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Morpho-meristic characteristics and growth pattern of walking snakehead (*Channa orientalis*) collected from different locations of Northwestern Bangladesh

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Abstract. This study aimed to reveal the morphometric and meristic variations, length-weight relationships, and condition factor of *Channa orientalis* collected from three regions (Kurigram, Rangpur, and Lalmonirhat districts) of Northwestern Bangladesh. Fifteen morphometric and six meristic characteristics were selected. Eight morphometric characteristics were significantly different (p<.05) among the regions; three characteristics were highly significant (p<.001) in Kurigram (Pre-orbital distance, PrOD; Lower-jaw length, LJL; Upper-jaw length, UJL) indicating *C. orientalis* population of Kurigram was significantly different (p<.001) from the other two locations. On the other hand, among six meristic characteristics, number of dorsal fin rays (DFR), pectoral fin rays (PFR), anal fin rays (AFR), and branchiostegal rays (BR) were found to be significantly different among three locations. The values of PFR varied significantly (p<.05) in Kurigram, which distinguishes the other two regions. Likewise, DFR and BR showed significant variations in the Rangpur region, whereas AFR significantly (p<.001) separated the Lalmonirhat population from the others. In length-weight relationships, the generalized relationship between total length (TL) and body weight (BW) were $BW=0.007TL^{3.147}$ (r^2=0.945), $BW=0.03TL^{2.573}$ (r^2=0.916) and $BW=0.008TL^{3.084}$ (r^2=0.899) for Kurigram, Rangpur, and Lalmonirhat, respectively. The growth pattern showed positive allometric in Kurigram (b=3.14) and Lalmonirhat (b=3.08). Negative allometric was observed in Rangpur (b=2.57). The study exhibited a higher condition factor (K) value in Kurigram (1.068) and Rangpur (1.049) whereas the lowest in Lalmonirhat (0.978). The study reveals that the *C. orientalis* population`s morpho-meristic and growth status were comparatively better in Kurigram region.
Keywords: *Channa orientalis*, Morpho-meristic characteristics, Length-weight relationship

Introduction

The walking snakehead, *Channa orientalis* is a regionally adapted freshwater fish species that is a member of the family Channidae under the order of Channiformes (Rahman 1989). In Bangladesh, it is called as cheng or ghachua. In the Indian subcontinent and adjacent regions, including Afghanistan, Bangladesh, India, Myanmar, Nepal, Pakistan, and Sri Lanka, *C. orientalis* is very well-known. It is a carnivorous species and easily attracted by any moving bait (Rahman 1989). It is found in freshwater environment including rivers, lakes, ponds, mountain streams and even brackish water (Rainboth, 1996). This species is vulnerable through worldwide (IUCN 2019) and as of least concern in Bangladesh (IUCN 2015). Therefore, *Channa orientalis* is considered as threatened species due to their gradual population declination with loss of habitat (Ahmed *et al.* 2018).

Although, this fish has gained popularity among consumers in different areas in Bangladesh, it is neglected in research priority. Because of people choice, many farmers are interested in

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culture of this species in ponds. But, due to lack of proper induced breeding technique, seeds are not produced yet, thus, the production of this fish is still depending on the capture from wild. The increasing demand of *C. orientalis* has led over exploitation from natural water-bodies which are ultimately altering their morphological, physiological and growth status. There are several researches have been carried out regarding *Channa* in Bangladesh and around the world. But, no noteworthy previous research regarding taxonomic characteristics, length-weight relationships and condition factor of *Channa* is found in Bangladesh. Details and perfect information on morphometric and meristic characters of *C. orientalis* is essentially needed for the proper management of this species. Therefore, this study is intended to focus on detailed morphometric and meristic features, length-weight relationships, and condition factor to gather more information about *Channa orientalis* collected from three different geographical locations of northwestern part of Bangladesh.

Materials and Methods

Sample collection and preservation: In the study, total 90 samples were collected from three different geographical locations of northwestern part of Bangladesh. The selected locations were Kurigram (Rajarhat upazilla), Rangpur (Kaunia upazilla), and Lalmonirhat (Sadar upazilla). From each location, 30 specimens were collected from fishermen and adjacent freshwater sources for data collection. The research work was conducted for a period of one year between July 2019 and June 2020. The collected fish samples were taken alive to the laboratory of department of Aquaculture, faculty of fisheries, HSTU, Dinajpur, and labeled with the date, and finally preserved in refrigerator for further study.

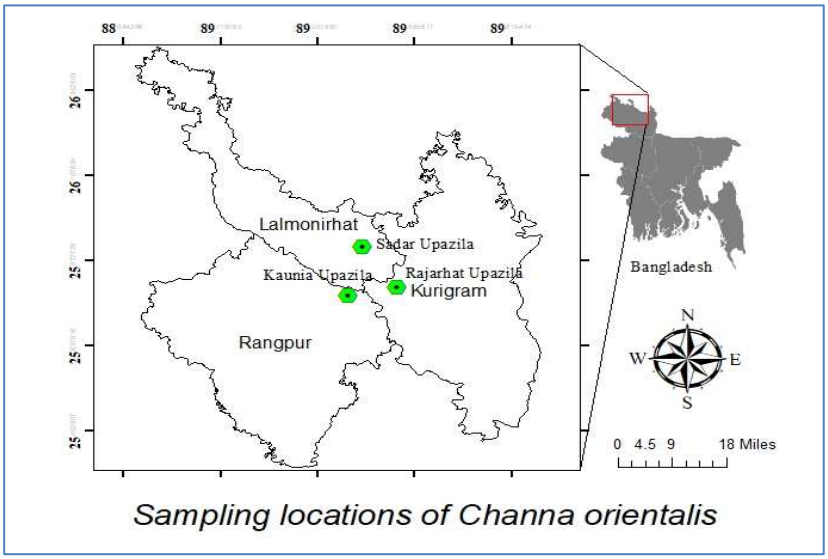

Fig. 1. Map of Bangladesh, showing different sampling locations of *C. orientalis*.

Measurement of morphometric characteristics: The frozen fish samples were kept in a metallic plate and subsequently placed into water for about 10 minutes in order to defrost. The excessive water from body surface of each fish was blotched using tissue paper. The sample was kept in room temperature to facilitate weighing and to get rid of biasness. The representative

characteristics (cm) and weight (g) were estimated using centimeter scale, and an electronic balance. Finally, all the data were recorded and inputted in Microsoft Excel spreadsheet. The estimated morphometric parameters and their abbreviations were given in Fig. 2 and Table I.

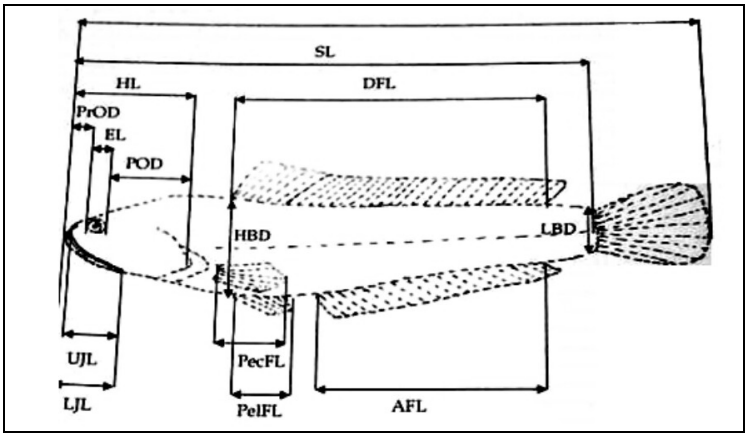

Fig. 2. Schematic representation of the morphometric measurements of *C. orientalis.*

Table 1. Studied morphometric parameters with abbreviations

Parameters	Abbreviations	Parameters	Abbreviations
Body Weight	BW	Pre-orbital distance	PrOD
Total Length	TL	Post-orbital distance	POD
Standard length	SL	Dorsal fin length	DFL
Head length	HL	Pectoral fin length	PcFL
Eye length	EL	Anal fin length	AFL
Highest body depth	HBD	Pelvic fin length	PlFL
Lowest body depth	LBD	Lower-jaw length	LJL
Upper-jaw length	UJL		

Measurement of meristic characteristics*:* Six meristic characteristics were studied by following Hubbs and Lagler (1958) method with some modifications. The studied meristic characteristics and their description are given below in Table II.

Table II. Studied meristic parameters with abbreviations

Parameters	Abbreviations	Parameters	Abbreviations
Dorsal fin rays	DFR	Anal fin rays	AFR
Pectoral fin rays	PFR	Caudal fin rays	CFR
Pelvic fin rays	PVR	Branchiostegal rays	BR

Measurement of length and weight: The fish samples were put in a metallic plate for measuring total length (TL) and body weight (BW) by using centimeter scale (cm) and an electronic balance (g), respectively.

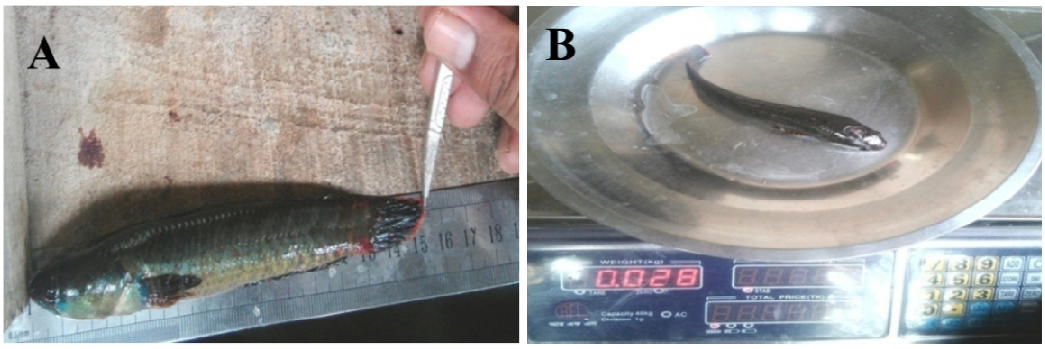

Fig. 3. Measurement of length and weight. (A) Total length and (B) Body weight measurement of *C. orientalis* by using centimeter scale (cm) and electronic balance (g), respectively.

Length-weight relationship: The relationship between total length (TL) and body weight (BW) were determined utilizing the formula given by Ricker (1975):

$BW=aTL^b$

Where, BW=body weight (g), TL=total length (cm), a=intercept or the initial growth coefficient, b=slope or the growth coefficient. Parameters a and b of the length-weight relationships were assessed by liner regression analysis based on natural logarithms given by Le Cren (1951):

$\ln BW = \ln a + b \ln TL$

The level of linear relationship between factors, the correlation coefficient, r was evaluated by:

$r = [n\Sigma XY - \Sigma X\Sigma Y]/\sqrt{([n\Sigma X^2 - (\Sigma X)^2][n\Sigma Y^2 - (\Sigma Y)^2])}$

Statistical analysis: Statistical analyses for targeted parameters were performed using SPSS, version 22.0 and Microsoft Excel 2010. Besides, one-way analysis of variance (ANOVA) was tested to know morphological variation ($p<0.05$). Confidence interval (CI) at 95% significance level was determined for the regression parameter a and b. Correlation coefficient (r), degree of coefficient (r^2) and condition factor (K) values were also calculated.

Results and Discussion

Morphometric variations: Fifteen morphometric characteristics were recorded from the samples collected from three regions (Table I and III). Among fifteen morphometric characteristics, eight features (BW, HL, EL, HBD, LBD, PrOD, LJL and UJL) were found significantly different and seven characters (TL, SL, POD, DFL, PcFL, AFL and PlFL) were found non-significant. The present study showed highly significant differences between populations by means of pre-orbital distance, lower jaw length and upper jaw length (PrOD= 0.59±0.022, $p<0.001$; LJL= 1.26±0.04, $p<0.001$; UJL= 1.2±0.038, $p<0.001$), accordingly. For Kurigram, all the fifteen morphometric characteristics showed the highest average values. On the other hand, five morphometric characteristics (BW, HBD, PrOD, PcFL, and PlFL) showed the lowest average values (19.233,

1.827, 0.51, 1.947, and 0.843, respectively) in Lalmonirhat, in which three characteristics (BW, HBD, and PrOD) have significant variations. In Rangpur, ten characteristics (TL, SL, HL, EL, LBD, POD, DFL, AFL, LJL and UJL) showed the lowest average values (12.227, 10.23, 3.01, 0.55, 1.097, 1.947, 7.15, 4.563, 0.987, and 0.897, respectively) than other two regions, in which five characteristics (HL, EL, LBD, LJL, and UJL) were significantly different. In the present study, total length (TL) of *C. orientalis* population in Kurigram was greater (12.943±0.373cm) than that of other populations. Among all variations, three variations i.e., pre-orbital distance, lower jaw length and upper jaw length (PrOD=0.59±0.022, $p<0.001$; LJL=1.26±0.04, $p<0.001$; UJL=1.2±0.038, $p<0.001$) were highly significant and showed greater value in Kurigram than that of other two regions. These variations among populations from three different locations are agreeable with that of Rahman (2005), who reported that the average values of each character varied considerably by population, representing its unique characteristics. Furthermore, the variation in morphometric characteristics is likely due to age, size, nutrition, habitat condition, pollution and geographical distance among locations etc.

Table III. Average values of morphometric characteristics recorded from *C. orientalis* of three wild populations (n=30 for each population)

Sl.	Parame-ters	Lalmonirhat	Rangpur	Kurigram	Average	p value
		Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	
1	BW	19.233±1.295^{a}	19.733±1.259^{a}	25.167±2.348^{b}	21.378±1.899	0.029*
2	TL	12.373±0.249	12.227±0.294	12.943±0.373	12.514±0.219	0.230
3	SL	10.38±0.226	10.23±0.254	10.797±0.338	10.469±0.17	0.329
4	HL	3.05±0.063^{a}	3.01±0.08^{a}	3.293±0.098^{b}	3.118±0.089	0.034*
5	EL	0.56±0.01^{a}	0.55±0.013^{a}	0.607±0.012^{b}	0.556±0.031	0.002**
6	HBD	1.827±0.051^{a}	1.897±0.05^{ab}	2.08±0.08^{b}	1.935±0.076	0.014*
7	LBD	1.12±0.0264^{a}	1.097±0.029^{a}	1.25±0.048^{b}	1.156±0.048	0.006**
8	PrOD	0.51±0.013^{a}	0.52±0.012^{a}	0.59±0.022^{b}	0.54±0.026	0.001***
9	POD	1.983±0.048	1.947±0.063	2.103±0.073	2.011±0.047	0.181
10	DFL	7.263±0.163	7.15±0.167	7.583±0.221	7.332±0.13	0.236
11	PcFL	1.947±0.039	1.953±0.05	2.063±0.056	1.995±0.035	0.170
12	AFL	4.797±0.105	4.563±0.126	4.87±0.155	4.743±0.093	0.226
13	PlFL	0.843±0.019	0.853±0.024	0.873±0.021	0.857±0.01	0.600
14	LJL	1.03±0.028^{a}	0.987±0.034^{a}	1.257±0.04^{b}	1.091±0.023	0.000***
15	UJL	0.933±0.027^{ab}	0.897±0.032^{a}	1.2±0.038^{b}	1.01±0.096	0.000***

Values in each row with different superscripts (a and b) differs significantly. *$p<0.05$, **$p<0.01$, ***$p<0.001$; SD=standard deviation.

Meristic variations*:* Six meristic characteristics recorded from the samples are shown in Table II and IV. In the present study, among the six meristic characteristics of *C. orientalis* population of Rangpur, Kurigram and Lalmonirhat, four characteristics (DFR, PFR, AFR, and BR) were found significantly different and two characteristics (PVR and CFR) were found non-significant. In Kurigram, PFR showed the highest significant variation (13.267±0.135, $p<0.05$) than other two locations, where, DFR and BR differentiate Rangpur population significantly (34.23±0.124, $p<0.001$ and 4.23±0.079, $p<0.01$) from others, and the Lalmonirhat population was significantly separated by means of number of anal fin rays (22.33±0.130, $p<0.001$). Four meristic characteristics (DFR, PVR, AFR, and CFR) showed the highest average values (34.97±0.122, 5.367±0.09, 23.067±0.107, and 12.267±0.082, respectively) in Kurigram region. On the other hand, BR showed the highest average value (4.63±0.089) in Lalmonirhat and PFR of Rangpur population was significantly higher (13.7±0.119) than those of other populations. In the present

study, the average values of all six meristic characteristics (DFR, PFR, PVR, AFR, CFR and BR) of all fish samples (collected from three different locations) were 34.711±0.239, 13.545±0.139, 5.267±0.069, 22.444±0.082, 12.178±0.040 and 4.478±0.124, respectively.

Based on above mentioned significantly varied morphometric and meristic characteristics, it is evident that the population of *C. orientalis* in Kurigram shows slight taxonomic differences than that of other regions. Several researchers around the world mentioned differences in taxonomic characteristics to distinguish fish population among different regions (Bhuiyan 1964, Kurata 1975, Schreck and Moyle 1990, Talwar and Jhingran 1991, IUCN 2000, Shafi and Quddus 2001, Rahman 1989 & 2005).

Table IV. Average values of eight meristic characteristics as recorded from *C. orientalis* of three wild populations (n=30 for each population)

Sl. No.	Parameters	Lalmonirhat	Rangpur	Kurigram	Average	p value
		Mean±SD	Mean±SD	Mean±SD	Mean±SD	
1	DFR	34.933±0.159^{a}	34.23±0.124^{b}	34.97±0.122^{a}	34.711±0.239	0.000***
2	PFR	13.67±0.088^{a}	13.7±0.119^{a}	13.267±0.135^{b}	13.545±0.139	0.016**
3	PVR	5.3±0.085	5.13±0.063	5.367±0.09	5.267±0.069	0.111
4	AFR	22.33±0.13^{b}	21.9±0.1^{a}	23.067±0.107^{c}	22.444±0.082	0.000***
5	CFR	12.2±0.074	12.1±0.056	12.267±0.082	12.178±0.040	0.259
6	BR	4.63±0.09^{a}	4.23±0.079^{b}	4.567±0.092^{a}	4.478±0.124	0.003**

Values in each row with different superscripts (a, b and c) differ significantly. *p<0.05, **p<0.01, ***p<0.001; SD=standard deviation.

Length-weight relationship*:* The total length and body weight of *C. orientalis* collected from Lalmonirhat ranged from 10.00 to 15.00 cm and 9.00 to 35.00 g, respectively. The total length varied between 8.80 to 15.60 cm and body weight were 7.00 to 37.00 g for Rangpur. The total length and body weight of fish from Kurigram were 9.90 to 16.40 cm and 9.00 to 53.00 g, respectively (Table V).

Table V. The recorded size ranges of *C. orientalis* collected from three different locations

SL No.	Location	Size Range of the fishes		Mean ±SD	
		Length (cm)	Weight (gm)	Length (cm)	Weight (gm)
1	Lalmonirhat	10.00-15.00	9.00-35.00	12.373±0.250	19.233±1.295
2	Rangpur	8.80-15.60	7.00-37.00	12.227±0.294	19.733±1.259
3	Kurigram	9.90-16.40	9.00-53.00	12.943±0.373	25.167±2.348

The generalized relationships of total length (TL) and body weight (BW) of *C. orientalis* were $BW=0.0073TL^{3.147}$, $BW=0.0303TL^{2.573}$, and $BW=0.007845TL^{3.084}$, and the values of 0.007, 0.03 and 0.008 were in Kurigram, Rangpur and Lalmonirhat, respectively. The b values were varied among populations with a range of 2.573 to 3.147 (Table 6). The lowest value of b was found in Rangpur (2.573) and the highest value was in Kurigram (3.147). The coefficient of determination (r^2) was obtained, ranges from 0.899 to 0.945. The lowest value of r^2 was found in Lalmonirhat (r^2=0.899) and highest value was in Kurigram (r^2=0.945) (Table VI and Fig. 4).

Table VI. Linear equation and power curve equations between Total length (TL) & Body weight (BW)

Location	Linear equation	Power Curve	Intercept, a	Slope, b	(r^2)
Lalmonirhat	lnBW=-4.84+3.084lnTL	$BW=0.008TL^{3.084}$	0.008	3.084	0.899
Rangpur	lnBW=-3.49+2.573lnTL	$BW=0.030TL^{2.573}$	0.030	2.573	0.916
Kurigram	lnBW=-4.92+3.147lnTL	$BW=0.007TL^{3.147}$	0.007	3.147	0.945

The length-weight relationship (LWR) is a helpful parameter for proper exploitation and management of the population of fish species. Moreover, length-weight relationship provides information on the condition and growth patterns of fish. According to Morey *et al.* (2003) this relationship has a number of necessary applications in fish stock assessment. Soomro *et al.* (2007) described that the generalized relationships of total length and body weight for male and female and combined fishes were $BW=0.0039TL^{3.159}$, $BW=0.0072TL^{2.958}$ and $W=0.0054TL^{3.05}$, whereas, Ara (2016) showed the generalized relationships of total length and body weight of *B. bendelisis, B. barna* and *B. telio* were $BW= 0.020TL^{2.778}$, $BW=0.017TL^{2.768}$, and $BW=0.026TL^{2.5884}$, respectively.

The degree of coefficient, r^2 expresses the level of correlation between length-weight relationships. In the present study, the relatively higher r^2 values were found in case of all three regression analyses. Here, the values of r^2 were found 0.899 for the Lalmonirhat, 0.916 for the Rangpur, and 0.945 for the Kurigram. These values are very close to 1, and indicated that a strong positive linear relationship exists in between total length and body weight that means most of the changes in body weight (BW) is accounted for the change in total length (TL). Similar study was carried out by Subba *et al.* (2009), observed that the length-length relationships in *Gudusia godanahiae* were highly correlated and significant (r^2=0.924).

Table VII. Parameters of the length-weight relationships of *C. orientalis* and their growth inference

Location	Slope(b)	95%CI of b	Growth inference	Condition factor (K)
Lalmonirhat	3.08	2.68-3.48	Positive allometric	0.977
Rangpur	2.57	2.27-2.87	Negative allometric	1.050
Kurigram	3.14	2.85-3.44	Positive allometric	1.068

In the length-weight relationship of *C. orientalis* species among three distinct populations, the regression co-efficient b was 3.084, 2.573, and 3.147 in Lalmonirhat, Rangpur, and Kurigram, respectively. According to Martin (1949), the growth of an organism is ideal if the value of slope b at 95% confidence interval is in between 2.5 to 4.0. Tesch (1968) added that this value might be in between 2.0 and 4.0. In addition, the growth of a population is said to be isometric i.e. length increments in equivalent extent with body weight, the slope value is 3. When the b value is greater than 3 (b>3), it indicates the growth has positive allometry, but, when b<3, the growth shows negative allometry (Reynold 1968). In this study, at 95% confidence interval of b value for Lalmonirhat was ranged from 2.68 to 3.48, for Rangpur 2.27 to 2.87, and for Kurigram 2.85 to 3.44 (Table VII). The slope, b values revealed that the growth of *C. orientalis* population was positive allometric in Lalmonirhat and Kurigram, that means the weight of that species increases at a higher rate than its length and negative allometric was observed in Rangpur, that means the growth of its length increases much higher than its weight. In comparison, according to b values, relatively higher weight was obtained at the same length of *C. orientalis* in Kurigram than that of other two locations and relatively poorer weight was found in Rangpur population. The result of this study is comparable with the observation of Gupta *et al.* (2011), where values of b ranged

from 2.81 to 3.32 for an endangered fish *Ompok pabda*. However, the variation observed in b values might be resulted from some biological and environmental aspects like size, age, feed availability, feeding behavior, metabolic rate, habitat condition, water quality parameters etc (Thirunavukkarasu and Shanmugam 2011).

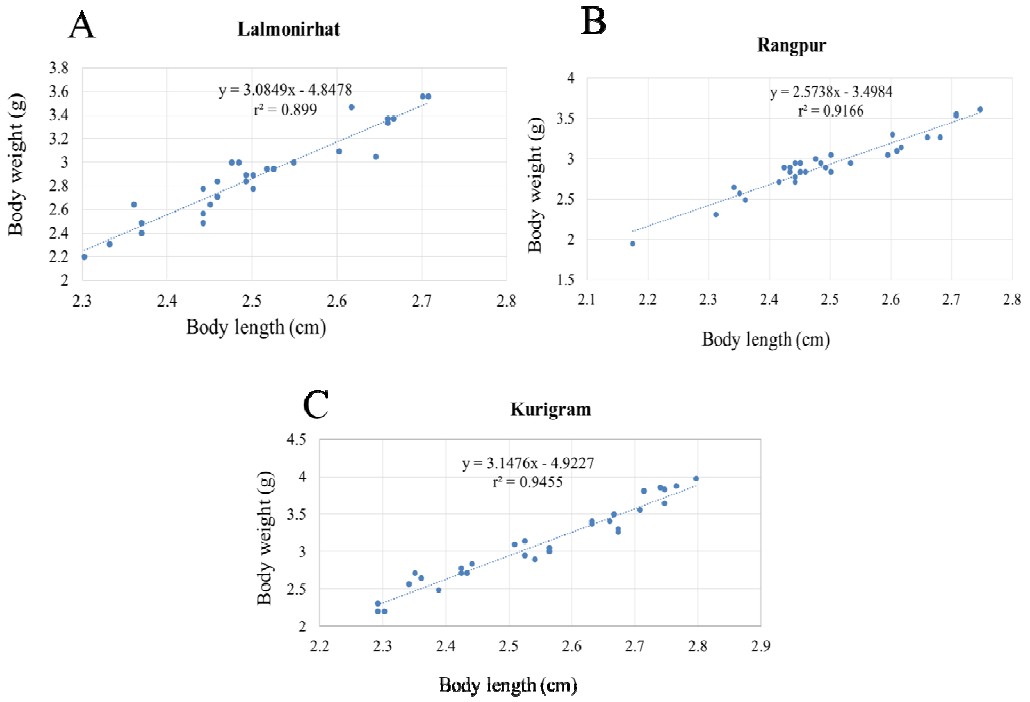

Fig. 4. Linear relationships (length-weight) of *C. orientalis* of (A) Lalmonirhat, (B) Rangpur and (C) Kurigram regions.

Condition factor (K) of *C. orientalis*: The condition factor (K) is determined with the aim of describing the condition of a specific fish from the relationship drawn between weight of the fish and length (Froese 2006). In the present study, *C. orientalis* exhibited a higher K value in Kurigram (1.068) and Rangpur (1.049) with a lower K value in Lalmonirhat (0.977) region. According to Froese (2006), condition factor (K) is a declaration of particularly relative fatness of fish as well as bigger estimation of K shows the better growth status of fish. The K values observed in this study implied that *C. orientalis* exhibited better growth condition in Kurigram than that of Rangpur and Lalmonirhat whereas, the growth condition of *C. orientalis* in Lalmonirhat region was comparatively poorer. According to Mookerjee and Mazumder (1946), the offspring's grow much faster in early developing stages in natural habitat which may be one of the causes of growth variation in the Kurigram population. However, condition factor (K) might vary depending upon some other factors such as life cycle, length, age, sexes, food availability etc.

The significantly varied taxonomic characteristics showed the population of *C. orientalis* in Kurigram as slightly different. In length-weight relationship, relatively higher r^2 values were found indicating a strong positive linear relationship existed in between total length (TL) and body weight (BW) for all three populations. The results in this study exhibited better growth condition

in Kurigram than that of fishes of Rangpur and Lalmonirhat whereas the growth condition of *C. orientalis* in Lalmonirhat region was comparatively poorer. The current study provides basic information on the morphometric and meristic variation and differentiation of *C. orientalis* populations of three distinct geographic locations in Northwestern Bangladesh and it suggests that morphological variations seen in this species should be taken into account in fisheries management and commercial exploitation of this species.

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