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Length-Weight, Length-Length Relationships and Condition Factors of Three Schibid Catfishes from the Padma River, Northwestern Bangladesh

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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 the three important Schibid catfishes from the Padma River, northwestern Bangladesh, namely *Ailia coila* (Hamilton, 1822), *Eutropiichthys vacha* (Hamilton, 1822), and *Neotropius atherinoides* (Bloch, 1794). A total of 347 specimens were caught using traditional fishing gears from March 2006 to February 2007. For each individual, the total (TL), fork (FL) and standard (SL) lengths were measured using digital slide calipers. Individual body weight (BW) was also taken through a digital balance. The coefficient *b* of the LWR was close to the isometric value ($b \approx 3.000$) in *A. coila*, although it suggested negative allometric growth in *E. vacha* ($b \approx 2.980$) and *N. atherinoides* ($b \approx 2.900$). The results also indicated that the LLRs were highly correlated ($r^2 > 0.914$; $P < 0.01$). The equations of the condition factors for each species were best expressed by $K= 100\times(BW/(TL^{3.000})$ for *A. coila*, $K= 100 \times(BW/(TL^{3.000})$ for *E. vacha*, and $Kn= BW/[(0.095\times TL^{2.899}]$ and $K= 100 \times(BW/(TL^{3.000})$ for *N. atherinoides*. This study presents for the first time results on the total length-body weight relationships and on the condition factors of these catfishes from the Padma River.

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Introduction

According to Craig et al. (2004), 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. Siluriformes are the most abundant group among these fishes (Craig et al. 2004). The Schibid catfishes (family: Siluriformes) including *Ailia coila* (Hamilton, 1822), *Eutropiichthys vacha* (Hamilton, 1822), and *Neotropius atherinoides* (Bloch, 1794) are important species of rivers and connected water bodies in Bangladesh. The Schibid catfishes occur widely throughout the Indian subcontinent including Bangladesh, India, Pakistan and Nepal (Froese and Pauly 2008). These are important target species for small scale fishermen in Bangladesh, who use a variety of traditional fishing gears (Craig et al. 2004; Kibria and Ahmed 2005).

According to King (2007), the relationship between body length and weight is useful in assessing the well-being of the individuals and in determining possible differences among different stocks of the same species. In addition, length-length relationships are also important in fisheries management for comparative growth studies (Moutopoulos and Stergiou 2002; Hossain et al. 2006a).

The condition of a fish reflects recent physical and biological circumstances, and fluctuates by interaction among feeding conditions, parasitic infections and physiological factors (Le Cren 1951). Moreover, body condition provides an alternative to the expensive *in-vitro* proximate analyses of tissues (Sutton et al. 2000).

Length-weight relationships (LWRs) and length-length relationships (LLRs) are still scarce for most tropical and sub-tropical fish species (Harrison 2001; Ecoutin et al. 2005; Hossain et al. 2006a; 2006b; Hossain and Ahmed 2008; Hossain et al. 2008; Hossain et al. 2009a; 2009b; Hossain 2010). No previous information on the condition factors and the L-W and L-L relationships of these species from the Padma River in Bangladesh exists (except Hossain et al. 2009c). Subsequently, the present paper reports the first complete and comprehensive description of the LWR and LLR of these schibid catfishes from the Padma River, Bangladesh.

Materials and Methods

The present study was conducted in the Padma River, northwestern Bangladesh (Fig. 1), the lower part of the Ganges (known as Padma River in Bangladesh) that enters Bangladesh from India through the Rajshahi district (Latitude 24° 22' N; Longitude 88° 35' E). Samples were collected during daytime on a seasonal basis from fishermen's catch landed at the Rajshahi city, Rajshahi, Bangladesh from March 2006 to February 2007.

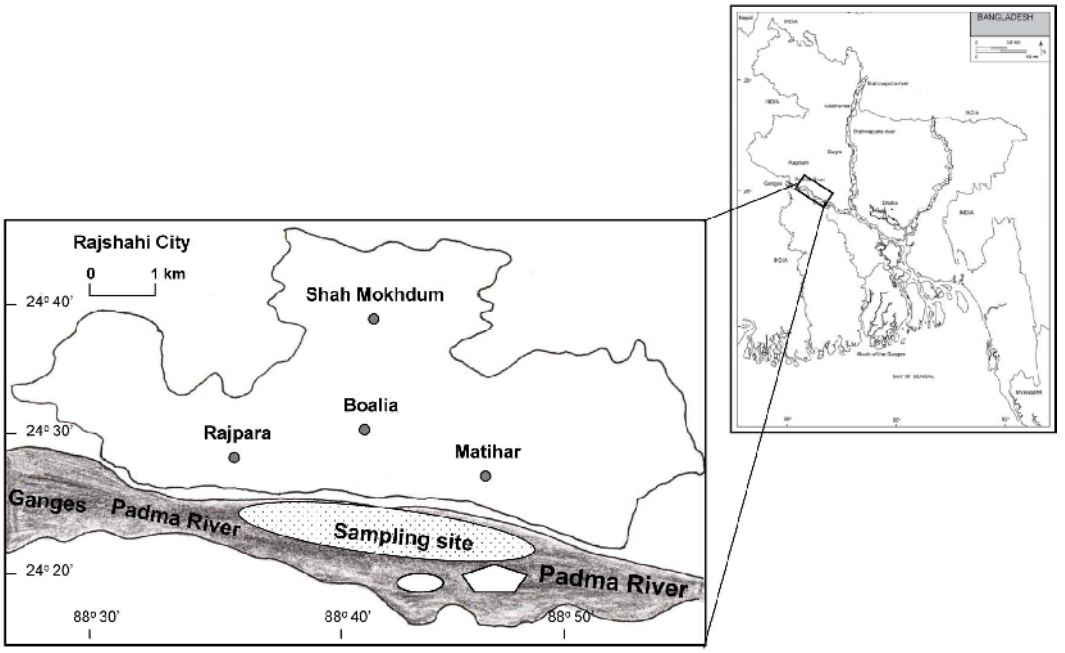

Fig. 1. Sampling site of the Padma River, northwestern Bangladesh, where the three Schibid catfishes were captured.

These fishes were caught by means of the traditional fishing gears *jhaki jal* (cast net), *tar jal* (square lift net), and *dughair* (conical trap) (Kibria and Ahmed 2005). Samples were immediately preserved with ice in the fish landed area and fixed with 5 % formalin upon arrival in the laboratory. For each individual, total length (TL), fork length (FL) and standard length (SL) were measured to the nearest 0.01 cm using digital slide calipers, and whole body weight (BW) was taken on a digital balance with 0.01 g accuracy.

The weight-length relationship was calculated using the expression: $W = a \times L^b$, where W is the body weight (g), L is the total length (cm) or fork length (cm). Parameters a and b of the weight-length relationship were estimated by linear regression analysis based on logarithms: $log(W) = log(a) + b\ log(L)$. The 95% confidence limits of parameters a and b and the coefficient of determination r^2 were also estimated. In order to confirm whether b values obtained in the linear regressions were significantly different from the isometric value of ±95% ($\alpha = 0.05$), the equation according to Sokal and Rohlf (1987): $t_s = (b-3) / s_b$ was applied, where ts is the t-test value, b the slope and s_b the standard error of the slope (b). The comparison between obtained values of t-test and the respective tabled critical values allowed for the determination of the b values statistically significant, and their inclusion in the isometric range (b=3) or allometric range (negative allometric; b<3 or positive allometric; b>3). In addition, total length (TL), fork length (FL) and standard length (SL) were also used to make the relationships, SL vs TL, TL vs FL, and FL vs SL by linear regressions.

The relative condition factor (*K*n) for each individual was calculated according to Le Cren (1951) equation $Kn = W/a \times L^b$, where W is the body weight (BW), and L, the total length (TL) or fork length (FL), and *a* and *b*, the parameters of the LWR. Fulton's condition factor *K* was calculated using the equation given by Htun-Han (1978) as $K = 100 \times (W/L^3)$.

Statistical analyses were performed using SPSS 16.0 Science software. Normality of each sex was visually accessed from histograms and box plots and confirmed with the Kolmogorov-Smirnov test. If the normality assumption was met, then the Pearson's correlation coefficients were calculated to analyze the relationship between the morphometric indices (relative *K*n and Fulton's *K* condition factors) with TL, FL and BW. All the statistical analyses were considered at a significance level of 5% ($P<0.05$).

Results

A total of 347 specimens of three schibid catfish species were collected from the Padma River near 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 5.30 cm, corresponding to a specimen of *N. atherinoides*, weighting 0.60 g.

Table 1. Descriptive statistics on the length (cm) and weight (g) measurements of the three Schibid catfishes from the Padma River, northwestern Bangladesh during March 2006 to February 2007.

Species	n	Measurements	Minimum	Maximum	Mean ± SD	95% Cl
Ailia coila	105	TL	8.1	15.6	10.19 ± 1.44	0.41
		FL	7.15	14	09.04 ± 1.31	0.37
		BW	2.5	18.1	05.21 ± 2.71	0.77
Eutropiichthys vacha	130	TL	7.45	21.3	12.98 ± 3.46	1.06
		FL	6.55	19	11.43 ± 3.12	0.96
		BW	2.5	59.6	17.78 ± 4.50	1.17
Neotropius atherinoides	112	TL	5.3	10.7	08.04 ± 1.39	0.38
		FL	4.65	9.25	06.99 ± 1.20	0.33
		BW	0.6	4.3	02.07 ± 1.02	0.28

n, sample size; TL, total length; FL, fork length; BW, body weight; SD, standard deviation; Cl, confidence level.

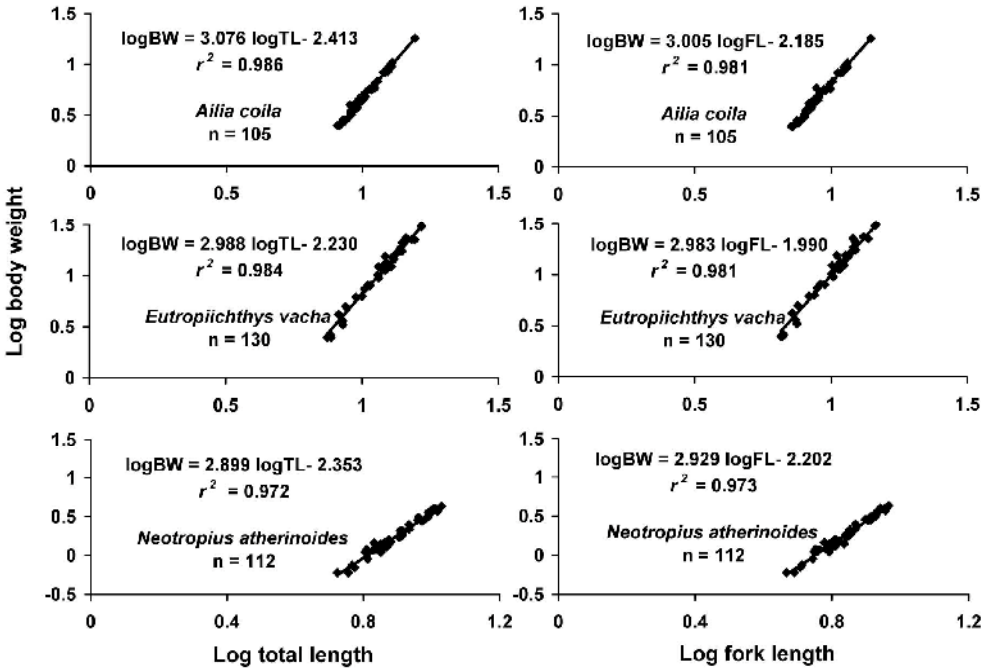

Fig. 2. Length-weight relationships (*log BW = log a + b log L*) for the three schibid catfishes from the Padma River, northwestern Bangladesh during March 2006 to February 2007.

The sample size (*n*), regression parameters *a* and *b* of the LWR, 95% confidence intervals of *a* and *b*, the coefficient of determination (r^2), and growth type of these three fishes are given in Figure 2 and Table 2. All relationships were highly significant (P<0.01), with r^2 values being greater than 0.972. The calculated allometric coefficient *b* ranged from a minimum of 2.899 (for TL) *N. atherinoides*, to a maximum of 3.076 (for TL) for *A. coila*, with an average value of 2.986. The *b* value of LWR for *A. coila* was close to 3 indicating the isometric growth. The LWRs indicated negative allometric growth in *E. vacha* and *N. atherinoides*.

The relationships between TL, FL and SL of the three catfishes including 347 specimens along with the estimated parameters of the length-length relationship and the coefficient of determination r^2 are presented in Table 3. All LLRs were highly significant (P<0.01), with most of the coefficient of determination values being >0.895.

Table 2. Descriptive statistics and estimated parameters of the length-weight relationships for three Schibid catfishes from the Padma River, northwestern Bangladesh during March 2006 to February 2007.

Species	Equation	n	Regression parameters		95% Cl of a	95% Cl of b	r^2	Growth type
			a	*b*				
Ailia coila	$BW = a \times TL^b$	105	0.089	3.076	0.079 – 0.095	3.014 – 3.188	0.986	I
	$BW = a \times FL^b$		0.112	3.005	0.094 – 0.118	2.957 – 3.187	0.981	I
Eutropiichthys vacha	$BW = a \times TL^b$	130	0.107	2.988	0.096 – 0.136	2.846 – 3.149	0.984	A -
	$BW = a \times FL^b$		0.137	2.983	0.115 – 0.165	2.816 – 3.103	0.981	A -
Neotropius atherinoides	$BW = a \times TL^b$	112	0.095	2.899	0.081 – 0.104	2.808 – 3.067	0.972	A -
	$BW = a \times FL^b$		0.111	2.929	0.090 – 0.125	2.795 – 3.158	0.973	A -

n, sample size; BW, body weight; TL, total length; FL, fork length; *a*, intercept; *b*, slope ; Cl, confidence intervals; r^2, coefficient of determination; I, isometric growth; A -, negative allometric growth.

Table 3. Morphometric relationships between total length (TL), fork length (FL) and standard length (SL) for three Schibid catfishes from the Padma River, northwestern Bangladesh during March 2006 to February 2007.

Species	Equation	n	a	b	95% Cl of a	95% Cl of b	r^2
Ailia coila	$SL = a + b \times TL$	105	0.267	0.799	-0.595 to -0.496	0.769 – 0.891	0.914
	$TL = a + b \times FL$		0.268	1.097	0.027 to 0.449	1.077 – 1.126	0.985
	$FL = a + b \times SL$		0.368	1.032	-0.903 to 0.487	1.010 – 1.195	0.895
Eutropiichthys vacha	$SL = a + b \times TL$	130	-0.455	0.85	-0.688 to -0.305	0.835 – 0.872	0.993
	$TL = a + b \times FL$		0.318	1.108	0.130 to 0.498	1.089 – 1.130	0.993
	$FL = a + b \times SL$		0.196	1.061	0.059 to 0.503	1.020 – 1.080	0.982
Neotropius atherinoides	$SL = a + b \times TL$	112	-0.135	0.826	-0.266 to -0.002	0.808 – 0.843	0.994
	$TL = a + b \times FL$		-0.097	1.163	-0.235 to 0.025	1.146 – 1.182	0.995
	$FL = a + b \times SL$		0.224	1.041	0.151 to 0.291	1.030 – 1.052	0.998

n, sample size; SL, standard length; TL, total length; FL, fork length; a, intercept; b, slope; CI, confidence intervals; r^2, coefficient of determination.

Table 4. Relative condition factor (*Kn*) and Fulton's condition factor (*K*) of three Schibid catfishes from the Padma River, northwestern Bangladesh during March 2006 to February 2007.

Species	n	Type of length	Relative condition factor (*Kn*)				Fulton's condition factor (*K*)			
			Min	Max	Mean ± SD	95% Cl	Min	Max	Mean ± SD	95% Cl
Ailia coila	105	TL	0.905	1.191	0.992 ± 0.049[a]	0.014	0.424	0.549	0.461 ± 0.023[a]	0.007
		FL	0.895	1.295	1.005 ± 0.060[a]	0.017	0.589	0.851	0.660 ± 0.039[a]	0.011
Eutropiichthys vacha	130	TL	0.818	1.293	1.002 ± 0.106[a]	0.033	0.537	0.864	0.671 ± 0.071[c]	0.022
		FL	1.839	3.167	2.342 ± 0.278[b]	0.086	0.782	1.339	0.989 ± 0.118[c]	0.036
Neotropius atherinoides	112	TL	0.901	1.345	1.076 ± 0.093[a]	0.026	0.307	0.462	0.362 ± 0.032[b]	0.009
		FL	0.793	1.21	1.001 ± 0.084[a]	0.023	0.436	0.672	0.550 ± 0.047[b]	0.013

n, sample size; TL, total length; FL, fork length; BW, body length; Min, Minimum; Max, maximum; SD, standard deviation; Cl, confidence level; [a, b, c] indicate significant differences by species.

These three schibid catfishes exhibited similar relative condition factor (*Kn*) except *E. vacha* for its FL. Fulton's condition factor *K* showed significant variation (Kruskal-Wallis test, P< 0.001) among all the three species, with best performance by *E. vacha*, followed by *A. coila* and *N. atherinoides*, calculated as 0.671±0.071, 0.461±0.023, and 0.362±0.0032 respectively (Table 4). The Pearson's correlation test showed significant correlation between *K* and TL for all the three species. Positive correlations were extracted between *K*n-BW, K-BW, K-TL, and K-FL for *A. coila*, and Kn-TL, and Kn-BW for *N. atherinoides* (P<0.01). However, for *E. vacha* positive correlations were recorded only for *K* and TL and BW (P< 0.01).

Discussion

Information on the biological aspects of Schibid catfishes from Bangladesh is insufficient (except Hossain et al. 2009c). The present study used a large number of specimens with different body sizes captured by some traditional fishing gears (Kibria and Ahmed 2005). However, it was not possible to catch fishes smaller than 5.00 cm TL. The absence of small sized fishes (<5.00 cm TL) was associated with the selectivity of the fishing gear rather than the absence of small sized individuals in the study area. However, the present study recorded the maximum size of *A. coila* in the Padma River as 15.60 cm TL, which was

lower than the maximum record value of 18.00 cm TL in Nepal (Froese and Pauly 2008). The maximum weight of *A. coila* observed in this study (18.10 g) was higher than the maximum record value of 15.00 g in Maharashtra, India (Froese and Pauly 2008).

The calculated allometric coefficient *b* varied among the species from a minimum of 2.899 for *N. atherinoides*, to a maximum of 3.076 for *A. coila*. The values of *b* were within the limits 2.5-3.5 reported by Froese (2006) for most fishes. In general and despite the many variations in fish forms between species, *b* is close to 3, indicating that fish grow isometrically; values significantly different from 3.0 indicate allometric growth (Tesch 1971). The LWR with *b* values significantly different from 3.0 were often associated with narrow size ranges of the specimens examined; such LWR should be used only within the respective size range. 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 observed length ranges of the specimen caught (Tesch 1971), all of which were not accounted for in the present study. Since samples of each species included individuals collected over several seasons, the parameters *a* and *b* would be treated as mean annual values. In a recent study in Indus River, Sindh, Pakistan, Soomro et al. (2007) estimated the positive allometric growth in males ($b = 3.159$), negative allometric growth in females ($b = 2.958$) and isometric growth in combined sexes ($b = 3.053$) of *E. vacha* (Soomro et al. 2007), and they did not include the 95% confidence intervals in their studies. However, Hossain at al. (2009c) recorded negative allometric growth in *E. vacha* from the lower Ganges, which is in accordance with the present study. Nevertheless, the length range of the specimens and sampling period of the studies by Soomro et al. (2007) were not similar to the present study. In addition, Hossain et al. (2009c) reported negative allometric growth for *A. coila*; nevertheless, there was no significant difference ($b \approx 3.000$) from the present study. In case of *N. atherinoides*, Hossain and Afroze (1991) recorded the negative allometric growth from the Bangladeshi waters, which is also in accordance with the present study. However, for all of the studied species presented in this paper, 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 (Hossain et al. 2006b; Hossain et al. 2009c).

All LLRs were highly correlated and they were compared with the available literature. In the Soomro et al. (2007) study, the length-length relationships of *E. vacha* were reported as TL = 0.923 SL + 1.017 ($r^2 = 0.971$), SL = 1.036 FL + 0.934 ($r^2 = 0.986$) and FL = 1.012 TL + 0.940 ($r^2 = 0.977$) for combined sexes from the Indus River, Pakistan. These results were different from the present study, and such differences may be attributed to differences in ecological conditions of the habits or variation in the physiology of animals, or both (Le Cren 1951). Nevertheless, the length ranges and the sampling period were not similar to the present study.

Conclusion

The condition factor among all these three species showed significant differences in the present study. No references dealing with the body condition factors of the three Schibid species are available, thus it was not possible to compare the results of this work with previous ones. However, the condition factor based on the LWR is an indicator of the changes in food reserves and therefore an indicator of the general fish condition. In general, the seasonal cycle in the fish's condition suggested a relationship to gonadal development. According to Šantić et al. (2006), the condition factor of *Trachurus mediterraneus* (Steindachner, 1868) was constant during the pre-spawning period, decreased during and was lowest immediately after spawning. However, only the seasonal data were used during this study, thus it is difficult to compare among the condition of fishes throughout the year.

This study also presented the basic information on the length-weight relationships and conditions for three schibid catfishes from the Padma River, northwestern Bangladesh, which would be useful for fishery managers as well as the sustainable management of its numerous stocks in the region. Moreover, no condition factor currently exists in the FishBase for these species and therefore, our results may contribute to this invaluable database.

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