Journal of Entomology and Zoology Studies
Available online at www.entomoljournal.com

E-ISSN: 2320-7078
P-ISSN: 2349-6800
www.entomoljournal.com
JEZS 2023; 11(5): 101-105

Received: 18-06-2023
Accepted: 20-07-2023

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# Length-weight relationship and condition factors of congaturi halfbeak (*Hyporhamphus limbatus*) in the Kangsha river of Netrokona, Bangladesh

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**DOI:** https://doi.org/10.22271/j.ento.2023.v11.i5b.9237

## Abstract
The Congaturi halfbeak, *Hyporhamphus limbatus* (Valenciennes, 1847) belonging to the family Hemiramphidae is a significant indigenous fish species in Bangladesh. This research work was carried out to analyze the monthly length-weight relationships (LWR) with the construction of generalized relationships of body weight to standard length measurements and the condition of *H. limbatus* for males and females separately. A total of 524 specimens (228 males and 296 females) used in this study were sampled from the Kangsha River in Netrokona, Bangladesh over a year from September 2020 to August 2021. The results revealed that length-weight relationships were highly correlated (r>0.730) in *H. limbatus*. The parameters of the equation $W=aL^b$ describing the relationships between body weight and standard length for male and female varied monthly. The generalized LWR was fitted with the pooled data of all monthly samples for male and female separately. In case of male, the parameters of equations (a) varied monthly from 3.30 to 7.24 and the slope of equations (b) varied from 2.02 to 3.68. In case of female, the coefficient of equations (a) varied monthly and it ranged from 4.2905 to 9.504 and the slope of equations (b) varied from 2.18 to 3.92. The higher value of regression co-efficient (b) was found either due to maturation of gonad or due to favorable feeding environment. In case of males, fish growth was both positive and negative allometric. In case of females, fish growth was negative allometric except in September, December, June and July. Monthly relative condition factors based on $CF_{BW}$ values ranged from 1.0187 to 1.2070 for male, the lowest condition factor appeared on October 2020 and the highest was on May 2021. In case of female the relative condition factors based on $CF_{BW}$ ranged from 1.1117 to 1.4281, the lowest condition factor appeared on February 2021 and the highest condition factor appeared on April 2021 for female. It has been used as an index of growth and feeding intensity to be detected seasonal variation in the condition of fish and the average storage of population.

**Keywords:** *Hyporhamphus limbatus*, length-weight relationship, condition factor; seasonality

## Introduction
The length–weight relationship of fishes is one of the most important biological parameters. It generates more knowledge on the morphological characteristics, life history, distribution, and purpose of a stock to help understand the population dynamics (Schneider *et al*., 2000; Froese, 2006) [18, 6]. It offers details about the biomass, maturation, development pattern, behavior, or degree of wellbeing of a particular fish species as well as the overall health of the fish population (Schneider *et al*., 2000) [18]. This relationship is regarded as a primary consideration when calculating specific length-based fish weights, measuring length frequency distributions, condition indices, and biomass, or differentiating the embryonic changes and life histories of populations distributed throughout different geographical regions (Petrakis and Stergiou, 1995) [15]. The Congaturi halfbeak, *Hyporhamphus limbatus* (Valenciennes, 1847) [20] is one of the important fish species belong to the family Hemiramphidae commonly available in rivers, canals, haors, ditches, floodplains, man-made reservoir, lakes etc. This species provides a rich source of nutrients, including saturated, monounsaturated, and polyunsaturated fatty acids (SFA, MUFA and PUFA) which is 123.21, 121.77 and 290.77 mg/100gm dry tissue respectively (More *et al*., 2022) [13]. The specific gravity of fish flesh is known to undergo changes, and density of fish might be maintained in the surrounding water by means of swim bladder (Le Cren, 1951) [10].

Data on male, female and combined fish functional length-weight relationships are important for fish stock assessment. Current study aimed to establish length-weight relationship and condition factor of male, female and combined sexes of *H. limbatus* collected from a transboundary river of north-eastern part of Bangladesh. The results would be helpful for managers to impose adequate regulations for sustainable Congaturi halfbeak fishery management in the habitat.

## Materials and Methods

### Sample collection

Fish samples were collected monthly from September 2020 to August 2021 from the Kangsha River, Netrokona, Bangladesh (Figure 1). To assure the presence of all size groups in the sample, *H. limbatus* individuals were randomly caught using fine-mesh seine nets. The sampled fish specimens were preserved in glass jars using 10% formalin.


**Fig 1:** Map showing sampling location

### Length and weight measurement

Standard length (SL) was measured from the tip of the snout to the last vertebra. SL was recorded to the nearest cm using a wooden device marked in standard units. An electronic balance was used to measure the body weight (BW) in g. Fishes were identified as male and female by considering external morphology with naked eye.

### Calculation of length-weight relationship (LWR) and condition factors (CF)

The relationship between SL and BW was established using the cube-law equation as, $BW = aSL^b$ where, BW = body weight of fish in (g), SL = standard length of fish in (cm), `a' and `b' are parameters, a = (Constant) intercept, b = slope. Values of the exponent b provide information on fish growth. When b = 3, increase in weight is isometric. When the value of b is other than 3, weight increase is allometric (positive if b>3, negative if b<3). The straight line is easier to fit than a power curve or any non-linear curve. For this, the above power equation is transformed into a to double logarithmic linear equivalent as lnBW=lna+ blnSL. The smoothed predicted body weight BWpred, which was computed from the generalized LWR, $BW = aSL^b$. Equation using the mean standard length of all the fish in the monthly sample, was used to examine the condition of the fish by examining the relative condition factor. The monthly mean body weight values were compared to the average anticipated value for fish with the same mean standard length to determine the relative condition factor. $CF_{BW}=BW/BW_{pred}$ where, BW=observed body weight and $BW_{perd}$ = calculated body weight or predicted body weight to be computed from length-weight equations.

## Results and discussion

For the purposes of the current investigation, 524 *H. limbatus* specimens were measured. A variety of strategies for fishing were used to catch these fish. Variations in class size may thus be a common occurrence. *H. limbatus* collected from the Kangsha River ranged in total size and weight. were observed when compared to other studies (Karna *et al*. 2017, Ranjit *et al*. 2020) [9, 16]. The current regional variations in overall length may be explained by the environmental factors of the investigation's points in the sense of their availability of foodstuffs (Weatherley *et al*. 1987) [21]. However, the results of the current study, which are in agreement with the findings from, demonstrated that female fishes had a maximum weight when compared to male fishes (Samad *et al*. 2022) [17]. Variations in the size of catch fish might be due to different fishing gear used.

**Table 1:** Collection record of Congaturi halfbeak *H. limbatus* from the Kangsha River

| Sampling date | Sample size | No. of Female | Size range | | No. of Male | Size range | |
|---|---|---|---|---|---|---|---|
| | | | SL (cm) | BW (g) | | SL (cm) | BW (g) |
| September, 20 | 38 | 22 | 8.1-10.5 | 2.04-3.95 | 16 | 7.2-9.4 | 1.2-1.84 |
| October, 20 | 44 | 26 | 7.2-9.3 | 1.45-3.05 | 18 | 7.8-10.0 | 1.48-3.84 |
| November, 20 | 44 | 30 | 8.2-12.8 | 1.76-7.55 | 14 | 6.3-8.4 | 1.19-1.54 |
| December, 20 | 46 | 28 | 7.1-9.4 | 1.14-1.75 | 18 | 8.0-10.3 | 1.96-3.57 |
| January, 21 | 32 | 16 | 8.4-12.4 | 1.67-4.71 | 16 | 7.8-9.0 | 1.71-2.37 |
| February, 21 | 44 | 28 | 6.5-10.5 | 1.10-3.66 | 16 | 7.9-10.4 | 1.59-3.58 |
| March, 21 | 58 | 30 | 8.3-12.7 | 1.86-7.45 | 28 | 9.1-12.4 | 2.07-6.31 |
| April, 21 | 42 | 24 | 11.4-13.5 | 3.97-7.55 | 18 | 7.9-10.1 | 1.66-3.11 |
| May, 21 | 32 | 16 | 9.4-11.1 | 3.36-4.62 | 16 | 10.7-12 | 3.48-5.27 |
| June, 21 | 54 | 28 | 10.7-11.8 | 2.58-5.38 | 26 | 9-10.6 | 3.22-4.89 |
| July, 21 | 52 | 30 | 8.0-10.8 | 1.16-4.21 | 22 | 8.6-10.4 | 2.01-3.84 |
| August, 21 | 38 | 18 | 8.8-10.3 | 2.41-3.77 | 20 | 8.8-10 | 2.71-3.8 |

The current investigation's month-by-length-weight assessment differentiates between several growth types over the course of times. The results of the growth type at various months and according to sex indicated some similarities with the findings of (Karna *et al*. 2017, Islam *et al*. 2017 and Ranjit *et al.* 2020) [9, 8, 16]. The weight and length values for 'b' estimated for male were lower than 3 in the month of December to April and August. Negative allometric growth was seen over these months although there was positive allometric growth in the months of September to November and June to July. However, the growth pattern in May was isometric, where the 'b' value was 3.07. In case of female the calculated values of 'b' for length and weight were lower than 3 in the month of October and January to May. In these months the growth type was observed negative allometric. Although there was a four-month period of favorable allometric growth such as November, December, June and July. That could be as a result of how the environment affects fish growth patterns. Similar statement was also made by Froese, 2006, who stated that, According to theories, seasonal changes in environmental elements, fish physiological conditions at the time of collection, sex, gonad development, and nutritional conditions are to blame for this month- and sex-specific variance in growth types. Tesch, 1971 [19] also mentioned a few more factors that could impact the length-weight relationship in fishes, including as habitat, stomach fullness, preservation methods, and variations in the observed length ranges of the specimen captured. Behavior (active or passive swimmer) and there may be other sources of variations in length-weight relationships, such as behavior and water flow. Muchlisin *et al*. 2010 [14].

Condition factors were used to assess the overall health and productivity of *H. limbatus* of Kongsha river during the study period. The condition factor is an index that illustrates how biotic and abiotic factors interact to affect the physiological state of fishes Lizama *et al*. 2002 [11]. Monthly relative condition factors based on $CF_{BW}$ values ranged from 1.0187 to 1.2070 for male, the lowest condition factor appeared on October 2020 and the highest was on May 2021. In case of female the relative condition factors based on $CF_{BW}$ ranged from 1.1117 to 1.4281, the lowest condition factor appeared on February 2021 and the highest condition factor appeared on April 2021 for female. While examining various morphometric traits of additional fish species by Froese (2006) [6], Britton and Devies (2007) [5], Aguirre *et al*. (2008) [1], Arshad *et al*. (2008) [4], Hossain *et al*. (2009) [7], Alam *et al*. (2013) [2] and Alam *et al*. (2014) [3] observed similar results. Seasonal variations in feeding intensity and gonadal development, as were earlier highlighted, may be responsible for the variation in CFBW.by Mathialagan *et al.* 2014 [12] for *C. Reba* species from lower Anicut, Tamil Nadu, India. The condition factor was likewise inconsistent and varied according to the season and size categories. When there was more food available throughout the study period, the highest value was observed in those months suggesting that feeding intensity may also have an impact.

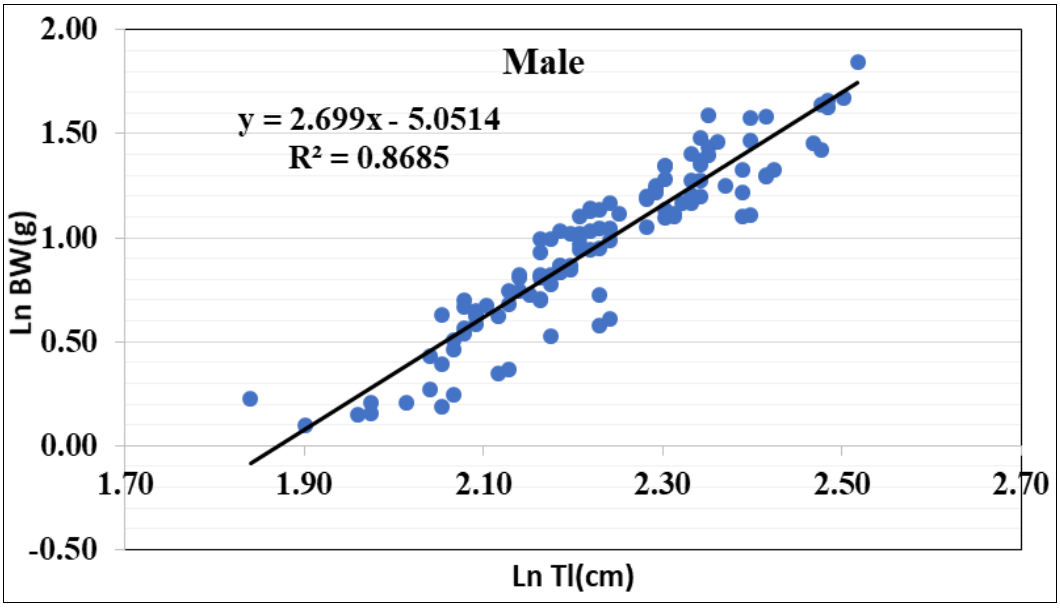


**Fig 2:** Length weight relationship of male *H. limbatus*

**Table 2:** Length-weight relationship parameters of monthly samples for male Congaturi halfbeak, *H. limbatus*

| Sampling date | Gender | Mean SL (cm) | General a | General b | n – 2 (df) | Mean BW(g) | $R^2$ | $CF_{BW}$ | Co-efficient® (r) | Sig. Level |
|---|---|---|---|---|---|---|---|---|---|---|
| Sep-20 | M | 8.16 | 6.87 | 3.54 | 14 | 1.73 | 0.8557 | 1.0673 | 0.9699 | ** |
| Oct-20 | M | 8.40 | 7.09 | 3.68 | 16 | 2.09 | 0.9726 | 1.0187 | 0.9947 | ** |
| Nov-20 | M | 7.54 | 7.24 | 3.76 | 12 | 1.44 | 0.7832 | 1.0400 | 0.7307 | NS |
| Dec-20 | M | 8.80 | 4.74 | 2.58 | 16 | 2.39 | 0.9212 | 1.0615 | 0.9651 | ** |
| Jan-21 | M | 8.45 | 3.56 | 2.02 | 14 | 2.12 | 0.8457 | 1.0596 | 0.9319 | ** |
| Feb-21 | M | 8.56 | 3.84 | 2.21 | 14 | 2.48 | 0.8248 | 1.0627 | 0.9632 | ** |
| Mar-21 | M | 10.88 | 4.68 | 2.50 | 26 | 3.59 | 0.7057 | 1.1731 | 0.8344 | * |
| Apr-21 | M | 9.37 | 4.39 | 2.39 | 16 | 2.59 | 0.9881 | 1.1214 | 0.9953 | ** |
| May-21 | M | 11.43 | 6.01 | 3.07 | 14 | 4.33 | 0.7849 | 1.2070 | 0.8861 | ** |
| Jun-21 | M | 10.12 | 7.20 | 3.67 | 24 | 3.61 | 0.8081 | 1.1209 | 0.8644 | ** |
| Jul-21 | M | 9.20 | 6.40 | 3.33 | 20 | 2.67 | 0.8769 | 1.0733 | 0.9563 | ** |
| Aug-21 | M | 9.42 | 3.30 | 2.25 | 18 | 3.19 | 0.8257 | 1.1036 | 0.9127 | ** |

SL= Standard length, BW = Body weight, CF = Condition factor, df = degree of freedom, Sig.* = Significance, NS = Not significance

**Table 3:** Length-weight relationship parameters of monthly samples for female Congaturi halfbeak, *H. limbatus*

| Sampling date | Gender | Mean SL (cm) | General a | General b | n – 2 (df) | Mean BW (g) | $CF_{BW}$ | Co-efficient® (r) | Sig. Level |
|---|---|---|---|---|---|---|---|---|---|
| Sep-20 | F | 9.35 | 4.73 | 2.60 | 20 | 2.87 | 1.2370 | 0.9752 | ** |
| Oct-20 | F | 8.39 | 5.28 | 2.87 | 24 | 2.24 | 1.1401 | 0.8078 | NS |
| Nov-20 | F | 9.74 | 5.99 | 3.13 | 28 | 3.08 | 1.2354 | 0.9710 | ** |
| Dec-20 | F | 7.96 | 7.69 | 3.92 | 26 | 2.04 | 1.1624 | 0.7835 | NS |
| Jan-21 | F | 10.6 | 5.07 | 2.65 | 14 | 3.21 | 1.3268 | 0.9770 | ** |
| Feb-21 | F | 7.89 | 5.07 | 2.66 | 26 | 1.50 | 1.1117 | 0.9554 | ** |
| Mar-21 | F | 9.8 | 5.59 | 2.97 | 28 | 3.23 | 1.2400 | 0.9645 | ** |
| Apr-21 | F | 12.63 | 5.46 | 2.84 | 22 | 5.65 | 1.4281 | 0.8114 | * |
| May-21 | F | 10.21 | 3.71 | 2.18 | 14 | 3.83 | 1.3009 | 0.9450 | ** |
| Jun-21 | F | 10.1 | 6.18 | 3.21 | 26 | 3.50 | 1.2587 | 0.9196 | ** |
| Jul-21 | F | 9.83 | 6.67 | 3.42 | 28 | 3.06 | 1.2406 | 0.8485 | ** |
| Aug-21 | F | 9.79 | 5.23 | 2.80 | 16 | 3.16 | 1.2490 | 0.9222 | ** |

SL= Standard length, BW = Body weight, CF = Condition factor, df = degree of freedom, Sig.* = Significance, NS = Not significance

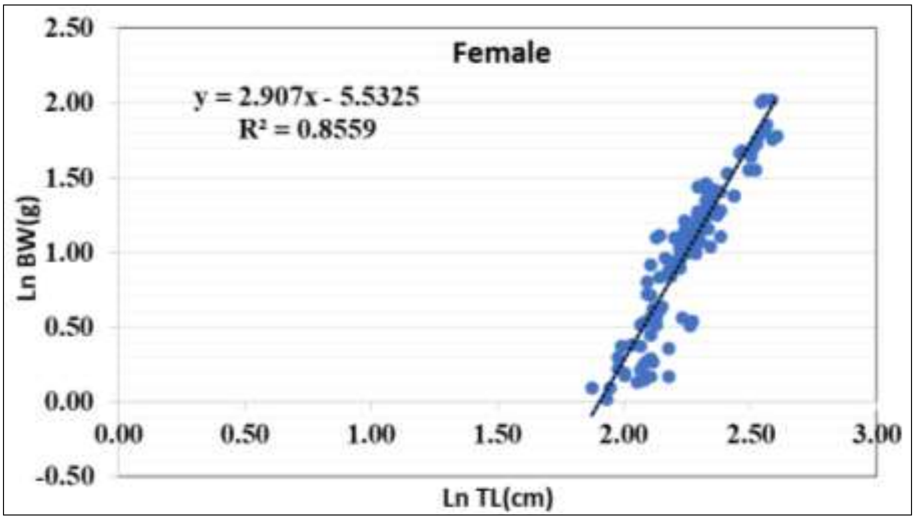


**Fig 3:** Length weight relationship of Female Ek-tuta fish

## Conclusion

The output of the research will provide useful baseline information of *H. limbatus* populations not only for the Kangsha River habitat but also its whole geographic region. The length-weight relations which were observed in this study will be helpful for fishery managers to impose adequate regulations for sustainable fishery management.

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