formula $W = aL^b$ (Le Cren, 1951)[11] and is expressed logarithmically as Log W = Log a + b Log L
Where, W denotes body weight of the fish; L = total length of the fish; 'a' = a constant showing the initial growth index and 'b' being the growth coefficient. Parameter 'a' and 'b' were calculated by least square regression methods as follows:

$$\text{Log a} = \frac{\sum \text{Log W}.\sum(\log \text{L})^2 - \sum \text{Log L}.\sum(\text{Log L}.\text{Log W})}{\text{N}.\sum(\text{Log L})^2 - (\sum \text{Log L})^2}$$

$$\text{Log b} = \frac{\sum \text{Log W} - \text{N. Log a}}{\sum \text{Log L}}$$

Relative condition factor (Kn) was also estimated following Le Cren (1951) [11] as expressed bellow

$$\text{Kn} = \frac{\text{W}}{\text{\^{}W}}$$

Where W = observed weight
^W = calculated weight derived from length-weight relationship.
The mean, standard deviation (SD) and Correlation coefficient (r) of total length and body weight were calculated with the help of SPSS software (version-16) and Microsoft Office 7.

3. Results

The total length of *Labeo bata* is recorded as 7.4-13.2 cm and 7.5-13.8 cm in male and female respectively and weight as 3.66-20.63 gram in male and 4.24-24.1 gram in female. Table-1 shows the value of 'a', 'b', mean±SD of total length and body weight for male and female *Labeo bata*. The value of correlation coefficient 'r' and relative condition factor 'Kn' expressed as mean±SD are given in the Table-2. Figure-1&2 depicts the regression graph of length-weight relationship and relative condition factor (Kn) respectively. The result of logarithmic length-weight relationship formula of *Labeo bata* under the present study is as follows during the period of investigation in Deepar Beel.

Labeo bata (male) - Log W = -2.10 + 3.06 Log L
Labeo bata (female) - Log W = -1.92 + 2.89 Log L

Table 1: Mean ± Standard deviation of Body weight (BW) and Total length (TL), value of 'a' and 'b'.

Species	Sex	Weight Range (g)	Size Range (cm)	Mean±SD BW (g)	Mean±SD TL (cm)	Value of 'a'	Value of 'b'
Labeo bata	Male(n=74)	3.66-20.63	7.4-13.2	9.09±3.83	9.79±1.32	-2.10	3.06
	Female(n=80)	4.24-24.1	7.5-13.8	9.01±3.65	9.70±1.23	-1.92	2.89

Table 2: Value of Correlation coefficient 'r', Kn range and Mean ± Standard deviation of condition factor 'Kn'.

Species	Sex	Value of 'r'	Kn range	Mean ± SD of Kn
Labeo bata	Male(n=74)	0.98**	0.88-1.22	1.01±0.05
	Female(n=80)	0.97**	0.87-1.26	1.01±0.06

**.Correlation is significant at the 0.01 level (2-tailed).

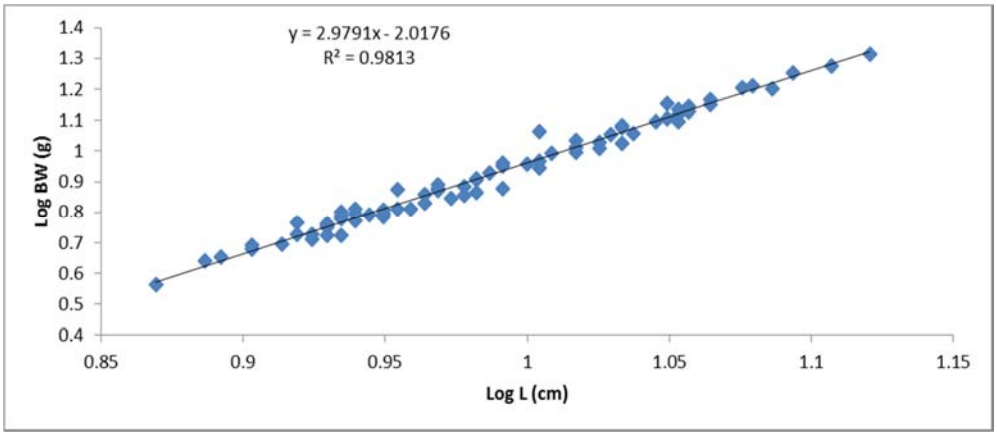

Fig 1 (a): Relation between Log TL (cm) and Log BW (g) of *Labeo bata* (male)

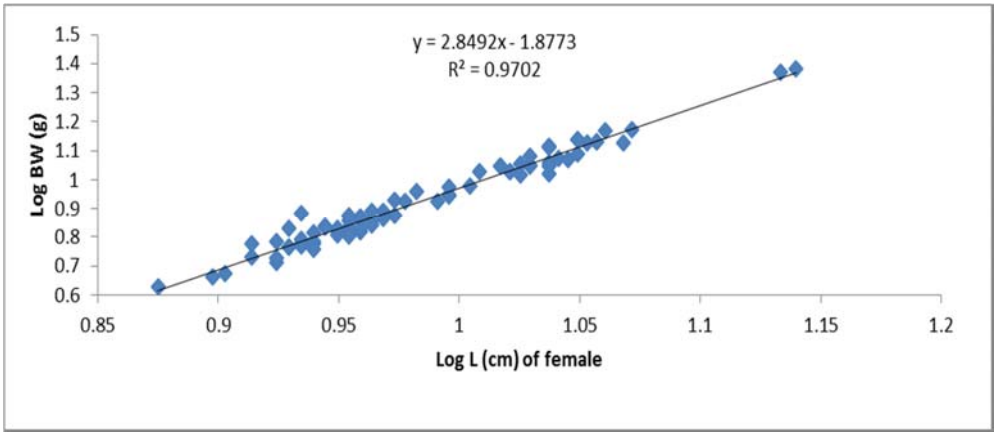

Fig 1 (b): Relation between Log TL (cm) and Log BW (g) of *Labeo bata* (female)

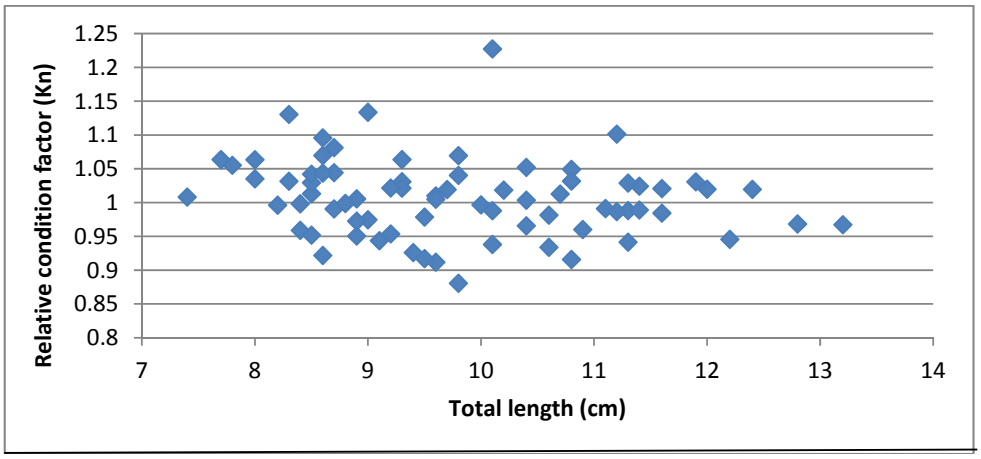

Fig 2(a): Relative condition factor (Kn) in relation to total length (cm) of *Labeo bata* (male)

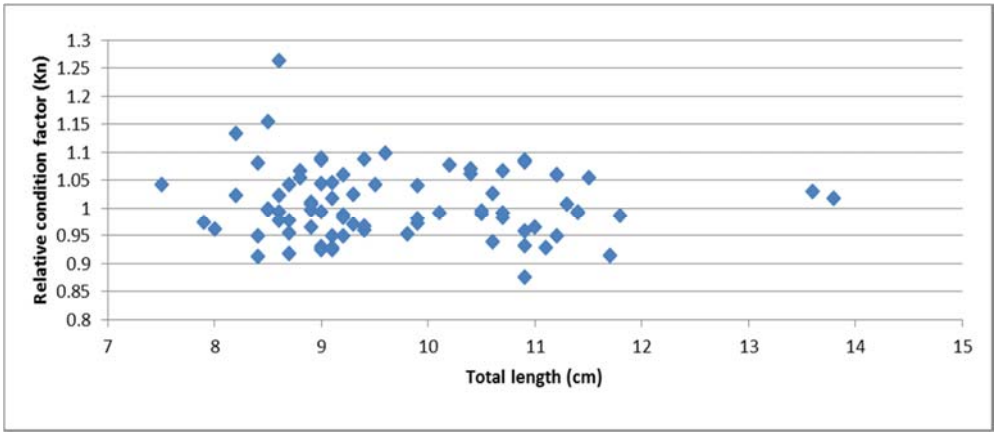

Fig 2(b): Relative condition factor (Kn) in relation to total length (cm) of *Labeo bata* (female)

4. Discussion

The present investigation is an attempt to study the length-weight relationship of *Labeo bata* in both male and female individual. The study reveals that the growth performance in both male and female are found high since the correlation coefficient 'r' exhibits high degree of correlation between the length-weight relationships. The correlation coefficient 'r' in *Labeo bata* is very closer to 1.0 in both male (0.98) and female (0.97).

The degree of variation of exponential value of length-weight relationship indicated by 'b' value in male is above 3 (3.06) indicting positive allometric growth unlike female (2.89) where negative allometric growth is observed. The positive allometric growth so observed in male may be due to higher feeding proficiencies and better environmental condition. Soni and Kathal 1953 [15]; Kaur 1981 [9]; Saikia *et al.,* 2011 [14]; Bhatta and Goswami 2014 [3]; Deka and Bura Gohain 2015 also observed the higher proficiencies in feeding, availability of food and other associated factors for positive allometric growth in different fishes. The negative allometric growth so observed in female may be the result of loss of energy due to gonad development at breeding season of the present study.

It is interesting to note that the value of exponent 'b' (Table-1) and correlation coefficient 'r' (Table-2) remain higher in male *Labeo rohita.* However, in both the sexes the value of exponent 'b' is found to be in normal ranges between 2.5 and 4.0 as suggested by Hile, 1936 and Martin, 1949 and between 2.5 and 3.5 as reported by Froese, 2006 for most fishes. The present study also indicates that the value of 'b' deviate from 'cube law' as it remains constant at 3.0 for an ideal fish (Allen, 1938) [1] in a particular environmental condition.

Kn- factor is an index to monitor feeding intensity and growth rate (Oni *et al.,* 1983) [13] which express the 'Condition', 'fatness' or wellbeing of a fish. It is based on hypothesis that heavier fish for a particular length are in better condition (Bagenal and Tesch, 1978) [2]. Fish with high value of 'Kn' are heavy for its length, while with low 'Kn' are lighter (Bagenal and Tesch, 1978) [2]. 'Kn' value greater than 1 indicates better condition of fish (Le Cren, 1951) [11]. The ranges Kn value in male *Labeo rohita* is 0.88 to 1.22 with an average of 1.01±0.05 and in female is 0.87 - 1.26 with an average of 1.01±0.06. Thus the present investigation reveals that the relative condition factor (Kn) is more or less similar (Table-2) in both the sexes.

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