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Length-Weight relationship and relative condition factor of *Nandus nandus* (Hamilton, 1822) of Garjan Beel (wetland) of Assam, India

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Abstract
The present study reports the length-weight relationship of male and female *Nandus nandus* (Hamilton, 1822) of Garjan Beel (wetland) of Assam. The fishes are separated into male and female for calculation of length weight relationship and relative condition factor. The growth performance of length-weight relationship are found high since the correlation coefficient 'r' exhibits high degree of relationship, although the growth being negative allometric in both male and female. The negative allometric growth observed may be due to lower feeding proficiencies and/or the environmental condition and/or physico-chemical parameters and/or the season of experiment are not suitable for proper growth of fishes. The 'Kn' value of male *Nandus nandus* ranges from 1.02 to 1.84 with an average 0f 1.36±0.20 and in female from 1.02 to 2.04 with an average of 1.32±0.23 showing better condition of the experimental fish. Such a high value of 'Kn' (greater than 1) is a special feature recorded in the present study for the species *Nandus nandus.* The relative condition factor is also observed to decrease from lighter to heavier fish first and increase slightly near to the heaviest fish.

Keywords: Length-Weight relationship, relative condition factor, *Nandus nandus,* Garjan Beel

1. Introduction
Growth is a natural property of all living creatures in the world. When an individual grows, the length and/or weight increases simultaneously because growth is a function of length and weight. Length-weight relationship is a significant biological parameter in fishery science as it helps in easy assessment of growth rate, appearance of first maturity, time of spawning, status of stock variation, growth dynamics, general well-being of fishes etc.
In an ideal environment, fishes grow isometrically and obeys the Cube law ($W=L^3$) (Brody, 1945; Lagler, 1952) [3, 14]; however there is every possibility of deviation of length-weight relationship from Cube's law due to different environmental factors that influences the physico-chemical parameters of water where different species of fishes reside. Therefore, Le Cren, 1951 modified Cube's law as $W = aL^b$ to get a satisfactory result to calculate the length - weight relationship throughout the life history stages of fishes.
Nandus nandus is a very important species of fish called Gangetic leaffish. The fish is generally gray in colour with irregular brown markings which is recorded from Pakistan, India, Nepal, Bangladesh and Mynmar. The fish is available almost in all Beels (wetlands) of Assam.

2. Materials and Methods: A total number of 102 live samples of *Nandus nandus* of various weight and size groups of different age were collected randomly from February, 2015 to May, 2015 from Garjan Beel (Wetland) located at $91^0 30^/ 41^{//}$-$91^0 35^/ 40^{//}$ East longitude and $26^0 13^/ 5^{//}$ to $26^0 18^/ 5^{//}$ North latitude;. After separation of male and female, total length of the fishes were measured with digital slide caliper from the tip of the snout to the tip of the caudal fin and body weight were measured with the help of a standard digital balance (nearest to 0.01 g) individually. The length – weight relationships were estimated following the formula $W = aL^b$ (Le Cren, 1951) [15], which is expressed logarithmically as Log W = Log a + b Log L.
Where, W indicates body weight of the fish; L denotes total length of the fish; 'a' is a constant showing the initial growth index and 'b' is growth coefficient. Parameter 'a' and 'b' were calculated by method of least square regression as follows.

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

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

Relative condition factor (Kn) was also estimated by following Le Cren (1951) [15] formula 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 coefficient of correlation (r) of total length and body weight were calculated with the help of SPSS software (16^{th} version) and Microsoft Office 7.

3. Results: In the present study total length and body weight of *Nandus nandus* ranges from 6.92 to 10.31 cm in length and 5.58 to 25.56 g in weight in males; while total length in females ranges from 6.81 to 11.71 cm and total weight from 5.56 to 17.86 g. The value of 'a', 'b', mean ±SD of total length and body weight for *Nandus nandus* (male & female) are given in the Table-1. The co-efficient of correlation 'r' and relative condition factor 'Kn' (mean±SD) are given in the Table-2. The regression graph of length-weight relationship is depicted in Figure-1 and relative condition factor (Kn) in Figure-2. The result of logarithmic length-weight relationship for *Nandus nandus* (male & female) is as follows during the period of investigation in the present study at Garjan Beel.

Nandus nandus (Male) - Log W = -1.55 + 2.70 Log L
Nandus nandus (Female) – Log W = -1.63 + 2.80 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'
Nandus nandus	Male (n=50)	5.58-25.56	6.92-10.31	10.51±3.84	8.77±1.04	-1.55	2.70
	Female (n=52)	5.56-26.17	6.80-11.71	9.93±4.11	8.54±1.12	-1.63	2.80

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
Nandus nandus	Male (n=50)	0.870**	1.02-2.04	1.32±0.23
	Female (n=52)	0.950**	1.02-1.84	1.36±0.20

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

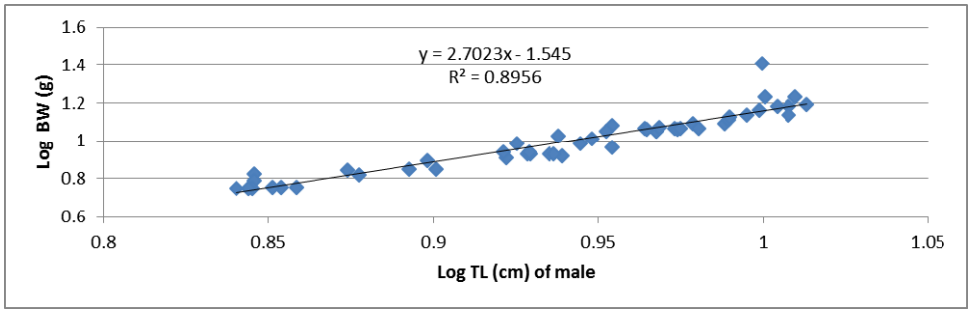

Fig 1 (a): Relation between Log TL (cm) and Log BW (g) of *Nandus nandus* (Male)

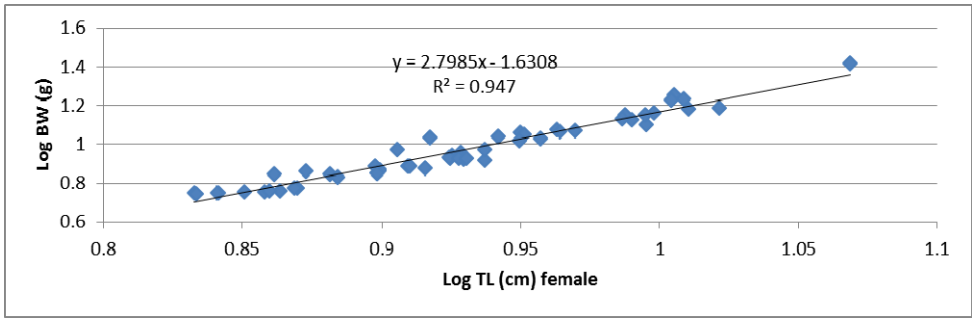

Fig 1 (b): Relation between Log TL (cm) and Log BW (g) of *Nandus nandus* (Female)

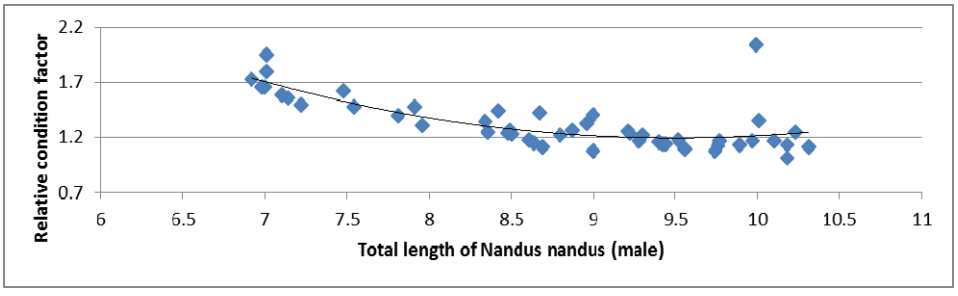

Fig 2 (a): Relative condition factor (Kn) in relation to total length (cm) of *Nandus nandus* (Male)

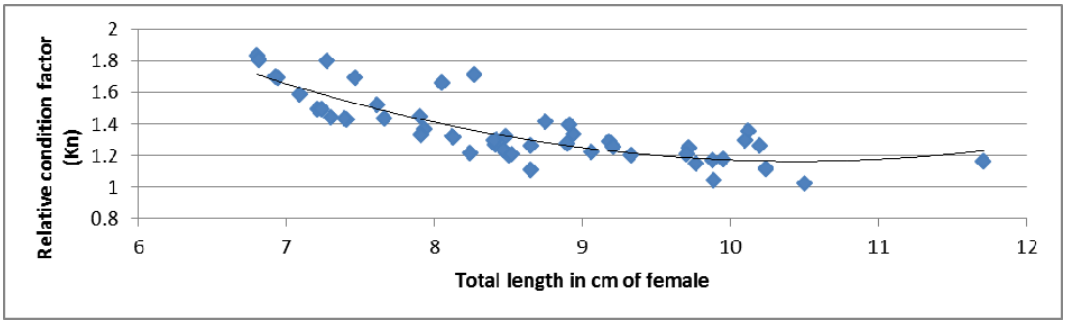

Fig 2 (b): Relative condition factor (Kn) in relation to total length (cm) of *Nandus nandus* (Female)

4. Discussion: The present study reveals that the growth performance in both male and female *Nandus nandus* are found high since the correlation coefficient 'r' exhibits high degree of correlation between the length-weight relationship of in both sexes (Table-1&2), although the growth being negative allometric in all cases (Table-1&2). The negative allometric growth observed may be due to lower feeding proficiencies and/or the environmental condition and/or physico-chemical parameters and/or the season of experiment are not suitable for proper growth of fishes. Soni and Kathal, 1953 [15]; Kaur, 1981 [13]; Saikia *et al.,* 2011 [18]; Bura Gohain and Goswami, 2013 [4]; Deka and Bura Gohain, 2015 [7]; Das *et al.,* 2015 [5]; Rahman *et al.,* 2015 [6, 20]; Kalita *et al.,* 2016 [12] observed the higher proficiencies in feeding, availability of food and other associated factors for positive allometric growth in different fishes.

Degree of variation of exponential value of length-weight relationship indicated by 'b' value in *Nandus nadus* male is 2.70 and in female 2.80. The value of exponent 'b' is found to be in normal range between 2.5 and 4.0 as recommended by Hile, 1936 [10] and Martin 1949 [16] and between 2.5 and 3.5 as reported by Froese, 2006 [8] for most fishes. Variation in the value of growth co-efficient (b) can be attributed due to feeding (Le-Cren, 1951) [15], sex (Hile and Jobes, 1940) [11], developmental stages of gonads, specially the ovary affect the weight (Weatherly, 1972 and Hile, 1936) [21, 10] and state of maturity (Frost, 1945) [9]. The present study, however, reveals that the growth co-efficient (b) in both sexes of *Nandus nandus* deviated from 'Cube law' as it remains constant at 3.0 for an ideal environment showing isometric growth pattern (Bura Gohain and Goswami, 2013) [4].

The well-being or 'Condition' or 'fatness' of fish determined by Kn-factor, is an index to monitor feeding intensity and growth rate (Oni *et al.,* 1983) [17] is based on hypothesis that heavier fish for a given length are in better condition (Bagenal and Tesch, 1978) [1]. The high value of 'Kn' for fishes are heavy for its length, while with low 'Kn' are lighter (Bagenal and Tesch, 1978) [1]. However, 'Kn' value greater than 1 indicates better condition of fish (Le Cren, 1951) [15]. In the present study it is very interesting that 'Kn' value of *Nandus nandus* (Male) ranges from 1.02 to 2.04 with an average of 1.32±0.23 while in female from 1.02-1.84 with an average 0f 1.36±0.20 showing better condition of the experimental fish. Such a high value of 'Kn' (in all cases greater than 1) is a special feature recorded in the present study for the species *Nandus nandus.* However, the relative condition factor is observed to decrease from lighter to heavier fish first and increase slightly near to the heaviest fish (Figure-2) which does not corroborate with the result of Yousuf and Khurshid, 2008 [22] who noticed reverse phenomenon in their study. However, Rahman *et al.,* 2015 [6. 20] in female *Anabas testudineus* and Das *et al.,* 2015 [6] in male *Heteropneustes fossilis* also recorded more or less similar trend where 'Kn' declines from lower sized fish and exhibit the lowest value at medium fish and thereafter steadily incline to get the highest value in bigger fishes. Nevertheless, Bhatta and Goswami, 2014 [2] recorded a contradictory result with the present study where peak Kn value is recorded in medium sized fishes of *Channa aurantimaculata.*

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