Length–weight relationship and Relative condition factor of Barilius bendelisis (Hamilton, 1807) and Barilius barna (Hamilton, 1822) from Manu River, Tripura, India

Ansuman Panda and Mrinal Kanti Datta

Abstract
The present investigation documents the relationship between Total length (TL) - Weight (W), Standard length (SL) - Weight (W) and Total length (TL) - Standard length (SL) for two bariline fish species from Manu River, Tripura. The study has been done on 80 samples of Barilius bendelisis with size ranged from 4.30 to 15.55 cm and 77 samples of Barilius barna with size ranged from 4.62 to 10.19 cm in total length for a period of 12 months. The Total length (TL) - Weight (W) relationships were found to be $W=0.0100TL^{2.99}$ and $W=0.0081L^{3.14}$ for Barilius bendelisis and Barilius barna respectively. The Mean relative condition factors (Kn) were found to be 1.014±0.023 and 1.043±0.025 for Barilius bendelisis and Barilius barna respectively which shows the good health and condition of the fishes.

Keywords: Total length–Weight relationship, Barilius bendelisis, Barilius barna, Mean Relative condition factor, Manu, Tripura

1. Introduction
The Manu River is the longest river of Tripura having a total length of 167 km. It originates from the Sakhan range and moves northward and enters Bangladesh at Kailasahar. From this river, [1] reported about 28 fish species and out of which 6 are from genus Barilius. Fishes of the genus Barilius are freshwater fishes of the family Cyprinidae (Order Cypriniformes). Barilius bendelisis and Barilius barna are generally called as Indian hill trout and characterized by their relatively elongate compressed body, blue-black bars or spots on the body and dorsal fin inserted behind the middle of the body [2]. They thrive in shallow, clear and cold waters [3]. They have food as well as ornamental values and some play a significant role in capture fisheries [4]. Study of length–weight relationship has a number of important applications like it helps in fish stock assessment, in the estimation of biomass from the observed length, in the estimation of the condition of the fish and also for comparisons of life histories of certain species between different regions [5]. The present study was undertaken with the objective to estimate the length–weight relationships for 2 species of genus Barilius collected from the Manu River Tripura, India.

2. Materials and methods
A total of 153 fish samples (80= Barilius bendelisis and 73= Barilius barna) were collected from different sampling sites of the Manu river using cast net during the time period between October, 2016 to September, 2017 (1 year) under COE-FAB project. The specimens were brought to the laboratory to study the length–weight relationship. The total lengths (TL) and standard length (SL) to the nearest 0.01 cm were recorded using a vernier caliper and weights (W) of the fish specimens were recorded to the nearest 0.01 gm using an electronic weighing machine. Fish species identification was done following [6 7]. The length–weight relationship was determined using the formula given by [8]:

$W=aL^b$

This could be further linearised by the application of natural logarithm as:

$\ln W = \ln a + b \ln L$

Where, W= weight of the fish in gm, L= Length of the fish in cm, a= intercept and b= regression coefficient.

In order to find out the significance of regression coefficient (b) student t-test was applied.
Condition factor (K) was estimated using the formula:

\[ K = \frac{100 \ W/L}{3} \]

Further the relative condition factor (Kn) was calculated by using the formula:

\[ Kn = \frac{W_o}{\bar{W}} \]

Where \( W_o \) = observed weight and \( \bar{W} \) = calculated weight. All statistical analyses were done using Excel (2007).

3. Results

About 80 specimens of \( B. \) bendelisis and 73 specimens of \( B. \) barna are measured and their total length (TL) ranges between 4.30 cm-15.55 cm and 4.62 cm-10.19 cm respectively. All the regression parameters and descriptive statistics for the relationship between total length (TL)-Weight (W) and Standard length (SL)-Weight (W) for both the species are tabulated in Table 1 and Table 2 respectively. The ‘b’ values in TL-W relationship for \( B. \) bendelisis and \( B. \) barna is found to be 2.99 and 3.14 respectively. And the ‘b’ values in SL-W relationship for \( B. \) bendelisis and \( B. \) barna is found to be 2.90 and 3.21 respectively. All the ‘b’ values are found to be significant (\( p<0.05 \)). The relationships between TL-W are plotted in fig.1-4 and SL-W is plotted in fig.5-8 for both the species. The TL-W scatter plot shows a curve line where as ln TL-ln W shows a linear straight line. Like this the SL-W scatter plot shows curve line and ln SL-ln w shows a linear straight line. All the linear and non-linear equations from TL-W and SL-W relationships are tabulated (Table 3). Table 4 reflects all the parameters for the relationships between TL and SL and these relations were plotted in fig.9-10 which shows a linear straight line. Relationship between total length (TL) and standard length (SL) was determined according to the Pearson correlation and regression method. The relationship was found to be:

\[ \ln TL=1.360+0.96 \ln SL \] \((B. \) bendelisis\)

\[ \ln TL=1.234+1.02 \ln SL \] \((B. \) barna\)

The mean condition factor (K) for \( B. \) bendelisis and \( B. \) barna are 1.001±0.014 and 1.078±0.011 respectively. And also the mean relative condition factor (Kn) for both \( B. \) bendelisis and \( B. \) barna are 1.014±0.023 and 1.043±0.025 respectively (Table 5). Fig.11-12 shows the different Kn values for different length group for both the species.

4. Discussion

The present study depicts TL-W relationship of \( B. \) bendelisis and \( B. \) barna, TW=0.0100xTL2.99 and TW=0.0081xTL3.14 correspondingly. The values of ‘b’ calculated for the two species were within the expected range of 2.5–3.5, as reported by \(^9\). For \( B. \) bendelisis (‘b’=2.99), \( b=3 \) indicates that the species grow equally in length and weight or the small sized specimens in the sample are in same nutritional condition as the larger one. LWR study on \( B. \) bendelisis have been reported by a number of workers from Beas River; Himachal Pradesh, Manas river; Assam and Kosi River; Uttarakhand \(^{10-12} \) which reports a ‘b’ value of 3 or near to 3. These results support this present study. Whereas value of ‘b’ reported by \(^{13} \) from Garhwal, Himalaya, India (\( b = 2.84 \)) and \(^{14} \) from Basistha River in Assam, India (\( b = 3.21 \)) varied from the present study. The ‘b’ value for \( Barilius \) barna is 3.14, which indicate that the species grows higher in weight in comparison to the length or the smaller specimens are in better nutritional condition than the larger one. However \(^{11} \) found ‘b’ value 2.89 which shows a contrast result to this finding. This variations in the ‘b’ value for both the species may be due to the length ranges used, habitat, maturity of gonad, sex, study season, fullness of gut, methods of preservation and annual differences in the environmental conditions \(^{15} \). The mean condition factor (K) and mean relative condition factor (Kn) for both the species are one which indicates good health and condition of the fishes. The graph of Kn for both the species shows the variation of Kn among the different length group of fishes, which indicates the degree of food sources availability for each length group, age, sex, state of sexual maturity of the fish and environmental conditions of the habitat \(^{16} \). \( B. \) bendelisis has the highest Kn value of 1.163 and \( B. \) barna has the highest Kn value of 1.166 at length group 8-8.9cm and 10-10.9 cm respectively. This may represent the maturity stage of the species.

![Fig 1: Total Length (TL)-Weight (W) relationship of B. bendelisis](image1)

![Fig 2: LnTL-LnW relationship of B. bendelisis](image2)

![Fig 3: Total Length (TL)-Weight (W) relationship of B. barna](image3)
Fig 4: LnTL-LnW relationship of B. barna

Fig 5: Standard Length (SL)-Weight (W) relationship of B. bendelisis

Fig 6: LnSL-LnW relationship of B. bendelisis

Fig 7: Standard Length (SL)-Weight (W) relationship of B. barna

Fig 8: LnSL-LnW relationship of B. barna

Fig 9: Ln TL- Ln SL relationship of B. bendelisis

Fig 10: Ln TL- Ln SL relationship of B. barna

Fig 11: Kn values of B. bendelisis at different length group
We are also thankful to the Department of Bio-technology, Government of India and COE-FAB project for providing financial assistance. We are also thankful to Dr. J.R. Dhanze, Consultant COE-FAB Project for providing valuable guidance. First author is also thankful to all his advisory committee members of M.F.Sc. (Dr. Rani Dhanze, Dr. K.V. Radhakrishnan and Dr. Janmejay Parhi) for the encouragement.

7. References

![Fig 12: Kn values of B. barna at different length group](image)

**Table 1:** All the regression parameters and ‘b’ values according to Ln TL and Ln W relationship

<table>
<thead>
<tr>
<th>Species</th>
<th>Total Length range (cm)</th>
<th>Total Weight range (gm)</th>
<th>Regression parameters</th>
<th>R²</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Minimum</td>
<td>Maximum</td>
<td>Minimum</td>
<td>Maximum</td>
</tr>
<tr>
<td>B. bendelisis</td>
<td>4.30</td>
<td>15.55</td>
<td>0.71</td>
<td>45.06</td>
</tr>
<tr>
<td>B. barna</td>
<td>4.62</td>
<td>10.19</td>
<td>0.87</td>
<td>12.45</td>
</tr>
</tbody>
</table>

Table 2: All the regression parameters and ‘b’ values according to Ln SL and Ln W relationship

<table>
<thead>
<tr>
<th>Species</th>
<th>Standard Length range (cm)</th>
<th>Total Weight range (gm)</th>
<th>Regression parameters</th>
<th>R²</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Minimum</td>
<td>Maximum</td>
<td>Minimum</td>
<td>Maximum</td>
</tr>
<tr>
<td>B. bendelisis</td>
<td>3.23</td>
<td>12.57</td>
<td>0.71</td>
<td>45.06</td>
</tr>
<tr>
<td>B. barna</td>
<td>3.61</td>
<td>7.76</td>
<td>0.87</td>
<td>12.45</td>
</tr>
</tbody>
</table>

Table 3: All the linear and non-linear equations from TL-W and SL-W relationship

<table>
<thead>
<tr>
<th>Species</th>
<th>TL-W</th>
<th>SL-W</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Non-linear</td>
<td>Linear</td>
</tr>
<tr>
<td>B. bendelisis</td>
<td>W=0.0100 TL 2.99</td>
<td>LnW= -4.60347 + 2.99 LnTL</td>
</tr>
<tr>
<td>B. barna</td>
<td>W=0.0081 TL 1.14</td>
<td>LnW= -4.81158 + 3.14 LnTL</td>
</tr>
</tbody>
</table>

Table 4: TL-SL relationship of both the species

<table>
<thead>
<tr>
<th>Species</th>
<th>N (No. of specimens)</th>
<th>LnTL=a+b LnSL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>a</td>
<td>b</td>
</tr>
<tr>
<td>B. bendelisis</td>
<td>80</td>
<td>1.360</td>
</tr>
<tr>
<td>B. barna</td>
<td>73</td>
<td>1.234</td>
</tr>
</tbody>
</table>

Table 5: Mean condition factor and mean relative condition factor of both the species

<table>
<thead>
<tr>
<th>Species</th>
<th>Mean Condition Factor (K)</th>
<th>Mean Relative Condition Factor (Kn)</th>
</tr>
</thead>
<tbody>
<tr>
<td>B. bendelisis</td>
<td>1.001±0.014</td>
<td>1.014±0.023</td>
</tr>
<tr>
<td>B. barna</td>
<td>1.078±0.011</td>
<td>1.043±0.025</td>
</tr>
</tbody>
</table>

5. Conclusion
This study was based on the samples collected from the riverine rater of Tripura. The ‘b’ value for B. bendelisis was found to be 2.99 which indicate isometric growth of the species. The ‘b’ value for B. barna was found to be 3.14 which indicate positive allometric growth of the species.

6. Acknowledgement
The authors are grateful to Dr. P.K. Pandey, Dean, College of Fisheries, CAU (I), Tripura for providing required facilities. We are also thankful to the Department of Bio-technology (DBT), Government of India and COE-FAB project for providing financial assistance. We are also thankful to Dr. J.R. Dhanze, Consultant COE-FAB Project for providing valuable guidance. First author is also thankful to all his advisory committee members of M.F.Sc. (Dr. Rani Dhanze, Dr. K.V. Radhakrishnan and Dr. Janmejay Parhi) for the encouragement.