Original Article

Study of Morphometric Characteristics of Freshwater Putul, Botia lohachata in Kompo River of Bagmara, Rajshahi, Bangladesh

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Abstract

This study described about the morphometric characteristics of Botia lohachata, collected from the Kompo River at Rajshahi, were studied for a period of four months from July to October 2014. Length frequency distributions, length-length relationships, length-weight relationship, sex ratio, Fulton's condition factor and fecundity of B. lohachata were studied in the present study. This is the maiden research conducted on B. lohachata in Bangladesh. The highest mean total lengths were 61.16±4.77 mm (combined sex), 63.80±4.79mm (female) and 58.17 ±3.30mm (male). Maximum 43.34% female fishes were belonging to the length category of 61-65 mm where as 61.41% male were belonging to 56-60 mm. Similar findings are also presented for standard length, fork length, body depth, dorsal length, pectoral length, pelvic length and anal length. Linear relationships were also studied among mentioned lengths. Strong positive correlations were observed in all cases. The highest mean body weight was weight 2.67±0.71g (October) in combined sex, this value was 3.10±0.59 in female (September) and 2.25±0.38g in male (September). Strong positive correlations were also observed between total length and body weight. Observed value of sex indicated that 54% specimens were female and remaining 46% were male. The value of chi square (x²) was 2.4 at 1 degree of freedom (p<0.005) strongly indicated that the observed sex ratio not differs significantly from the expected ratio (1:1). The Fulton’s condition factors In case of combined sexes, the highest condition factor 1.156±0.126 was recorded in month of October, female highest condition factor 1.190±0.136 and male highest condition factor 1.135±0.103. [Journal of Science Foundation 2019;17(1):15-33]

Keywords: Botia lohachata; Kompo River; length-weight relationship; condition factor

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Introduction

The morphometric study of fishes is becoming prominent all over the world to fulfill the lacuna of the knowledge on biological aspects of fishes. Therefore fisheries biologists are turning their eyes to these aspects from various points of view. Length-weight relationships for fish have been used extensively to provide information on the condition of fishes, their isometric or allometric growth, in the analysis of ontogenic change, compare life histories of fish between regions as well as other aspects of fish population dynamics. In fisheries biology, length-weight relationships useful for conversion of growth-in-length equations of growth-in-weight for use in stock assessment models and to estimate stock biomass from limited sample sizes (Binohlan and Pauly, 1998; Koutrakis and Tsiklis, 2003; Ecoutin et al., 2005).

The length weight (LWR) of fishes in a given geographic zone is important in fisheries biology because it allows estimation of the average weight at a given length. LWR parameters can also be used as indices of fish condition for life-history comparisons of different regions (Petrakis and Stergiou, 1995).

Length-weight relationships for fish were originally used to provide information on the condition of fish and to determine whether somatic growth was isometric or allometric (Le Cren, 1951; Ricker, 1975). All living animals a tendency to maintain symmetrical growth of its different body parts in relation to one another. It is generally known that all parts are dependent on the length of the body i.e. growth of the body parts are proportional to the growth of total length. But the total length of the body is not dependent on all other body parts. So morphometric measurements of fishes and the study of statistical relationship among them are essential for taxonomic study of species (Tandon et al., 1993).

Morphometric character is the character based on measurement. In fish, measurements are taken on a straight line basis, not around the curve of body with the exception of such measurements specifically intended to measure roundness, e.g. girth. Any measurements should be defined or referenced to a standard work as some may include soft parts or only be from bony margin to bony margin. Some measurements include total length (TL), standard length (SL), head length (HL) etc.

Methodology

The study was conducted in the Kompo river of Bagmara upazila under Rajshahi district. Bagmara is located at 24.5639°N and 88.8083°E (Figure a). Fish specimens were collected for four months from July 2014 to October, 2014.

Figure a: Map of Bagmara upazila under Rajshahi district (blue circle showing the study area).
**Sampling framework:** A total of fifty (50) specimens were collected every month for study of different parameters regarding biology of *Botia lohachata*. Fish specimens were collected with the help of fishermen who used their own fishing nets, traps and crafts to harvest target species in the river Kompo. Collected specimens were brought to the Laboratory of the Department of Fisheries and preserved in 10% formalin solution for further study. The specimens were preserved in labeled plastic and glass jars. No physically damaged specimens were selected for the study.

**Length and Weight Measurements:** The measurements of different lengths were made with the help of an electric slide calipers. Body weight (BW) was weighted by a digital balance to the nearest 0.01 g. The LWR for BW was calculated using the equation, \( BW = aSL^b \), where coefficient \( a \) is the intercept in the y-axis, and the regression coefficient \( b \) is an exponent indicating isometric growth when equal to 3. However, following morphometric characters were measured in the present study- TL, SL, BD, PcL, PvL, AL, DL, TW.

**Meristic characters:** In the present study following meristic characters were recorded-Fin rays, Barbels, Lateral line scale.

**Descriptive characters:** Shape of the body, the orientation of the paired and unpaired fins, Coloration of body, Sexually dimorphic characters

**Length-length relationships:** Total length (TL), standard length (SL), fork length (FL), Dorsal length (DL), Pectoral length (PcL), Pelvic length (PvL) and Anal length (AL) were used to make the relationships, TL vs. SL, TL vs. FL, SL vs. FL, TL vs. DL, TL vs. PcL, TL vs. PvL, TL vs. AL by linear regressions for both males and females separately.

**Length-weight relationship:** The relationship between weight and length was calculated using the expression: \( W = aL^b \), where the \( W \) is the body weight (g), \( L \) the standard length (cm), a intercept of the regression and \( b \) is the regression coefficient (slope). Parameters \( a \) and \( b \) of the weight-length relationship will be estimated by linear regression analysis based on natural logarithms: \( \ln(W) = \ln(a) + b \ln(L) \).

**Statistical analyses:** Statistical analyses were done using computer software Statistical Package for Social Science (SPSS) version 16.00 and Microsoft Excel 2010.

**Condition factor:** The Fulton’s condition factor (\( K \)) was calculated using the following equation, \( K = 100 \times \left( \frac{W}{L^3} \right) \) (Htun-Han 1978).

**Sex Ratio:** The ratio between male and female was analyzed using the monthly samples from July to October 2015. A chi-square test was applied to identify the sex ratio from expected value of 1:1 (male: female).

**Result and Discussion**

**Length-frequency distribution:** The total length (TL), standard length (SL), fork length (FL), dorsal length (DL), pectoral length (PcL), pelvic length (PvL) and anal length (AL) of *Botia lohachata* were studied. Month and sex based length frequency distributions of these lengths are presented here.

**Total length:** In case of combined sexes, the highest total length was found in the month of September and the mean (±SD) value was 61.16±4.77 mm. The second highest value 61.04±5.26 mm was recorded in month October. The lowest mean total length 58.84±4.79 mm was recorded in month July (Table 1). The highest TL for male was recorded highest 58.17 ±3.30mm in the month September and lowest 55.71±2.96 mm in the month July. On the other hand the highest TL for female was found as 63.80±4.79mm (October) and lowest TL 61.73±4.34 mm (July) (Table 1).

The sex-wise length frequency distributions shown in figure I (male), figure II (female) and III (combined). In case of male, maximum 61.415% fishes were belonging to the length category of 56-60 mm followed by 51-55mm 21.721% and61-65mm 11.931% (Figure I).
Table 1: Various Analyses Regarding Total Length (mm) of *Botia lohachata* During Study Months

| Month | Sex   | n  | Min | Max | Mean±SD | 95% CL  |
|-------|-------|----|-----|-----|---------|---------|
| June  | Male  | 24 | 46  | 60  | 55.71±2.96 | 54.46-56.96 |
| Female| 26    |    | 55  | 71  | 61.73±4.34 | 59.98-63.48 |
|       | Combined | 50 | 46  | 71  | 58.84±4.79 | 57.48-60.20 |
| July  | Male  | 25 | 46  | 83  | 57.52±6.55 | 54.82-60.22 |
| Female| 25    |    | 50  | 69  | 61.76±3.70 | 60.23-63.29 |
|       | Combined | 50 | 46  | 83  | 59.64±5.68 | 58.03-61.25 |
| August| Male  | 23 | 52  | 64  | 58.17±3.30 | 56.75-59.60 |
| Female| 27    |    | 57  | 71  | 63.70±4.36 | 61.98-65.43 |
|       | Combined | 50 | 52  | 71  | 61.16±4.77 | 59.81-62.51 |
| September| Male | 20  | 50  | 62  | 57.14±2.67 | 55.93-58.36 |
| Female| 30    |    | 55  | 74  | 63.80±4.79 | 62.01-65.59 |
|       | Combined | 50 | 50  | 74  | 61.04±5.26 | 59.55-62.53 |

On the other hand, in case of female specimens, maximum 43.344% fishes were belonging to the length of 61 to 65 mm followed by 56-60 mm 26.847% and 66 to 70 mm 17.942% (Figure II). In combined sex, maximum 41.896% fishes were belonging to the length of 56 to 60 mm followed by 61 to 65 mm 29.680% and 51 to 55 mm and 66 to 70 mm 10.68% (Figure III).

**Figure I:** Frequency distribution of male fishes (n=92) according to their total length

**Figure II:** Frequency distribution of female fishes (n=108) according to their total length
Figure III: Frequency distribution of combined fishes (n=200) according to their total length

**Fork length:** Details analysis of the length of *Botia lohachata* are presented in table 2. In case of combined sexes, the highest fork length was found in the month of September and the mean (±SD) value was 55.28±4.35mm. The second highest value 54.38±4.54 mm was recorded in month October. The lowest mean total length 52.96±4.39 mm was recorded in month August (Table 2). The highest FL for male was recorded highest 53.00±3.13mm in the month September and lowest 50.56±3.04mm in the month August. On the other hand the highest FL for female was found as 57.22±4.34 mm (September) and lowest 55.27±3.86 mm (July) (Table 2).

**Table 2: Various Analysis Regarding Fork Length (mm) of *Botia lohachata* During Study Months**

| Month   | Sex    | n   | Min | Max | Total Length (mm) |
|---------|--------|-----|-----|-----|-------------------|
|         |        |     |     |     | Mean±SD | 95% CI   |
| July    | Male   | 24  | 41  | 68  | 50.79±4.71 | 48.80 to 52.78 |
|         | Female | 26  | 50  | 63  | 55.27±3.86 | 53.71 to 56.83 |
|         | Combined | 50  | 41  | 67  | 53.12±4.81 | 51.75 to 54.49 |
| August  | Male   | 25  | 41  | 57  | 50.56±3.04 | 49.30 to 51.82 |
|         | Female | 25  | 44  | 69  | 55.36±4.26 | 53.60 to 57.12 |
|         | Combined | 50  | 41  | 69  | 52.96±4.39 | 51.71 to 54.21 |
| September | Male   | 23  | 48  | 61  | 53.00±3.13 | 51.65 to 54.35 |
|         | Female | 27  | 50  | 65  | 57.22±4.34 | 55.50 to 58.94 |
|         | Combined | 50  | 48  | 65  | 55.28±4.35 | 54.04 to 56.52 |
| October | Male   | 20  | 44  | 55  | 51.14±2.43 | 50.03 to 52.25 |
|         | Female | 30  | 51  | 66  | 56.57±4.28 | 54.97 to 58.17 |
|         | Combined | 50  | 44  | 66  | 54.38±4.54 | 53.09 to 55.67 |

**Standard Length:** Details analysis of the length of *Botia lohachata* are presented in table 3. In case of combined sexes, the highest standard length was found in the month of September and the mean (±SD) value was 47.26±4.08 mm. The second highest value 47.16±4.07 mm was recorded in month October. The lowest mean total length 45.42±3.73 mm was recorded in month July (Table 3).

The highest SL for male was recorded highest 44.83±2.10 mm in the month September and lowest 43.13±2.46 mm in the month July. On the other hand the highest SL for female was found as 49.33±4.23mm (September) and lowest SL 47.54±3.46 mm (July) (Table 3).
### Table 3: Various Analysis Regarding Standard Length (mm) of *Botia lohachata* During Study Months

| Month | Sex  | n   | Min | Max   | Total Length (mm) |
|-------|------|-----|-----|-------|-------------------|
|       |      |     |     |       | Mean±SD   | 95% CI |
| July  | Male | 24  | 36  | 45    | 43.13±2.46 | 42.09 to 44.16 |
|       | Female | 26 | 42  | 54    | 47.54±3.46 | 46.14 to 48.93 |
|       | Combined | 50 | 36  | 54    | 45.42±3.73 | 44.36 to 46.48 |
| August | Male | 25  | 36  | 51    | 43.32±2.78 | 42.17 to 44.47 |
|       | Female | 25 | 38  | 60    | 47.92±3.88 | 46.32 to 49.52 |
|       | Combined | 50 | 36  | 60    | 45.62±4.07 | 44.46 to 46.78 |
| September | Male | 23  | 41  | 48    | 44.83±2.10 | 43.92 to 45.74 |
|       | Female | 27 | 43  | 63    | 49.33±4.23 | 47.66 to 51.01 |
|       | Combined | 50 | 41  | 63    | 47.26±4.08 | 46.10 to 48.42 |
| October | Male | 20  | 38  | 52    | 44.43±2.80 | 43.15 to 45.70 |
|       | Female | 30 | 42  | 57    | 49.03±3.68 | 47.66 to 50.41 |
|       | Combined | 50 | 38  | 57    | 47.16±4.07 | 46.00 to 48.32 |

**Body Depth:** Details analysis of the body depth of *Botia lohachata* are presented in table 4. In case of combined sexes, the highest body depth was found in the month of October and the mean (±SD) value was 11.00±1.20 mm. The lowest mean body depth 10.54±1.05 mm was recorded in month August (Table 4). The highest Bd for male was recorded highest 10.39±0.72 mm in the month September and lowest 10.20±1.00 mm in the month August (Table 4).

### Table 4: Various Analysis Regarding Body Depth (mm) of *Botia lohachata* During Study Months

| Month | Sex  | n   | Min | Max   | Total Length (mm) |
|-------|------|-----|-----|-------|-------------------|
|       |      |     |     |       | Mean±SD   | 95% CI |
| July  | Male | 24  | 8   | 11    | 10.33±0.87 | 9.97 to 10.70 |
|       | Female | 26 | 9   | 14    | 11.58±1.17 | 11.10 to 12.05 |
|       | Combined | 50 | 8   | 14    | 10.98±1.20 | 10.64 to 11.32 |
| August | Male | 25  | 8   | 12    | 10.20±1.00 | 9.79 to 10.61 |
|       | Female | 25 | 9   | 13    | 10.88±1.01 | 10.46 to 11.30 |
|       | Combined | 50 | 8   | 13    | 10.54±1.05 | 10.24 to 10.84 |
| September | Male | 23  | 9   | 12    | 10.39±0.72 | 10.08 to 10.70 |
|       | Female | 27 | 10  | 13    | 11.48±0.98 | 11.10 to 11.87 |
|       | Combined | 50 | 9   | 13    | 10.98±1.02 | 10.69 to 11.27 |
| October | Male | 20  | 9   | 12    | 10.33±0.86 | 9.94 to 10.72 |
|       | Female | 30 | 9   | 14    | 11.47±1.17 | 11.03 to 11.90 |
|       | Combined | 50 | 9   | 14    | 11.00±1.20 | 10.66 to 11.34 |

**Dorsal Length:** Details analysis of the length of *Botia lohachata* are presented in table 5. In case of combined sexes, the highest dorsal length was found in the month of September and the mean (±SD) value was 24.68±1.83 mm. The lowest mean dorsal length 23.60±1.96 mm was recorded in month July (Table 5).

The highest DL for male was recorded highest23.57±1.34 mm in the month September and lowest 22.58±1.44 mm in the month July. On the other hand the highest DL for female was found as 25.63 ±1.67 mm (September) and lowest 24.54±1.92 mm (July) (Table 5).
Table 5: Various analysis regarding dorsal length (mm) of *Botia lohachata* during study months

| Month | Sex | n  | Min | Max  | Total Length (mm) |
|-------|-----|----|-----|------|------------------|
|       |     |    |     |      | Mean±SD | 95% CI |
| July  | Male | 24 | 19  | 26   | 22.58±1.44   | 21.97 to 23.19 |
|       | Female | 26 | 22  | 29   | 24.54±1.92   | 23.76 to 25.32 |
|       | Combined | 50 | 19  | 29   | 23.60±1.96   | 23.04 to 24.16 |
| August | Male | 25 | 19  | 26   | 22.72±1.46   | 22.12 to 23.32 |
|       | Female | 25 | 20  | 27   | 24.76±1.48   | 24.15 to 25.37 |
|       | Combined | 50 | 19  | 27   | 23.74±1.78   | 23.23 to 24.25 |
| September | Male | 23 | 21  | 26   | 23.57±1.34   | 22.98 to 24.15 |
|       | Female | 27 | 23  | 29   | 25.63±1.67   | 24.97 to 26.29 |
|       | Combined | 50 | 21  | 29   | 24.68±1.83   | 24.16 to 25.20 |
| October | Male | 20 | 20  | 25   | 22.90±1.26   | 22.33 to 23.48 |
|       | Female | 30 | 23  | 29   | 25.33±1.63   | 24.73 to 25.94 |
|       | Combined | 50 | 20  | 29   | 24.32±1.92   | 23.77 to 24.87 |

**Pectoral Length:** Details analysis of the length of *Botia lohachata* are presented in table 6. In case of combined sexes, the highest pectoral length was found in the month of September and the mean (±SD) value was 12.06±0.87mm. The lowest mean pectoral length 11.80±0.83mm was recorded in month August (Table 6). The highest PcL for male was recorded highest 11.76±0.60 mm in the month August and lowest 11.48±0.75mm in the month October. On the other hand the highest PcL for female was found as 12.52±0.85 mm (September) and lowest 11.84±1.03 mm (August) (Table 6).

Table 6: Various Analysis Regarding Pectoral Length (mm) of *Botia lohachata* During Study Months

| Month | Sex | n  | Min | Max  | Total Length (mm) |
|-------|-----|----|-----|------|------------------|
|       |     |    |     |      | Mean±SD | 95% CI |
| July  | Male | 24 | 10  | 12   | 11.71±0.62   | 11.44 to 11.97 |
|       | Female | 26 | 11  | 15   | 12.38±0.94   | 12.00 to 12.76 |
|       | Combined | 50 | 10  | 15   | 12.06±0.87   | 11.81 to 12.31 |
| August | Male | 25 | 10  | 13   | 11.76±0.60   | 11.51 to 12.01 |
|       | Female | 25 | 10  | 15   | 11.84±1.03   | 11.42 to 12.26 |
|       | Combined | 50 | 10  | 15   | 11.80±0.83   | 11.56 to 12.04 |
| September | Male | 23 | 11  | 12   | 11.65±0.49   | 11.44 to 11.86 |
|       | Female | 27 | 11  | 15   | 12.52±0.85   | 12.18 to 12.85 |
|       | Combined | 50 | 11  | 15   | 12.12±0.82   | 11.89 to 12.35 |
| October | Male | 20 | 10  | 12   | 11.48±0.75   | 11.13 to 11.82 |
|       | Female | 30 | 11  | 14   | 12.30±0.84   | 11.99 to 12.61 |
|       | Combined | 50 | 10  | 14   | 11.96±0.90   | 11.70 to 12.22 |

**Pelvic Length:** Details analysis of the length of *Botia lohachata* are presented in table 7. In case of combined sexes, the highest pelvic length was found in the month of September and the mean (±SD) value was 25.38±1.69 mm. The lowest mean pelvic length 24.90±1.87 mm was recorded in month July (Table 7). The highest PvL for male was recorded highest 24.52±0.99 mm in the month September and lowest 23.83±1.46mm in the month July. On the other hand the highest PvL for female was found as 26.13±1.36 mm October and lowest 25.88±1.66 mm July and August (Table 7).
Table 7: Various Analysis Regarding Pelvic Length (mm) of *Botia lohachata* During Study Months

| Month | Sex    | n  | Min | Max | Total Length (mm) |
|-------|--------|----|-----|-----|--------------------|
|       |        |    |     |     | Mean±SD  | 95% CI       |
| July  | Male   | 24 | 19  | 26  | 23.83±1.46 | 23.21 to 24.45 |
|       | Female | 26 | 24  | 29  | 25.88±1.66 | 25.22 to 26.55 |
|       | Combined | 50 | 19  | 29  | 24.90±1.87 | 24.37 to 25.43 |
| August| Male   | 25 | 19  | 27  | 24.24±1.54 | 23.61 to 24.87 |
|       | Female | 25 | 21  | 29  | 25.88±1.48 | 25.27 to 26.49 |
|       | Combined | 50 | 19  | 29  | 25.06±1.71 | 24.57 to 25.55 |
| September| Male | 23  | 23  | 26  | 24.52±0.99 | 24.09 to 24.95 |
|        | Female | 27  | 20  | 29  | 26.11±1.83 | 25.39 to 26.83 |
|        | Combined | 50  | 20  | 29  | 25.38±1.69 | 24.90 to 25.86 |
| October| Male   | 20  | 21  | 26  | 24.00±1.22 | 23.44 to 24.56 |
|       | Female | 30  | 24  | 29  | 26.13±1.36 | 25.63 to 26.64 |
|       | Combined | 50  | 21  | 29  | 25.24±1.68 | 24.76 to 25.72 |

**Anal length:** Details analyses of the length of *Botia lohachata* are presented in table 8. In case of combined sexes, the highest anal length was found in the month of September and the mean (±SD) value was 37.10±3.17 mm. The lowest mean anal length 36.12±2.95 mm was recorded in month July (Table 8). The highest AL for male was recorded highest 35.74±1.45 mm in the month September and lowest 34.25±2.03 mm in the month July. On the other hand the highest AL for female was found as 38.33±2.70 mm October and 37.64±1.98 mm in the month of August (Table 8).

Table 8: Various analysis regarding anal length (mm) of *Botia lohachata* during study months

| Month | Sex    | n  | Min | Max | Total Length (mm) |
|-------|--------|----|-----|-----|--------------------|
|       |        |    |     |     | Mean±SD  | 95% CI       |
| July  | Male   | 24 | 28  | 24  | 34.25±2.03 | 33.39 to 35.11 |
|       | Female | 26 | 34  | 43  | 37.85±2.62 | 36.79 to 38.90 |
|       | Combined | 50 | 43  | 43  | 36.12±2.95 | 35.28 to 36.96 |
| August| Male   | 25 | 28  | 41  | 34.68±2.36 | 33.71 to 35.65 |
|       | Female | 25 | 35  | 42  | 37.64±1.98 | 36.82 to 38.46 |
|       | Combined | 50 | 28  | 42  | 36.16±2.62 | 35.42 to 36.90 |
| September| Male | 23  | 31  | 38  | 35.74±1.45 | 35.11 to 36.37 |
|        | Female | 27  | 25  | 43  | 38.26±3.76 | 36.77 to 39.75 |
|        | Combined | 50  | 25  | 43  | 37.10±3.17 | 36.20 to 38.00 |
| October| Male   | 20  | 26  | 37  | 34.43±2.54 | 33.27 to 35.59 |
|       | Female | 30  | 34  | 44  | 38.33±2.70 | 37.33 to 39.34 |
|       | Combined | 50  | 26  | 44  | 36.74±3.28 | 35.81 to 37.67 |

**Length-Length Relationship:** The relationship between total length (TL) and fork length (FL), total length (TL) and standard length (SL), total length (TL) and body depth (BD), total length (TL) and dorsal length (DL), total length (TL) and pectoral length (PcL), total length (TL) and pelvic length (PcL), total length (TL) and anal length (AL) were studied in this study. The various results obtained from the study are mentioned here.
The Relationship between Total Length (TL) and Fork Length (FL): Relationship between total length (TL) and fork length (FL) in male, female and both or combined sexes are presented in Figure IV, V, VI, respectively. The values of $R^2=0.9434$ for male specimens, 0.9687 for female specimens and 0.9712 for combined sexes.

Figure IV: Relationship between total length (TL) and fork length (FL) in male

Figure V: Relationship between total length (TL) and fork length (FL) in female

Figure VI: Relationship between total length (TL) and fork length (FL) in combined sexes

The relationship between total length (TL) and standard length (SL): Relationship between total length (TL) and standard length (SL) in male, female and both or combined sexes are presented in fig.VII, VIII, and IX respectively. The values of $R^2=0.9548$ for male specimens0.9505 for female specimens and 0.9664 for combined sexes. The relationship between total length (TL) and body depth (BD): Relationship between total length (TL) and body depth (BD) in male, female and both or combined sexes are presented in fig.X, XI, and XII respectively. The values of $R^2=0.9348$ for male specimens 0.924 for female specimens and 0.9318 for combined sexes.
Figure VII: Relationship between total length (TL) and standard length (SL) in male

Figure VIII: Relationship between total length (TL) and standard length (SL) in female

Figure IX: Relationship between total length (TL) and standard length (SL) in combined sexes

Figure X: Relationship between total length (TL) and body depth (BD) in male
Figure XI: Relationship between total length (TL) and body depth (BD) in female

Figure XII: Relationship between total length (TL) and body depth (BD) in combined sexes

Figure XIII: Relationship between total length (TL) and dorsal length (DL) in male

Figure XIV: Relationship between total length (TL) and dorsal length (DL) in female
The relationship between total length (TL) and dorsal length (DL): Relationship between total length (TL) and dorsal length (DL) in male, female and both or combined sexes are presented in Fig.XIII, XIV, and XV respectively. The values of $R^2=0.9381$ for male specimens 0.9403 for female specimens and 0.9585 for combined sexes.

The relationship between total length (TL) and pectoral length (PcL): Relationship between total length (TL) and pectoral length (PcL) in male, female and both or combined sexes are presented in Fig.XVI, XVII, and XVIII respectively. The values of $R^2=0.9137$ for male specimens 0.921 for female specimens and 0.9147 for combined sexes.
The Relationship between Total Length (TL) and Pelvic Length (PvL): Relationship between total length (TL) and pelvic length (PvL) in male, female and both or combined sexes are presented in fig.XIX, XX, and XXI respectively. The values of $R^2=0.9364$ for male specimens 0.9402 for female specimens and 0.9442 for combined sexes.

The relationship between total length (TL) and anal length (AL): Relationship between total length (TL) and anal length (AL) in male, female and both or combined sexes are presented in figure XXII, XXIII, XXIV respectively. The values of $R^2=0.9216$ for male specimens 0.9289 for female specimens and 0.9467 for combined sexes.
Figure XXI: Relationship between total length (TL) and pelvic length (PvL) in combined sexes

Figure XXII: Relationship between total length (TL) and anal length (AL) in male

Figure XXIII: Relationship between total length (TL) and anal length (AL) in female

Length-Weight Relationship: The various analysis regarding the body weight of Botia lohachata were performed to understand the different variables. These results are presented here under different headings.
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Figure XXIV: Relationship between total length (TL) and anal length (AL) in combined sexes

Table 9: Relationship status among various lengths

| Relation type | Sex   | n  | Regression Parameters |  |  |  |
|---------------|-------|----|-----------------------|---|---|---|
|               |       |    | a         | b   | R²       |  |
| TL vs. FL     | Male  | 92 | -1.7124   | 0.9225 | 0.9434   |  |
|               | Female| 108| -3.1723   | 0.9444 | 0.9687   |  |
|               | Combined| 200| -0.9426   | 0.9140 | 0.9712   |  |
| TL vs. SL     | Male  | 92 | 1.6349    | 0.7449 | 0.9548   |  |
|               | Female| 108| -5.0285   | 0.8521 | 0.9505   |  |
|               | Combined| 200| -1.8630   | 0.8033 | 0.9664   |  |
| TL vs. BD     | Male  | 92 | -1.8599   | 0.2119 | 0.9348   |  |
|               | Female| 108| -3.6002   | 0.2382 | 0.9240   |  |
|               | Combined| 200| -2.4326   | 0.2211 | 0.9318   |  |
| TL vs. DL     | Male  | 92 | -0.2518   | 0.4082 | 0.9381   |  |
|               | Female| 108| 1.2648    | 0.3794 | 0.9403   |  |
|               | Combined| 200| 1.3777    | 0.3785 | 0.9585   |  |
| TL vs. PcL    | Male  | 92 | 3.5106    | 0.1443 | 0.9137   |  |
|               | Female| 108| -0.7216   | 0.2063 | 0.921    |  |
|               | Combined| 200| 1.7375    | 0.1689 | 0.9147   |  |
| TL vs. PvL    | Male  | 92 | 1.6187    | 0.3952 | 0.9364   |  |
|               | Female| 108| 4.8046    | 0.3378 | 0.9402   |  |
|               | Combined| 200| 4.7701    | 0.3394 | 0.9442   |  |
| TL vs. AL     | Male  | 92 | -1.4033   | 0.6396 | 0.9216   |  |
|               | Female| 108| -0.6478   | 0.6155 | 0.9289   |  |
|               | Combined| 200| 1.0667    | 0.5905 | 0.9467   |  |

Body weight (BW) estimation: The various analysis regarding the body weight of Botia lohachata is table 10. In case of combined sexes, the highest mean(±SD) body weight 2.67±0.71g was recorded in the month of October. The lowest body weight was recorded in the month of August which was 2.26±0.61g (Table 10).

Table 10: Various Analyses Regarding the Body Weight of Botia lohachata of Study Months

| Month | Sex   | n  | Min | Max          | Total Length (mm)          |
|-------|-------|----|-----|--------------|----------------------------|
|       |       |    |     |              | Mean±SD 95% CI             |
|       |       |    |     |              |                            |
| July  | Male  | 24 | 1.09| 2.21         | 1.90±0.30 1.77-2.02       |
|       | Female| 26 | 1.74| 3.67         | 2.72±0.55 2.49-2.94       |
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|    | Combined | 50  | 1.09 | 3.67 | 2.32±0.61 | 2.15-2.50 |
|----|----------|-----|------|------|-----------|-----------|
| August | Male | 25  | 1.09 | 3.24 | 1.88±0.51 | 1.67-2.09 |
|       | Female | 25  | 1.27 | 3.45 | 2.64±0.45 | 2.46-2.83 |
|       | Combined | 50  | 1.09 | 3.45 | 2.26±0.61 | 2.09-2.44 |
| September | Male | 23  | 1.34 | 2.98 | 2.25±0.38 | 2.08-2.41 |
|        | Female | 27  | 2.22 | 3.78 | 3.01±0.52 | 2.81-3.22 |
|        | Combined | 50  | 1.34 | 3.78 | 2.66±0.60 | 2.49-2.83 |
| October | Male | 20  | 1.27 | 2.62 | 2.08±3.20 | 1.93-2.22 |
|        | Female | 30  | 2.43 | 4.65 | 3.10±0.59 | 2.88-3.31 |
|        | Combined | 50  | 1.27 | 4.65 | 2.67±0.71 | 2.47-2.88 |

In case of female, the highest mean (±SD) body weight 3.10±0.59 g was recorded in the month of September. The lowest body weight was recorded in the month of August which was 2.64±0.45 g (Table 10). On the other hand, in case of male, the highest mean (±SD) body weight 2.25±0.38 g was recorded in the month of September. The lowest body weight was recorded in the month of August which was 1.88±0.51 g (Table 10).

**Relationship between total length (TL) and body weight (BD):** The relationship between total length (TL) and body weight (BD) among male, female and combined sexes are shown in figures XXV, XXVI and XXVII. In cases, the value of R² was found high indicating strong correlation between total length and body weight (Fig. XXV, XXVI and XXVII).

**Figure XXV:** Relationship between total length (TL) and body weight (BD) in male

**Figure XXVI:** Relationship between total length (TL) and body weight (BD) in female
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Figure XXVII: Relationship between total length (TL) and body weight (BD) in combined sex

**Sex-ratio:** A total of 200 specimens were examined and studied during the period of study. Fifty specimens were collected each month from the Kompo River and selected in each month for study. 54% specimens were female and remaining 46% specimens were male (Fig. XXVIII).

![Sex ratio of studied fish specimens](image)

Figure XXVIII: Sex ratio of studied fish specimens

From the results of chi-square test, it was revealed that the overall sex ratio (Female=108, male=92; male:female =1:1.17) of *Botia lohachata* in the Kompo river during the study period was not significantly differed from the expected value 1:1. The value of chi-square ($\chi^2$) was found 2.4 at 1 degree of freedom (df) (p<0.05) which strongly indicates that the observed sex ratio not significantly differs from the expected ratio (Table 11). Month wise results of chi-square test regarding sex ratio are in table 11. The results have shown that there were no significantly different in sex ratio from the expected ratio in all months (Table 11).

**Table 11: Results of chi-square test in order to determine the sex ratio**

| Month      | Male | Female | Total | Ratio (M:F) | $\chi^2$, df=1 | P value | Significance |
|------------|------|--------|-------|-------------|----------------|---------|--------------|
| July       | 24   | 26     | 50    | 1:1.08      | 0.08           | 5.063   | ns           |
| August     | 25   | 25     | 50    | 1:1.00      | 0              | 9.660   | ns           |
| September  | 23   | 27     | 50    | 1:1.17      | 0.32           | 4.381   | ns           |
| October    | 20   | 30     | 50    | 1:1.50      | 2.0            | 2.902   | ns           |
| Total      | 92   | 108    | 200   | 1:1.17      | 2.4            | 5.045   | ns           |

ns=not significantly different

**Condition factor:** Month and sex wise Fulton’s condition factors are shown in table 12. In case of cobined sexes, the highest condition factor 1.156±0.126 was recorded in month of October and lowest condition factor 1.066±0.0205 was recorded in month of August (Table 12 and Fig XXIX). In case of female, the highest condition factor 1.190±0.136 was recorded in month of October and lowest condition factor 1.114±0.095 was recorded in month of August (Table 12 and Fig 4.30). In case of male, the highest condition factor 1.135±0.103 was recorded in month of September and lowest condition factor 1.019±0.268 was recorded in month of August (Table 12 and Fig XXXI).
### Table 12: Fulton’s condition factors of *Botia lohachata*

| Month | Sex  | n   | Condition factor (K) | 95% CL     |
|-------|------|-----|----------------------|------------|
|       |      |     | Min                  | Max        |
|       |      |     | Mean±SD              |            |
|       |      |     |                      |            |
| July  | Male | 24  | 0.900                | 1.166      |
|       |      |     | 1.088±0.065          | 1.060-1.115|
|       | Female | 26  | 0.821                | 1.399      |
|       |      |     | 1.147±0.121          | 1.098-0.821|
|       | Combined | 50 | 0.821                | 1.399      |
|       |      |     | 1.118±0.101          | 1.090-1.147|
| August| Male | 25  | 0.536                | 1.631      |
|       |      |     | 1.019±0.268          | 0.909-1.130|
|       | Female | 25  | 0.969                | 1.354      |
|       |      |     | 1.114±0.095          | 1.074-1.153|
|       | Combined | 50 | 0.536                | 1.631      |
|       |      |     | 1.066±0.205          | 1.008-1.125|
| September | Male | 23  | 0.900                | 1.437      |
|         |      |     | 1.135±0.103          | 1.090-1.179|
|         | Female | 27  | 0.975                | 1.399      |
|         |      |     | 1.160±0.103          | 1.119-1.201|
|         | Combined | 50 | 0.600                | 1.437      |
|         |      |     | 1.148±0.103          | 1.119-1.178|
| October| Male | 21  | 0.900                | 1.231      |
|         |      |     | 1.106±0.093          | 1.064-1.149|
|         | Female | 30  | 1.008                | 1.647      |
|         |      |     | 1.190±0.136          | 1.139-1.241|
|         | Combined | 50 | 0.900                | 1.647      |
|         |      |     | 1.156±0.126          | 1.120-1.191|

**Figure XXIX:** Fulton’s condition factor (K) in different month in male

**Figure XXX:** Fulton’s condition factor (K) in different month in female
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Figure XXXI: Fulton’s condition factor (K) in different month in combined sexes

Conclusion

Though the amount of catch of B. lohachata is not much in water bodies of Bangladesh but it is important from the point of view of biological conservation. The present research findings would help to update and enhance the existing morphological measurements of B. lohachata in both Bangladesh and outside the country. Condition factors would allow biologist to understand its population status and future success. Further in depth research efforts on other aspects of B. lohachata, which are not included in present study, are recommended.

Reference

Binohlan, C, Pauly D. The length-weight table. In: Concepts, design and data sources, 1998
Ecoutin JM, Albaret JJ, Trape S. Length-weight relationships for fish populations of a relatively undisturbed tropical estuary: The Gambia. Fisheries Research 2005;72:347-351.
Koutrakis ET, Tsikiras AC. Length-weight relationship of fishes from three northern Aegean estuarial systems (Greece). J Appl Ichthyol. 2003;19:258-260
LeCren E.D. The length-weight relationships and seasonal cycle in gonad weight and condition in the perch (Percafluviatilis). Journal Animal Ecology, 1951;20:201-219
Petrakis G, Stergiou KI. Weight-length relationships for 33 fish species in Greek waters. Fisheries Research, 1995;21:465-469
Ricker WE. Computation and interpretation of biological statistics of fish populations. Fish Res Board Canada Bull, 1975;191(1), 82
Tandon KK, Johal MS, Bala S. Morphometry of Cirrhinusreba (Hamilton) from Kanjli wetland, Punjab, India. Panjab University Research Journal (Science) 1993;43(1-4): 73-78