Length-Weight, Length-Length Relationships and Condition Factor of Schilbid Catfish Neotropius atherinoides (Bloch, 1794) from the Padma River, Rajshahi

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Abstract: The present study describes the length-weight (LWR) and length-length (LLR) relationships, as well as the condition factors of Schilbid catfish Neotropius atherinoides from the Padma River, Rajshahi. A total of 426 specimens were caught using traditional fishing gears from January to December 2014. For each individual, the total (TL) and standard (SL) lengths were measured using digital slide calipers. Individual body weight (BW) was also taken through a digital balance. All relationships were highly significant ($P < 0.01$), with $r^2$ values being greater than 0.95. The generalized relationship of standard length and total length for combined population were $SL = 0.224 + 0.635 TL$. The results indicated that the LLR were highly significant ($r^2 > 0.914; P < 0.01$). The calculated allometric coefficient $b$, 2.87 (TL) and 2.93 (SL) for $N. atherinoides$ smaller than isometric value ($b = 3.000$). The generalized relationships for total length and body weight and standard length and body weight were $BW = 0.005TL^{2.872}$ and $BW=0.014SL^{2.936}$ respectively. The LWRs indicated negative allometric growth in $N. atherinoides$. Fulton’s condition factor $K$ showed significant variation (Kruskal-Wallis test, $P < 0.001$, with best performance of $N. atherinoides$, calculated as $0.366 \pm 0.017$ (TL) and $1.257 \pm 0.058$ (SL).

Key words: Population Biology • Condition Factors • $N. atherinoides$ • Padma River

INTRODUCTION

Bangladesh has the unique advantage of possessing the world’s largest river delta, the Ganges Delta which offers a vast and varied fisheries potentials in its fresh, brackish and marine waters [1-8]. Inland open water fishery resources play a significant role in the economy, culture, tradition and food habits of the people of Bangladesh [9-16]. As a riverine country, the economy of Bangladesh depends upon agriculture, livestock and fisheries [17-20]. Fish and fisheries sector play a significant role in the economy of Bangladesh in terms of animal protein supply, employment, foreign currency earning and poverty alleviation [21-30]. This sector contributes 4.37% to Gross Domestic Product (GDP) and 2.01% of export earnings and 60% of the total protein supplies in the diet of the people of Bangladesh [31-36]. The present per capita annual fish intake is about 19.30 kg against the actual demand of 21.90 kg and this shortfall is considered as one of the main causes of malnutrition in Bangladesh [31].

Small Indigenous Species (SIS) plays an important role in the national diet of Bangladesh. These small indigenous fishes were available in rivers, beels, canals, haors, ditches and floodplain of Bangladesh. But in recent years, due to indiscriminate exploitation of brood and young SIS by using destructive fishing gears and methods leads SIS to a high level of risk of extinction. Among 260 species of freshwater fishes, 143 may be considered as Small Indigenous Species (SIS). Small
Indigenous Species of fish grow to a maximum length of 25 cm and can multiply rapidly in any freshwaters and also in captivity [31].

In Bangladesh, 260 indigenous freshwater bony fish species, suitable for human consumption, belonging to 145 genera and 55 families, constitute a very rich aquatic bio-diversity in Bangladesh [37]. Siluriformes are the most abundant group among these fishes [37]. The Schibid catfish (family Siluriformes) Neotropius atherinoides (Bloch, 1794) is an important SIS of rivers and connected water bodies in Bangladesh. Length-weight relationships (LWRs) and length-length relationships (LLRs) are still scarce for most tropical and sub-tropical fish species [38-41]. The length weight relationship (LWR) of fishes in a given geographic zone in important in fisheries biology because it allows estimation of the average weight at a given length. Length-weight relationships for fish were originally used to provide information on the condition of fish and to determine whether somatic growth as isometric or allometric [42, 43]. Due to scarcity of length-weight and length-length relationship study of N. atherinoides from the Padma River in Bangladesh, the present study is most important. The objectives of this study were to measure the relationship of length-length, length-weight and observe the condition factor regarding body growth of N. atherinoides.

MATERIALS AND METHODS

Study Area: The study area (Figure 1) of the experiment was the Padma River at the point of Talaimari (24.50° N, 88.26° E), Rajshahi, Bangladesh.

Sample Collection: The specimens were collected at random regularly every month. All the specimens studied were collected during the period from January 2014 to December 2014. During this period a total of 426 specimens were collected for this experiment. The specimens were collected from the Padma river located at Rajshahi. The fishes were caught by means of the traditional fishing gears Jhaki Jal (Cast net), seine net etc. During the collection of these species, precautions were taken to save the species from spoilage and any damage.

Preservation: Just after collection the fishes were washed and preserved in 10% formalin solution in separate jars on monthly basis for the laboratory studies.

Measurement of Length and Weight: The fishes, preserved with formalin were washed with running tap water to eliminate any filthy substances and absorbed excess water with blotting paper from the body and finally left in room temperature for about half an hour for removal of all moisture. Total length (TL) was measured in (cm) from the most anterior to the most posterior point with the tail of the fish compressed to exhibit the longest possible length. Standard length (SL) was taken in (cm) from the snout up to the end of the base of the caudal fin. Total weight (TW) of the fish was measured by using Digital balance with 0.01g accuracy after absorbing all its body moisture and water particles by using blotting paper.

Determination of Length-Weight Relationship:

Length-weight relationship were determined based on the following formula:

\[ W = aL^n \]

where, \( W \) = Weight; \( L \) = Length; \( a \) = Constant; and, \( n \) = another constant to be calculated empirically.

The general equation, \( W = aL^n \) can be expressed in logarithmic form as:

\[ \log(TW) = \log(a) + n \log(TL) \]

This is \( Y = a + bX \)

where, \( a = \log(a); b = n; Y = \log(TW); X = \log(TL) \) (which is a linear relation between \( Y \) and \( X \)).

The value of the constant (a) and (n) can be determined by the following equations,

\[ \log a = \frac{\sum \log(TW) \times \sum \log(TL)^2 - \sum \log(TL) \times \sum(\log(TL) \times \log(TW))}{N \times \sum \log(TL)^2 - (\sum \log(TL))^2} \]

and, \( n = \frac{\sum \log(TW) - N \times \log(a)}{\sum \log(TL)} \)

where “\( N \)” indicates the number of specimens.

To express the degree of linear association on correlation between two variables, the correlation coefficient, \( r \) was estimated by:

\[ r = \frac{\sum xy - \frac{\sum x \times \sum y}{n}}{\sqrt{\left(\sum x^2 - \frac{(\sum x)^2}{n}\right) \times \left(\sum y^2 - \frac{(\sum y)^2}{n}\right)}} \]
Fig. 1: Sampling site of the Padma River Rajshahi, Bangladesh, where the species was captured

The co-efficient of determination $r$ is the square of the correlation co-efficient, an indicator of the quality of the liner regressions. The 95% confidence limits of parameters $a$ and $b$ and the coefficient of determination $r^2$ were also estimated.

**Determination of Condition Factor:** The relative conditional factor ($k_w$) for each individual was calculated by the following formula:

$$K_w = \frac{TW}{(a \times TL^b)}$$

The Fulton’s condition factor, $K$ was calculated by using the following formula:

$$K = \frac{TW}{(TL^{'})} \times 100$$

where, $K =$ Fulton’s condition factor, $TW=$ Total body weight, $TL =$ Total body length. Here, factor 100 is used to bring $K$ close unity.
Statistical Analysis: Statistical analyses were performed using computer software SPSS 16.0 (Statistical Package for Social Science) and statistical programming language R-3.02.

RESULTS

A total of 426 *N. atherinoides* catfish were collected from the Padma River in Rajshahi city, Bangladesh during the study. Descriptive statistics on the length and weight measurements are given in Table 1. The minimum observed total length of all individuals captured was 5.31 cm, corresponding to a specimen of *N. atherinoides*, weighting 0.60 g.

Length-Length Relationships: The relationships between total length (TL) and standard length (SL) is study in this section for the specimen *N. atherinoides*. The sample size (n), regression parameters a and b of the LLR, 95% confidence intervals of a and b, the coefficient of determination (\(r^2\)) and growth type of *N. atherinoides* are given in Figure 2 and Table 2. The LLRs were highly significant (\(P < 0.01\)), with \(r^2\) values being greater than 0.95. The calculated allometric coefficient \(b\), 2.87 (for TL) and 2.93 (for SL) for *N. atherinoides* smaller than isometric value \((b \sim 3.000)\). The LWRs indicated negative allometric growth in *N. atherinoides*.

Fulton’s Condition Factor: In this section Relative condition factor (\(Kn\)) and Fulton’s condition factor (\(K\)) of *N. atherinoides* are described. Descriptive statistics of Relative condition factor (\(Kn\)) and Fulton’s condition factor (\(K\)) are given in Table 4.

The relative condition factor (\(Kn\)) is calculated as 1.020±0.045 (TL) and 1.086±0.049 (SL) for *N. atherinoides*. Fulton’s condition factor \(K\) showed significant variation (Kruskal-Wallis test, \(P < 0.001\), with best performance of *N. atherinoides*, calculated as 0.366 ± 0.017 (TL) and 1.257±0.058 (SL) (Table 4). The Pearson’s correlation test showed significant correlation between \(K\) and TL and BW for *N. atherinoides*. Positive correlations were extracted between \(Kn\)-BW for *N. atherinoides* (\(P < 0.01\)).

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Table 1: Descriptive statistics on the length (cm) and weight (g) measurements of the catfish *N. atherinoides* from the Padma River, northwestern Bangladesh during January 2014 to December 2014

<table>
<thead>
<tr>
<th>Species</th>
<th>n</th>
<th>Measurements</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean±SD</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>N. atherinoides</em></td>
<td>426</td>
<td>TL</td>
<td>5.31</td>
<td>10.49</td>
<td>7.99±0.88</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SL</td>
<td>3.67</td>
<td>6.82</td>
<td>5.29±0.57</td>
</tr>
<tr>
<td></td>
<td></td>
<td>BW</td>
<td>0.6</td>
<td>4.19</td>
<td>1.93±0.61</td>
</tr>
</tbody>
</table>

Note: n, sample size; TL, total length; BW, body weight; SD, standard deviation

Table 2: Morphometric relationships between total length (TL) and standard length (SL) for *N. atherinoides* catfish from the Padma River, Rajshahi, Bangladesh during January 2014 to December 2014

<table>
<thead>
<tr>
<th>Species</th>
<th>n</th>
<th>Equation</th>
<th>a</th>
<th>b</th>
<th>95% Cl of a</th>
<th>95% Cl of b</th>
<th>(r^2)</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>N. atherinoides</em></td>
<td>426</td>
<td>SL = a + b×TL</td>
<td>0.224</td>
<td>0.634</td>
<td>0.128-0.319</td>
<td>0.622-0.646</td>
<td>0.96</td>
</tr>
</tbody>
</table>

Note: n, sample size; SL, standard length; TL, total length; a, intercept; b, slope; CI, confidence intervals; \(r^2\), coefficient of determination

Table 3: Descriptive statistics and estimated parameters of the length-weight relationships for *N. atherinoides* catfish from the Padma River, Rajshahi, Bangladesh during January 2014 to December 2014

<table>
<thead>
<tr>
<th>Species</th>
<th>n</th>
<th>Equation</th>
<th>a</th>
<th>b</th>
<th>95% Cl of a</th>
<th>95% Cl of b</th>
<th>(r^2)</th>
<th>Growth type</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>N. atherinoides</em></td>
<td>426</td>
<td>BW = a×TL(^2)</td>
<td>0.005</td>
<td>2.87</td>
<td>0.0043-0.0051</td>
<td>2.83-2.91</td>
<td>0.98</td>
<td>A-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>BW = a×SL(^2)</td>
<td>0.013</td>
<td>2.93</td>
<td>0.012-0.014</td>
<td>2.89-2.97</td>
<td>0.97</td>
<td>A-</td>
</tr>
</tbody>
</table>

Note: n, sample size; BW, body weight; TL, total length; a, intercept; b, slope; \(r^2\), coefficient of determination; A-, negative allometric growth.
Table 4: Relative condition factor (Kn) and Fulton’s condition factor (K) of *N. atherinoides* from the Padma River, northwestern Bangladesh during January 2014 to December 2014

<table>
<thead>
<tr>
<th>Species</th>
<th>n</th>
<th>Type of length</th>
<th>Min</th>
<th>Max</th>
<th>Mean ± SE</th>
<th>Min</th>
<th>Max</th>
<th>Mean ± SE</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>N. atherinoides</em></td>
<td>426</td>
<td>TL</td>
<td>0.895</td>
<td>1.199</td>
<td>1.020 ± 0.045</td>
<td>0.317</td>
<td>0.437</td>
<td>0.366 ± 0.017</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SL</td>
<td>0.954</td>
<td>1.249</td>
<td>1.086 ± 0.049</td>
<td>1.108</td>
<td>1.462</td>
<td>1.257 ± 0.058</td>
</tr>
</tbody>
</table>

Note: n, sample size; TL, total length; BW, body length; Min, Minimum; Max, maximum; SD, standard deviation; CI, confidence level

Fig. 2: Relationship between total length and standard length of *N. atherinoides*

Fig. 3: Relationship between total length and body weight of *N. atherinoides*
**DISCUSSION**

The present study used a large number of specimens with different body sizes captured by some traditional fishing gears [9, 15]. The present study recorded the maximum size of *N. atherinoides* in the Padma River as 10.49 cm TL which was nearest to the maximum recorded value of 10.7cm TL in Padma River Northwestern Bangladesh [44].

The values of b were within the limits 2.5-3.5 reported by Froese [43] for most fishes. The calculated allometric coefficient b value is 2.87 for *N. atherinoides* in the present study which is nearest to the estimated b value 2.89 in Padma River Northwestern Bangladesh [44].

In general and despite the many variation in fish forms between species, b is close to 3, indicating that fish grow isometrically; values significantly different from 3.0 indicate allometric growth [45].

The length-weight relationship in fishes can be affected by several factors including habitat, area, seasonal effect, degree of stomach fullness, gonad maturity, sex, health, preservation techniques and differences in the observes length ranges of the specimen caught [45-54], all of which were not accounted for the present study. Since samples of the species included individuals collected over several seasons, the parameters a and b would be treated as mean annual values.

In case of *N. atherinoides*, Hossain, *et al.* [41], recorded the negative allometric growth from the Bangladeshi waters, which is also in accordance with the present study. However, for the studied species presented in this study, the b values were mostly in agreement with the results for fishes of the same family obtained from the same and /or other geographical areas [40, 44, 55]. All LLRs were highly correlated and they were compared with the available literature.

**CONCLUSION**

Fisheries is an integral part of agriculture sector and play a vital role in the socio-economic development. This study provides an important baseline study on the length-weight relationship, length-length relationship and condition factors of *N. atherinoides* in Padma river, Bangladesh.

The results of the study initiate early management strategies and regulations for the sustainable conservation of the remaining stock of these species in the Padma River ecosystem.

The result of the present study will provide some new and updated information on the morphometric characters of *N. atherinoides* will be helpful to the fisheries scientists and play an important role in the management and conservation of the specimens.
REFERENCES


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