



Morphometric Relationships of Length-Weight and Length-Length of Four Cyprinid Small Indigenous Fish Species from the Padma River (NW Bangladesh)

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Abstract

This study describes the length-weight (LWR) and length-length (LLR) relationships of four cyprinid important small indigenous fish species (SIS) from the Padma River, Bangladesh. A total of 914 specimens were caught by traditional fishing gear from March 2006 to February 2007. Length (cm) and body weight (g) for each specimen was taken by a digital slide caliper and balance, respectively. The allometric coefficient b was close to isometric value (≈ 3.000) in *Aspidoparia morar* and *Puntius ticto*, although it suggested positive allometric growth in *Amblypharyngodon mola* and *Lepidocephalus guntea*. The results further indicated that LLRs were highly correlated ($r^2 > 0.932$; $P < 0.001$).

Keywords: total length-body weight relationships, SIS, Bangladesh.

Padma Nehri'nde (Kuzeybatı Banglades) Yerli Dört Küçük Sazan Türünün Boy-Boy, Boy-Ağırlık ve Morfometrik İlişkisi

Özet

Bu çalışma, Padma Nehrinde (Banglades) dört önemli küçük yerli balık türünün (SIS), boy-ağırlık ve boy ilişkisini tanımlamaktadır. Geleneksel av aracıyla Mart 2006'dan Şubat 2007'ye kadar toplam 914 örnek yakalandı. Her örneğin, boy (cm) ve vücut ağırlığı (g) ölçüldü. *Amblypharyngodon mola* ve *Lepidocephalus guntea*'da pozitif allometrik büyümenin olduğu öne sürülse de *Aspidoparia morar* ve *Puntius ticto*'da "b" allometri katsayısı izometrik değere ($\approx 3,00$) yakın oldu. Sonuçlar boy ilişkilerinin oldukça korelasyon içinde olduğunu göstermiştir ($r^2 > 0,932$; $P < 0,001$).

Anahtar Kelimeler: toplam boy – vücut ağırlığı ilişkileri, SIS, Banglades.

Introduction

According to (Ross *et al.*, 2003), the small indigenous fish species (SIS), which are defined as species attaining a maximum length of 5-25 cm contribute considerably to total fish intake. There are 260 indigenous freshwater bony fish species suitable for human consumption, belonging to 145 genera and 55 families, constitute a very rich aquatic biodiversity in Bangladesh (Craig *et al.*, 2004). *Amblypharyngodon mola* (Hamilton, 1822), *Aspidoparia morar* (Hamilton, 1822), *Lepidocephalus guntea* (Hamilton, 1822), and *Puntius ticto* (Hamilton, 1822) are small indigenous fish species of Bangladesh. These are important target species for small scale fisher in Bangladesh, who use a variety of

traditional fishing gears (Kibria and Ahmed, 2005; Craig *et al.*, 2004).

The morphometric relationships between length and weight can be used to assess the well-being of individuals and to determine possible differences between separate unit stocks of the same species (King, 2007). In addition, length-length relationships are also important in fisheries management for comparative growth studies (Moutopoulos and Stergiou, 2002).

Length-weight relationships (LWRs) and length-length relationships (LLRs) are still scarce for most tropical and sub-tropical fish species (Martin-Smith, 1996; Harrison, 2001; Ecoutin *et al.*, 2005; Hossain *et al.*, 2006a; Hossain and Ahmed, 2008; Hossain *et al.*, 2009a; Hossain *et al.*, 2009b). To the best of the

knowledge, there is no previous information on LWRs and LLRs of these species from the Padma River in Bangladesh, except a brief studies by Hossain *et al.* (2008a). Subsequently, the aim of the present paper was to carry out the first complete and comprehensive description of the LWR and LLR of these four species from the Padma River, Bangladesh.

Materials and Methods

The present study was conducted in the Padma River, northwestern Bangladesh. The lower part of the Ganges (known as Padma River in Bangladesh) entered Bangladesh from India through the Rajshahi district (Latitude 24°22' N; Longitude 88°35' E). The Padma River is believed to be an important spawning and feeding ground for riverine fish species of northwestern Bangladesh. A large number of fishes including some commercially important species are fished by both small and large scale fishers throughout the year.

The samples for four small indigenous fish species were collected during daytime on a seasonal basis from the catch landed at the Rajshahi city, Rajshahi, Bangladesh from March 2006 to February 2007. 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). The samples were immediately preserved with ice and fixed with 5% formalin on arrival in the laboratory. For each individual, total length (TL), standard length (SL) and fork length (FL) 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: $W = aL^b$, where the W is the body weight (g), L the total length (cm), " a " the intercept of the regression and b is the regression coefficient (slope). Parameters a and b of the weight-length relationship were estimated by linear regression analysis based on natural logarithms: $\ln(W) = \ln(a) + b \ln(L)$. The determination coefficient (r^2) was used as an indicator of the quality of the linear regressions (Scherrer, 1984). Additionally, 95% confidence limits of the parameters a and b and the statistical significance level of r^2 were estimated. In order to confirm whether b values obtained in the linear regressions were significantly different from the isometric value of $\pm 95\%$ ($\alpha = 0.05$) was applied, expressed by the equation according to Sokal and Rohlf (1987): $t_s = (b-3) / s_b$, where t_s is the t-test value, b the slope and s_b the standard error of the slope (b). All the statistical analyses were considered at significance level of 5% ($P < 0.05$).

Results

A total of 914 specimens of four small indigenous fish species were collected from the

Padma River near Rajshahi city, Bangladesh during the present study. The sample size (n), length range, parameters a and b of the LWR, 95% confidence intervals of a and b , the determination coefficient (r^2), and growth type of these 4 fishes are given in Table 1. All relationships were highly significant ($P < 0.001$), with r^2 values being greater than 0.913. The calculated allometric coefficient b ranged from a minimum of 3.004 for *A. morar*, to a maximum of 3.758 for *A. mola*, with an average value of 3.374. The b value of LWRs for *A. morar* and *P. ticto* were close to 3 indicating the isometric growth. The LWRs indicated a positive allometric growth in *A. mola* and *L. guntea* (Table 1).

Conversion among length measurements, i.e. relationships between TL, FL and SL of 914 small indigenous fish specimens along with the estimated parameters of the length-length relationship and the coefficient of determination r^2 are presented in Table 2. All LLRs were highly significant ($P < 0.001$), with most of the coefficient of determination values being > 0.932 .

Discussion

Information regarding on any biological aspects of SIS from the Padma River is quite insufficient and the data quality of previous studies (except Hossain *et al.*, 2006a; Hossain *et al.*, 2008; Hossain *et al.*, 2009a; Hossain *et al.*, 2009b) on LWRs and LLRs from these areas are not well defined. In the present study, the smallest length of captured fish among the four species by means of the traditional fishing gears was 3.90 cm in total length with a minimum weight of 1.20 g for *P. ticto*. The absence of small sized fishes (< 4.00 cm SL) was associated with the selectivity of the fishing gear rather than indicating the absence of small sized individuals in the study area.

The calculated allometric coefficient b varied among the species from a minimum of 3.004 for *A. morar*, to a maximum of 3.758. These values are within the limits (2 and 4) reported by Tesch (1971) 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). 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 in the present study. The present results were comparable with the earlier available studies, although three of the species (among 4) had no weight-length relationships available in Fishbase

Table 1. Descriptive statistics and estimated parameters of the length-weight relationships for four cyprinid small indigenous fish species from the Padma River, northwestern Bangladesh

Species	n	Total length (cm)		Regression parameters		95% CI of a	95% CI of b	r^2	t_s	Growth type
		Min	Max	a	b					
<i>Amblypharyngodon mola</i>	184	4.80	7.40	0.076	3.758	0.062 to 0.088	3.566 – 4.016	0.951	8.390	A +
<i>Aspidoparia morar</i>	132	4.30	12.70	0.121	3.004	0.0112 to 0.132	2.945 – 3.112	0.981	0.071	I
<i>Lepidocephalus guntea</i>	167	6.30	10.00	0.068	3.640	0.054 to 0.085	3.384 – 3.901	0.946	5.770	A +
<i>Puntius ticto</i> *	431	3.90	11.60	0.150	3.093	0.135 to 0.166	2.976 – 3.213	0.913	2.006	I

n: sample size; a: intercept; b: slope; CI: confidence intervals; r^2 : coefficient of determination; A+ : positive allometric; A-: negative allometric; I: isometric.

Table 2. Morphometric relationships between total length (TL, cm), fork length (FL, cm) and standard length (SL, cm) for four cyprinid small indigenous fish species captured from the Padma River, northwestern Bangladesh

Species	n	Equation	Regression parameters		95% CI of a	95% CI of b	r^2
			a	b			
<i>Amblypharyngodon mola</i>	184	SL = a + b × TL	-0.297	0.823	-0.459 to -0.146	0.799 – 0.848	0.998
		TL = a + b × FL	0.309	1.129	-0.025 to 0.312	1.098 – 1.158	0.995
<i>Aspidoparia morar</i>	132	FL = a + b × SL	0.196	1.076	0.097 to 0.0294	1.055 – 1.098	0.995
		SL = a + b × TL	-0.055	0.785	-0.202 to 0.095	0.768 – 0.803	0.996
		TL = a + b × FL	0.104	1.129	-0.157 to 0.373	1.096 – 1.163	0.994
<i>Lepidocephalus guntea</i>	167	FL = a + b × SL	-0.039	1.130	-0.216 to -0.083	1.113 – 1.152	0.994
		TL = a + b × SL	0.422	1.165	0.192 to 0.675	1.121 – 1.204	0.989
		SL = a + b × TL	-0.362	0.854	-0.618 to -0.172	0.831 – 0.894	0.989
<i>Puntius ticto</i>	431	SL = a + b × TL	-0.267	0.829	-0.403 to -0.146	0.813 – 0.847	0.940
		TL = a + b × FL	-0.075	1.036	-0.095 to -0.056	1.015 – 1.060	0.960
		FL = a + b × SL	0.053	1.133	-0.083 to 0.194	1.109 – 1.159	0.932

n: sample size; a: intercept; b: slope; CI: confidence intervals; r^2 : coefficient of determination

(Froese and Pauly, 2007). However, Hossain *et al.* (2006a) also recorded the positive allometric growth in *A. mola* ($a = 0.0055$; $b = 3.397$) in the Mathabhanga River, southwestern Bangladesh. For *L. guntea*, the LWRs indicated positive allometric growth in females ($W = 0.46 \times 10^{-5} L^{3.5568}$), negative allometric growth in males ($W = 0.61 \times 10^{-3} L^{2.4349}$), positive allometric growth in juveniles ($W = 0.23 \times 10^{-5} L^{3.6583}$) and positive allometric growth in combined sexes ($W = 0.43 \times 10^{-5} L^{3.2167}$) in the Indian waters (Dhakal and Subba, 2003). Similarly, the present study also indicated the positive allometric growth for the combined sexes in the Padma Rivers, Bangladesh. This variation in the b exponents for the same species could be attributed to differences in sampling, sample size or length ranges. In addition, growth increment, differences in age and stage of maturity, food, as well as environmental conditions such as temperature, salinity and seasonality can also affect the value of b for the same species (Weatherley and Gill, 1987). However, for all of the studied species presented in this paper, the b values were generally in agreement with results for fishes of same family obtained from same and /or other geographical areas (Martin-Smith, 1996; Hossain *et al.*, 2006a; Hossain *et al.*, 2006b;

Hossain *et al.*, 2008; Hossain *et al.*, 2009a; Hossain *et al.*, 2009b).

All LLRs were highly correlated and they were compared with the available literatures. Earlier, Hossain *et al.* (2006a), however, reported the length-length relationship as $TL = 1.168 SL + 0.187$ ($r^2 = 0.901$), $SL = 0.709 FL + 0.822$ ($r^2 = 0.868$) and $FL = 1.014 TL - 0.553$ ($r^2 = 0.936$) for combined sexes of *A. mola* in the Mathabhanga River, southwestern Bangladesh. For the variations of LLRs in the same species from different locations, the ecological conditions of the habits or variation in the physiology of animals, or both, are responsible (Le Cren, 1951).

The total length-weight relationship estimates for the threatened ticto barb *P. ticto* is only available in FishBase, however, no information currently exists for the reminder three species and therefore, this study may contribute to this invaluable database.

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