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Conditions- and Form-Factor of the Five Threatened Fishes from the Jamuna (Brahmaputra River Distributary) River, Northern Bangladesh

(Keadaan dan Faktor-Bentuk bagi Lima Spesies Ikan Terancam dari Sungai Jamuna (Distributari bagi Sungai Brahmaputra), Bahagian Utara Bangladesh)

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ABSTRACT

The small indigenous species namely Ailiichthys punctata *(Day 1871),* Botia lohachata *(Chaudhuri 1912),* Chanda nama *(Hamilton 1822),* Laubuca laubuca *(Hamilton 1822) and* Mystus cavasius *(Hamilton 1822) comprise an important component of riverine fisheries of Bangladesh. But the natural populations are decreasing fast due to high fishing pressure as well as environmental degradation. Therefore, data and information is needed to avert the alarming decline and initiate conservation measures for these important fishes of the Jamuna River. This study describes the condition- (Fulton's and Relative weight) and form-factor ($a_{3.0}$) of the five threatened fishes from the Jamuna River, a distributary of the Brahmaputra River in northern Bangladesh. A total of 919 specimens from five species in five families used for this study were caught by traditional fishing gear during March 2010 through February 2011. For each individual, the total (TL), fork (FL) and standard (SL) length were measured by digital slide calipers while individual body weight (BW) was measured using a digital balance. The Fulton's condition factor (K_F) showed significant variations ($p<0.01$) among species, with best performance by* B. lohachata *(1.49±0.20) followed by* C. nama *(1.41±0.19),* M. cavasius *(0.79±0.14),* L. laubuca *(0.78±0.09) and* A. punctata *(0.71±0.12). The calculated minimum and maximum relative weight (W_R) was 53.14 for* C. nama *and 167.88 for* A. punctata*, respectively. However, the estimated relative weight (W_R) was close to 100 for all populations ($p>0.05$) indicating a balanced habitat with food availability relative to the presence of predators. The calculated minimum and maximum form factor ($a_{3.0}$) was 0.0062 for* A. punctata *and 0.0158 for* B. lohachata*, respectively. To the best of our knowledge, this study presents the first reference on K_F, W_R and $a_{3.0}$ factors for these threatened species in Bangladesh. The results would be useful for sustainable management and conservation of the limited stocks in the Brahmaputra River ecosystem.*

Keywords: Bangladesh; condition factor; form factor; Jamuna River; threatened species

ABSTRAK

Ailiichthys punctata *(Day1871),* Botia lohachata *(Chaudhuri 1912),* Chanda nama *(Hamilton 1822),* Laubuca laubuca *(Hamilton 1822) dan* Mystus cavasius *(Hamilton 1822) merupakan spesies asli ikan kecil yang penting di Bangladesh. Namun, populasi semula jadi ikan-ikan ini semakin berkurang akibat daripada aktiviti penangkapan dan kemerosotan persekitaran. Oleh itu, data dan maklumat diperlukan untuk menghalang kemerosotan dan membolehkan inisiatif langkah-langkah pemuliharaan ikan-ikan ini di Sungai Jamuna. Kajian ini memperihalkan keaadan – (berat Fulton's dan relatif) dan faktor-bentuk ($a_{3.0}$) lima spesies ikan terancam daripada Sungai Jamuna, sebuah distributari daripada Sungai Brahmaputra di bahagian utara Bangladesh. Sejumlah 919 spesimen daripada lima spesies tergolong dalam lima famili yang digunakan dalam kajian ini telah ditangkap dengan menggunakan alat penangkapan trandisi dari bulan Mac 2010 hingga Februari 2011. Bagi setiap individu, jumlah (TL), cabangan (FL) dan piawai (SL) kepanjangan telah diukur menggunakan slaid angkup digital, dan berat badan (BW) setiap individu diukur menggunakan penimbang digital. Faktor keadaan Fulton's (K_F) menunjukkan variasi yang signifikan ($p<0.01$) antara spesies, dengan prestasi terbaik pada* B. lohachata *(1.49 ± 0.20) diikuti oleh* C. nama *(1.41 ± 0.19),* M. cavasius *(0.79 ± 0.14),* L. laubuca *(0.78 ± 0.09) dan* A. punctata *(0.71 ± 0.12). Berat relatif (W_R) kiraan minimum dan maksimum adalah 53.14 bagi* C. nama *dan 167.88 bagi A. punctata masing-masing. Namun, berat relatif (W_R) jangkaan mendekati 100 bagi semua populasi ($p>0.05$). Ini menunjukkan keseimbangan habitat dengan pemperolehan makanan relatif kepada kehadiran pemangsa. Faktor bentuk ($a_{3.0}$) kiraan minimum dan maksimum adalah 0.0062 bagi* A. punctata *dan 0.0158 bagi B. lohachata masing-masing. Kajian ini merupakan kajian pertama untuk K_F, W_R dan $a_{3.0}$ ke atas spesies ikan terancam tersebut di Bangladesh. Hasil kajian ini berguna bagi pengurusan mampan dan pemuliharaan stok terhad di dalam ekosistem Sungai Brahmaputra.*

Kata kunci: Bangladesh; faktor bentuk; faktor keadaan; spesies terancam; Sungai Jamuna

Introduction

The conservation of threatened species has gained great ecological importance over recent years. Knowledge on the life-history characteristics of threatened species is important for the implementation of sound management strategies for conservation of these small economically important fishes (Hossain et al. 2008a; 2009a). These five small species are indigenous to Bangladesh and their spawning aggregations are heavily exploited by both small- and large-scale fishers (Hossain et al. 2009b; Sani et al. 2010).

Bangladesh is home to 260 indigenous freshwater bony fish species apposite for human utilization, belonging to 145 genera and 55 families which represent a very wealthy aquatic bio-diversity (cf., Hossain 2010a). The small indigenous species (SIS) of Bangladesh including five species: *Ailiichthys punctata* (Day 1871) (Siluriofrmes: Schilbeidae), *Botia lohachata* (Chaudhuri 1912) (Cypriniformes: Cobitidae), *Chanda nama* (Hamilton 1822) (Perciformes: Ambassidae), *Laubuca laubuca* (Hamilton 1822) (Cypriniformes: Cyprinidae), and *Mystus cavasius* (Hamilton 1822) (Siluriformes: Bagridae) comprise an important component of riverine fisheries in the country's vast river system. Among these five species, the first two are categorized as endangered (EN) while the last three are vulnerable (VU) (IUCN Bangladesh 2000). These fishes are important target species for small- and large-scale fishermen in Bangladesh, who use a variety of traditional fishing gears (Hossain et al. 2006a). Despite their threatened status, these five species are still target species for the riverine fisheries in Bangladesh and are a major source of fish protein and micronutrients in the diet of the rural fisherfolks (Hossain et al. 2006b). Although previously abundant in rivers, streams, canals, reservoirs, lakes, ponds and *beel*, *haor* and *baor* swamplands of Bangladesh (IUCN Bangladesh 2000), India, Nepal and Sri-Lanka (Froese & Pauly 2011). However, the populations have seriously declined or are on verge of extinction due to over exploitation augmented by various ecological changes and environmental degradation of the natural habitats (Hossain et al. 2009a).

The condition factors of threatened fishes are the most important biological parameter which provide information on condition of fish species and the entire community and is of high significance for management and conservation of natural populations (Muchlisin et al. 2010; Sarkar et al. 2009). In addition, condition factor is a quantitative parameter of the state of well-being of the fish that will determine present and future population success because of its influence on growth, reproduction and survival (Richter 2007). Moreover, relative weight (W_R) is one of the most popular indices used for assessing condition of fishes in the USA since the last two decades (Rypel & Richter 2008).

To the best of our knowledge, no information is available in the literature on the biological aspects with regard to conditions and form factor of the five threatened fishes in Bangladesh. Nevertheless, a number of studies on biology, life history characteristics and conservation of many small indigenous fishes (e.g., Hossain et al. 2006a; 2006b; 2008b; 2009b; 2009c; 2009d; Hossain & Ahmed 2008; Hossain 2010a; 2010b; Hossain et al. 2010) and threatened species (Hossain et al. 2012) of Bangladesh are well documented. This study presents the conditions and form factor of *A. punctata*, *B. lohachata*, *C. nama*, *L. laubuca*, and *M. cavasius* threatened fish populations from the Jamuna River, the main distributary of the Brahmaputra River in northern Bangladesh using morphometric data collected over a one year period.

Materials and Methods

Study area

This study was conducted in the Jamuna River (Sariakandi, Bogra region: Latitude 24° 88' N; Longitude 89° 57' E) of Bangladesh. The Jamuna is the main distributary of the Brahmaputra River, Bangladesh and is one of the world's largest rivers, ranked among the top three rivers in terms of sediment and water discharge volumes. The high water and sediment discharge are attributed to the monsoon flooding and tectonic setting which supplies profuse sediment from the Himalayan uplift into the subsiding Bay of Bengal (Best et al. 2007). A large number of commercially important species in this river are targeted by both small and large scale fishermen throughout the year. The river is also believed to be an important spawning and feeding ground for many riverine fish species of Bangladesh.

Sampling and laboratory analysis

Samples were collected on a seasonal basis from commercial catches landed at the Sariakandi fish landing center of Bogra region during March 2010 to February 2011. The main gears used by the commercial fishers include traditional fishing gears including *jhaki jal* (cast net), *tar jal* (square lift net), and *dughair* (conical trap). The fresh samples were immediately chilled in ice on site and fixed with 10% buffered formalin upon arrival in the laboratory. All morphometric measurements were contacted according to Froese & Pauly (2011). The fixed specimens were individually measured, and weighed. Total length (TL) was measured to the nearest 0.01 cm using digital slide calipers (Mitutoyo, CD-15PS), and total body weight (BW) was measured using an electronic balance (Shimadzu, EB-430DW) with 0.01 g accuracy.

Condition factors

Fulton's condition factor (K_F) (Fulton 1904) was calculated using the equation: $K_F = 100 \times (W/L^3)$, where W is the total body weight (BW, g) and L is the total length (TL, cm). The scaling factor of 100 was used to bring the K_F close to unit. Additionally, relative weight (W_R) was calculated by the equation given by Froese (2006) as $W_R = (W / W_S) \times 100$, where W is the weight of a particular individual and W_S

is the predicted standard weight for the same individual as calculated by $W_S = a\ L^b$ where the *a* and *b* values are obtained from the length-weight relationships (LWRs) between TL and BW (Hossain et al. 2012: *A. punctata, a* = 0.010, *b* = 2.81; *B. lohachata*, *a* = 0.0190, *b* = 2.85; *C. nama*, *a* = 0.0195, *b* = 2.79; *L. laubuca*, *a* = 0.0037, *b* = 3.31; *M. cavasius*, *a* = 0.0053, *b* = 3.21).

FORM FACTOR

The form factor ($a_{3.0}$) for each species was calculated using the equation given by Froese (2006) as: ($a_{3.0} = 10^{\log a - s(b-3)}$, where *a* and *b* are regression parameters of the length-weight relationships (LWRs) and *S* is the regression slope of log *a* vs. *b*. During this study, a mean slope *S* = -1.358 was used for estimating the form factor because information on LWRs is not available for these species for estimation of the regression (S) of *ln a* vs. *b*.

STATISTICAL ANALYSES

Statistical analyses were performed using Microsoft® Excel-add-in-DDXL, GraphPad Prism 5 and VassarStats online software (http://faculty.vassar.edu/lowry/VassarStats.html). Tests for normality of each group were conducted by visual assessment of histograms and box plots, and confirmed using the Kolmogorov-Smirnov test. Where the normality assumption was not met, the Wilcoxon signed rank test was used to compare the mean relative weight (W_R) and 100 (Anderson & Neumann 1996). The Spearman rank test was used to correlate body measurements (TL, FL, SL, and BW) and condition factors (K_F, and W_R). In addition, the Kruskal-Wallis test was used to compare the K_F and W_R among the species followed by the Dunn's multiple comparison post hoc test. All statistical analyses were considered significant at 5% (p<0.05).

RESULTS

A total of 919 specimens belonging to five fish species and five families were collected from the Jamuna River, at Sariakandi fish landing center, Bangladesh during this study. Descriptive statistics on the length and weight measurements and their 95% confidence limits of the five threatened species are given in TABLE 1. The observed minimum total length among all individuals sampled during the study was 3.08 cm, which was a specimen of *B. lohachata* with BW= 0.30 g. The maximum size of *M. cavasius* in this study was 11.29 cm TL.

The Fulton's condition (K_F) and relative weight (W_R) values calculated for the five threatened fishes are shown in TABLE 2. The K_F showed significant variations (p<0.01) among species (TABLE 3), with best performance by *B. lohachata* (1.49±0.20) followed by *C. nama* (1.41±0.19), *M. cavasius* (0.79±0.14), *L. laubuca* (0.78±0.09) and

TABLE 1. Descriptive statistics on the length (cm) and weight (g) measurements for the five threatened fishes from the Jamuna River (Brahmaputra River distributary), northern Bangladesh n, sample size; Min, minimum; Max, maximum; TL, total length; FL, fork length; SL, standard length; BW, body weight; SD, standard deviation; CL, confidence limit

Species	*n*	Measurements	Min	Max	Mean ± SD	95% CL
Ailiichthys punctata	183	TL	4.51	10.08	6.07±1.29	5.88 – 6.26
		FL	3.95	8.78	5.33±1.34	5.16 – 5.49
		SL	3.61	8.30	4.84±1.04	4.69 – 4.99
		BW	0.50	7.30	1.80±1.35	1.60 – 2.00
Botia lohachata	204	TL	3.08	7.00	5.11±1.02	4.97 – 5.25
		FL	2.57	6.31	4.54±0.97	4.41 – 4.67
		SL	2.11	5.66	4.00±0.89	3.88 – 4.12
		BW	0.30	4.80	2.22±1.19	2.06 – 2.38
Chanda nama	159	TL	3.33	6.44	4.70±0.77	4.58 – 4.82
		FL	2.70	5.45	4.05±0.67	3.95 – 4.15
		SL	2.28	4.99	3.61±0.62	3.53 – 3.69
		BW	0.30	3.60	1.57±0.69	1.46 – 1.68
Laubuca laubuca	197	TL	5.12	10.54	7.69±1.10	7.54 – 7.84
		FL	4.23	9.54	6.83±1.05	6.69 – 6.97
		SL	3.76	9.79	6.32±1.02	6.18 – 6.46
		BW	0.70	10.40	3.84±1.77	3.59 – 4.09
Mystus cavasius	176	TL	6.31	11.29	7.76±1.05	7.60 – 7.92
		FL	5.40	9.92	6.63±0.94	6.49 – 6.77
		SL	4.70	9.37	5.96±0.97	5.82 – 6.10
		BW	1.10	13.40	4.03±2.37	3.68 – 4.38

TABLE 2. Fulton's condition factor, $K_F = 100 \times (BW/TL^3)$, Relative weight, $W_R = (BW/ a \times TL^b)$ and Form factor, $a_{3.0} = 10^{loga-S\,(b-3)}$ for the five threatened fishes from the Jamuna River (Brahmaputra River distributary), northern Bangladesh

Species	*n*	Fulton's condition factor (K_F)				Relative weight (W_R)				$a_{3.0}$
		Min	Max	Mean ± SD	95% CL	Min	Max	Mean ± SD	95% CL	
Ailiichthys punctata	183	0.46	1.19	0.71 ± 0.12	0.64 – 0.73	70.95	153.90	100.85±13.37	98.82 – 102.88	0.0062
Botia lohachata	204	0.86	2.15	1.49 ± 0.20	1.46 – 1.50	77.10	138.22	101.49 ± 10.42	100.05 – 102.93	0.0158
Chanda nama	159	0.77	1.84	1.41 ± 0.19	1.38 – 1.44	63.60	124.66	100.88 ± 11.90	99.00 – 102.76	0.0122
Laubuca laubuca	197	0.44	1.17	0.78 ± 0.09	0.77 – 0.79	65.22	165.42	100.27 ± 11.79	98.61 – 101.93	0.0098
Mystus cavasius	176	0.39	1.08	0.79 ± 0.14	0.77 – 0.81	73.46	132.54	101.32 ± 13.50	99.32 – 103.32	0.0084

n, sample size; TL, total length; BW, body weight; $a_{3.0}$, form factor; S, slope = 1.358 according to Froese (2006); a and b are coefficients of length-weight relationships (LWRs) (Hossain et al. 2012); Min, Minimum; Max, maximum; SD, standard deviation; CL, confidence limit of mean. Species listed in alphabetic order.

A. punctata (0.71±0.12). The calculated minimum and maximum W_R was 53.14 for *C. nama* and 167.88 for *A. punctata*, respectively. However, W_R showed no significant variation among the species (Kruskal-Wallis test; p>0.05). In addition, the mean W_R for each species was close to 100 in this study (p>0.05) indicating the habitat was still in good condition. Moreover, Spearman rank test revealed that K_F was strongly correlated with TL, FL, SL and BW in most of the species (p<0.01), but not with FL and SL for *A. punctata*, and BW for *B. lohachata* and *C. nama* (TABLE 4). Furthermore, no significant relationship was observed between W_R and body metrics (TL, FL, SL and BW) for most of the species.

The calculated minimum and maximum form factor ($a_{3.0}$) was 0.0062 for *A. punctata* and 0.0158 for *B. lohachata*, respectively (TABLE 2).

DISCUSSION

Information on biometrics of the threatened fishes from Bangladesh has been quite insufficient (Hossain et al. 2009 c; Hossain et al. 2012). However, a number of studies have been conducted within the Asian countries (Gupta et al. 2011; Muchlisin et al. 2010; Naeem et al. 2011; Naeem et al. 2010; Patiyal et al. 2010; Sani et al. 2010; Sarkar et al. 2009; Yousaf et al. 2009). In this study, it was not possible to collect fishes smaller than 3.33 cm TL which was attributed to either the absence of small sized fishes (< 3.00 cm TL) in the populations or selectivity of the fishing gears. Hossain (2010a, 2010b) noted similar hypothesis, while he was studying on the biometric relationships on some small indigenous species from the Ganges River, northwestern Bangladesh. The maximum size of *M. cavasius* recorded in this study within the Jamuna River

TABLE 3. Fulton's condition factor among five threatened fishes in the Jamuna River (Brahmaputra River distributary), northern Bangladesh (Kruskal-Wallis test followed by the post hoc Dunn's multiple comparison test)

	Ailiichthys punctata	*Botia lohachata*	*Chanda nama*	*Laubuca laubuca*	*Mystus cavasius*
Ailiichthys punctata		*	ns	**	**
Botia lohachata	*		ns	**	**
Chanda nama	ns	ns		**	**
Laubuca laubuca	**	**	**		ns
Mystus cavasius	**	**	**	ns	

*, significant at 5%; **, significant at 1%; ns, not significant at 5 % level

TABLE 4. Spearman rank correlation coefficient (r_s) for Fulton's (K_F) and Relative weight (W_R) with total length (TL, cm), Fork length (FL, cm), standard length (SL, cm) and body weight (BW, g) for the five threatened fishes from the Jamuna River (Brahmaputra River distributary), northern Bangladesh

Species	*n*	r_s for Fulton's condition factor				r_s for Relative weight			
		K_F - *TL*	K_F - *FL*	K_F - *SL*	K_F - *BW*	W_R - *TL*	W_R - *FL*	W_R - *SL*	W_R - *BW*
Ailiichthys punctata	183	- 0.146 *	- 0.141 ^{ns}	- 0.138 ^{ns}	0.231**	- 0.043 ^{ns}	- 0.038 ^{ns}	- 0.036 ^{ns}	0.336 ***
		p=0.05	p=0.06	p=0.06	p<0.01	p=0.56	p=0.61	p=0.63	p<0.001
Botia lohachata	204	- 0.152 *	- 0.154 *	- 0.147 *	- 0.038 ^{ns}	- 0.202 **	- 0.204 **	- 0.198 **	- 0.091 ^{ns}
		p<0.05	p<0.05	p<0.05	p=0.59	p<0.01	p<0.01	p<0.01	p=0.20
Chanda nama	159	- 0.253 **	- 0.244 **	- 0.236 **	- 0.045 ^{ns}	- 0.162 *	- 0.154 ^{ns}	- 0.145 ^{ns}	0.052 ^{ns}
		p<0.01	p<0.01	p<0.01	p=0.58	p<0.05	p=0.05	p=0.07	p=0.52
Laubuca laubuca	197	0.417 ***	0.422 ***	0.430 ***	0.583 ***	- 0.036 ^{ns}	- 0.030 ^{ns}	- 0.023 ^{ns}	0.147 *
		p<0.001	p<0.001	p<0.001	p<0.001	p=0.62	p=0.67	p=0.75	p<0.05
Mystus cavasius	176	0.314 ***	0.313 ***	0.315 ***	0.639 ***	- 0.061 ^{ns}	- 0.062 ^{ns}	- 0.059 ^{ns}	0.297 ***
		p<0.001	p<0.001	p<0.001	p<0.001	p=0.421	p=0.413	p=0.437	p<0.001

n, samples size; p shows significance level (***, extremely significant, p<0.001 ; **, highly significant, p<0.01; * significant, p<0.05; ns, not significant at 5%)

was 11.29 cm TL. The size is far is less than the half of the maximum recorded value of 24.90 cm TL in Cauvery River at Hogenakal in South India (Muralidharan et al. 2011). In Central India, Sani et al. (2010) reported the maximum TL for *M. cavasius* as 27.40 cm from the Betwa (Yamuna River tributary). Hossain et al. (2011) reported that the decrease in the maximum sizes of individuals of these species landed within the Jamuna River (Brahmaputra River system) signaling the need for urgent measures conduct extensive studies on these species to provide more information for their management and conservation. However, the information on maximum length is required to estimate the population parameters including asymptotic length and growth coefficient of fishes, which is important for fisheries resource planning and management (Hossain 2010c). These sizes differences might be attributed to the variation of environmental factors, particularly water temperature and food availability (Hossain & Ohtomi 2010).

Several condition factors including (1) Fulton's (Fulton 1904), (2) Relative (Le Cren 1951), (3) Allometric (Tesch 1968), and (4) Relative weight (Froese 2006) are used to assess the overall health and productivity of freshwater fish populations (cf. Rypel & Richter 2008). Froese (2006) recommended the relative condition factor for comparison of condition of different specimens within the same sample. However, he did not allow for comparison across populations unless they have equivalent underlying length-weight relationship. Based on Froese (2006), the most popular index (relative weight, W_R) was use to compare the condition of these five threatened species in this study. In addition, the Fulton's condition was also applied because it is free from parameters *a* and *b* of the LWR. The K_F values among the species were significantly different in the present study. No references dealing with the condition factors are available in the literature (Hossain et al. 2009b; Hossain et al. 2010) on these fishes, preventing the comparison with previous results. However, the condition factor based on the LWR is an indicator of the changes in food reserves and the general fish condition. In general, the seasonal cycle in the condition of the fishes suggested a relationship with gonadal development. According to Hossain et al. (2006b), the condition factor of *Mystus vittatus* (Bloch 1794) (Siluriformes: Bagridae) was constant during the pre-spawning period, decreased in the period of spawning 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.

In addition, the values of W_R falling below 100 for an individual, size group, or population suggest problems such as low prey availability or high predator density; whereas values above 100 indicate a prey surplus or low predator density (Rypel & Richter 2008). Recently, a number studies have promoted the use of W_R for assisting in the management and conservation of nongame fishes, particularly those that are threatened or endangered (Muchlisin et al. 2010; Richter 2007). However, to the best our knowledge, the present paper conducts the first comprehensive description of W_R for the sub-tropical freshwater fishes of Bangladesh. The mean relative weight (W_R) value was close to 100 for each species in this study, indicating a balance habitat with food availability relative to the presence of predators (Anderson & Neumann 1996). In addition, it might suggest that the water quality of Jamuna River is still sufficient for these fisheries. However, Mijkherjee et al. (2002) reported that the populations have seriously declined due to over-exploitation and various ecological changes in the natural habitats. The results of this study provide the much needed information and are important to allow for urgent detection of any long-term declines in condition that may have occurred. Such changes may be attributed to environmental degradation because the relative condition integrates key physiological components of fish life history such as lipid storage and growth. Moreover, the relative weight is a strong, handy metric that managers can use to evaluate the overall health and fitness as well as population-level responses to ecosystem disturbance (Rypel & Richter 2008).

The application of the form factor $a_{3.0}$ can be used to verify whether the body shape of individuals in a given population or species is significantly different from others (Froese 2006). In this study, the estimated values of $a_{3.0}$ were as 0.01 suggesting that most of the species can be classified as relatively elongate which is characteristic of many riverine fishes. The $a_{3.0}$ of *M. cavasius* from three different habitats including Betwa River (0.0091), Cauvery River (0.0099) and Jamuna River (0.0084) were within the limits 0.00775-0.00906 reported by Froese (2006) and Treer et al (2009). No references dealing with the $a_{3.0}$ are available in the literature for other species, and therefore no comparison was conducted for previous references. Therefore, the present results provide an important basis for future comparisons.

Conclusion

This study provides an important baseline study on condition- and form-factors of five threatened fishes from Bangladesh. The results of the study would be an effective tool for fishery biologists, managers and conservationists to initiate early management strategies and regulations for the sustainable conservation of the remaining stocks of these endangered species in the Brahmaputra River ecosystem. Moreover, information on condition factors, and form factor for these five species are clearing lacking from literature and data bases including FishBase. Therefore, the results of this study provide invaluable information for the online FishBase database, as well as providing an important baseline for future studies within the Brahmaputra River and surrounding ecosystems such as the Ganges.

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