MORPHOMETRIC RELATIONSHIPS AND CONDITION FACTORS OF TWO FRESHWATER BARBS, *PUNTIUS SOPHORE* AND *PUNTIUS TICTO* FROM THE PADMA RIVER OF BANGLADESH

[1]**Saad Ahmad., **[2]**M. Afzal Hussain and **[2]**M. Manjurul Alam**[*]

[1]Fellow, Department of Fisheries, University of Rajshahi, Rajshahi-6205, Bangladesh.
[2]Department of Fisheries, University of Rajshahi, Rajshahi-6205, Bangladesh.
*(Corresponding Author, Dr. M. Manjurul Alam, E-mail: mamillat@yahoo.com)

ABSTRACT

The present study carried out the length-length, length-weight relationships and condition factors of two freshwater barbs *Puntius sophore* and *Puntius ticto* from Padma river of Bangladesh. The length-length relationships with total length among different body lengths for *P. sophore* and *P. ticto* were found highly significant with all "r" values ranged from 0.888 to 0.997 for *P. sophore* and 0.897 to 0.996 for *P. ticto*. The interrelationships among the length parameters were also found highly significant with all "r" values being >0.872 both for *P. sophore* and *P. ticto*. The length-weight relationship equations were obtained as $TW=0.00831TL^{3.015}$ for *P. sophore* and $TW=0.00647TL^{3.021}$ for *P. ticto* and found highly significant. The observed (K_o), calculated (K_c) and relative (K_n) condition factors showed little variation for both the species and maintained fairly same patterns among them. Findings of the present work would be helpful for fishery managers as well as the sustainable management of freshwater barbs of Bangladesh as well as other countries of the world.

KEY WORDS: Bangladesh, Barb, Condition factor, Morphometry, *Puntius*,

INTRODUCTION

There are 260 freshwater fish species in Bangladesh of which SIS (small indigenous fish) are playing a vital role in the economy and nutrition of the nation (DoF, 2012). *Puntius sophore* and *Puntius ticto* commonly known as barbs, belongs to the family Cyprinidae, are two small indigenous freshwater fish species (SIS) of Bangladesh Rahman (2005). These species were once abundant in river, streams, canal, beels and ponds. But at present these are endangered and *P. ticto* is identified as vulnerable (IUCN Bangladesh, 2000). Morphometric studies are essential to determine the growth form and growth rate of a species, which is very much important for proper exploitation and management of the population of a species. To obtain the length-weight relationship and condition factor it is also very much important for stabilizing the taxonomic characters of the species. Knowledge of the length-weight relationship of a fish is essential to stock assessment modeling and when evaluating the relative condition of fish among populations (Lai and Helser, 2004). Further length-weight relationships are useful in fishery management for both applied and basic use (Pitcher and Hart, 1982; Hossain *et al*., 2006). Condition factor is a quantitative parameter of the state of well-being of the fish that will determine present and future population success by its influence on growth, reproduction and survival (Hossain *et al*., 2006). To eliminate the effects of the length and correlated factors (LeCern, 1951; Doha and Dewan, 1967; Hoque and Hossain, 1992) the relative condition factor 'K_n' was calculated. The results of the study will play a vital role for the proper management and conservation of these species. The results will also help in further studies on the population assessment of these species in the Padma River and surrounding ecosystems of Bangladesh.

MATERIALS AND METHODS

A total of 800 specimens of *P. sophore* and 600 specimens of *P. ticto* were collected from January, 2011 to December, 2011. During the period all the specimens were collected from different fishing areas of Padma River and surrounding water bodies of Rajshahi. After collection of all specimens were washed well, confirmed to the species level and then preserved in 10% formalin. Different lengths *viz.* total length (TL), fork length (FL), standard length (SL), head length (HL), pectoral length (PL), pelvic length (PvL), anus length (AnL) and anal length (AL) of the fishes were measured to the nearest 0.01 cm using digital slide calipers, and total weight (TW) was taken on a digital balance with 0.01 g accuracy. The length-length relationships total length among different body lengths were determined by the method of least squares to fit a simple linear regression equation as:

$$Y = a + bX$$

Where
Y = various body lengths
X = total length
a = Proportionality constant and b = Regression coefficient

For studying the length-weight relationship the following exponential equation (LeCren, 1951) was used.

$TW = aTL^b$

Where, 'TW' is the total weight (expressed in g); 'TL' is the total length (expressed in cm); 'a' is a coefficient related to body form and 'b' is an exponent indicating isometric growth when equal to 3 and indicating allometric growth when significantly different from 3.

The parameters 'a' and 'b' of the exponential curve were estimated by linear regression analysis over log-transformed data expressed as:

log TW = log a + b log TL

The values of the constant 'a' and 'b' of the linear regression was determined by the following equations (Rounsefell and Everhart, 1953; Lagler, 1966):

$$\log a = \frac{\sum \log TW \times \sum \log TL - \sum \log TL \times \sum(\log TL \times \log TW)}{N \times \sum \log TL^2 - (\sum \log TL)^2} \text{ and,}$$

$$b = \frac{\sum \log TW - N \times \log a}{\sum \log TL}$$

Where, 'N' indicates the number of specimens.

For finding out the condition factor the formula for observed value (K_o) and (K_c) for calculated value is, $TW = KTL^3$,

which can be written as, $K_o = \dfrac{TW}{TL^3}$

Relative condition factor was determined by using the formula

$$K_n = \frac{TW}{aL^n}, \text{ Or, } K_n = \frac{TW}{\overline{TW}}$$

Where, TW = Observed total weight, $\overline{TW}$ = Calculated total weight

All sorts of statistical analysis were calculated by using the computer software SPSS Version 11.5.

RESULTS AND DISCUSSION

Length-length relationships: The regression equation of length-length relationships are established for *P. sophore* and *P. ticto* and presented in the Table 1.

Table 1: Length-length relationships with total length among different body lengths of *P. sophore* and *P. ticto*

Name of Species	Relationship Parameters	Mean ± SE (mm)	Regression equation	Coefficient of Correlation 'r'
P. sophore TL±SE = 65.35±0.39 mm N = 800	FL	57.58±0.34	Y = 0.8576x + 1.5369	**0.997**
	SL	50.74±0.30	Y = 0.7701x + 0.4436	**0.997**
	HL	14.63±0.10	Y = 0.178x + 2.8959	**0.888**
	PL	15.74±1.51	Y = 0.208x + 0.6486	**0.912**
	PvL	24.83±0.16	Y = 0.3914x - 0.7459	**0.976**
	AnL	36.69±0.23	Y = 0.5767x - 0.9994	**0.985**
	AL	34.72±0.23	Y = 0.5667x - 2.3118	**0.971**
P. ticto TL±SE = 93.41±0.42 mm N = 600	FL	81.64±2.19	Y = 1.4759x - 56.293	**0.996**
	SL	71.38±1.90	Y = 1.0176x - 23.607	**0.991**
	HL	21.65±0.46	Y = 0.5456x - 29.386	**0.897**
	PL	20.24±0.33	Y = 0.2282x - 1.0538	**0.902**
	PvL	34.61±1.28	Y = 0.7158x - 32.158	**0.921**
	AnL	41.47±11.45	Y = 0.1546x + 26.756	**0.963**
	AL	39.40±10.65	Y = 0.279x + 13.149	**0.954**

** Correlation is significant at the 0.01 level.

The result revealed the symmetrical growth in relation to different body lengths *i.e.* the relationships with TL among FL, SL, HL, PL, PvL, AnL and AL. It is observed that the equations are highly significant with all 'r' values being >0.888 for *P. sophore* and >0.897 for *P. ticto*. The interrelationships among aforementioned length parameters were also found highly significant (P<0.01) with all 'r' values being >0.872 (Table 2). The values of the equations clearly revealed that the lengths of the body parts are proportional to the total length which agreed with Tandon *et al.* (1993). The findings of the length-length relationship analysis of both species are similar to the findings of Bhuiyan and Biswas (1982), Hoque and Hossain (1992), Sinovćić *et al.* (2004), Hossain *et al.* (2006), Dadzie *et al.* (2008) and Dars *et al.* (2012).

Table 2: Correlation matrix (values of r) of different body lengths of *P. sophore* and *P. ticto*

Name of Species	Length parameters	TL	FL	SL	HL	PL	PvL	AnL	AL
P. sophore	TL	1.000							
	FL	0.997	1.000						
	SL	0.997	0.996	1.000					
	HL	0.888	0.875	0.892	1.000				
	PL	0.912	0.908	0.910	0.872	1.000			
	PvL	0.976	0.971	0.972	0.900	0.935	1.000		
	AnL	0.985	0.981	0.982	0.896	0.922	0.978	1.000	
	AL	0.971	0.966	0.968	0.890	0.909	0.963	0.985	**1.000**
P. ticto	TL	1.000							
	FL	0.996	1.000						
	SL	0.991	0.992	1.000					
	HL	0.897	0.892	0.872	1.000				
	PL	0.902	0.901	0.913	0.884	1.000			
	PvL	0.921	0.934	0.918	0.906	0.941	1.000		
	AnL	0.963	0.967	0.948	0.898	0.913	0.982	1.000	
	AL	**0.954**	**0.949**	**0.937**	**0.901**	**0.905**	**0.951**	**0.931**	**1.000**

** Correlation is significant at the 0.01 level.

Length-weight relationships: The relationship between length and weight is influenced by a number of factors. Length-weight data of each species was considered to establish the length-weight relationship. The characteristics of total length and weight, parameters 'a' and 'b' of the relationship, 95% confidence limit of 'b', correlation of coefficient (r) and growth types are presented in Table 3.

Table 3. Descriptive statistics and changes in parameters of the LWR for *P. sophore* and *P. ticto* based on TW =aTL^b

Name of Species	Total Length Characteristics		Total Weight Characteristics		Parameters of the Relationship				Growth Type
	Range (mm)	Mean±SE (mm)	Range (g)	Mean±SE (g)	a	b	bCL$_{95\%}$	r	
P. sophore	37.16-89.22	60.07±0.43	0.64-9.58	2.99±0.06	0.00831	3.015	2.95-3.19	0.981	**A$^+$**
P. ticto	49.50-96.20	91.12±0.48	0.95-8.95	7.65±0.12	0.00647	3.021	2.99-3.11	0.989	**A$^+$**

Note: a, proportionality constant; b, slope of the relationship; CL, confidence limits; r, correlation of co-efficient; A$^+$, positive allometric growth.

The result indicated positive allometric growth for both the species (TW=0.00831TL$^{3.015}$ for *P. sophore*) and (TW=0.00647TL$^{3.021}$ for *P. ticto*) that adequately adjusted to the exponential equation. Bhuiyan and Biswas (1982), Johal *et al*. (1989), Hoque and Hossain (1992), Moutopoulos and Stergiou (2002), Kiran *et al*. (2004), Oscoz *et al*. (2005), Cicek *et al.* (2006), Esmaeili and Ebrahimi (2006), Froese (2006), Tarkan *et al.* (2006), Aguirre *et al.* (2008), Arshad *et al*. (2008) and Ferreira *et al*. (2008) observed that the value of exponent 'b' usually lies between 2 and 4 and an ideal fish maintain the shape b=3. The value of 'b' will be exactly 3.0 when the growth is isometric (Allen, 1938; Ricker, 1963). The seasonal and sex dependent 'b' values of the present analysis were found in between 2.960-3.297 and 3.008-3.052 respectively that very close to exact value 3. Therefore, the fishes do follow the cube law. The reason behind may be the observed specimen were the inhabitants of quite good environment and gravid females were more in the samples (LeCren, 1951).

Condition factors: The mean values of K_o, K_c and K_n were obtained as 1.54, 1.58 and 0.97 respectively for *P. sophore*; and 1.05, 1.11 and 0.94 for *P. ticto*. In the present study the observed (K_o), calculated (K_c) and relative (K_n) condition factors showed little variation for both the species and maintained fairly same patterns among them (Table 4).

Table 4. The mean values of observed (K_0), calculated (K_c) and relative (K_n) condition factors of *P. sophore* and *P. ticto*

Species	Total length mean±SE (mm)	Total weight mean±SE (g)	Mean K_0	Mean K_c	Mean K_n
P. sophore	65.35±0.39	4.29±0.02	1.54±0.06	1.58±0.20	0.97±0.11
P. ticto	93.41±0.42	8.55±0.30	1.05±0.10	1.11±0.25	0.94±0.10

Similar result is also observed by Bhuiyan and Biswas (1982) in *Puntius chola*, Afroze *et al*. (1992) in *Amblypharyngodon mola,* Hoque and Hossain (1992) in *Mystus vittaus,* Alam *et al*. (1994) in *Ailia coila,* Mortuza and Mokarrama (2000) in *Botia lohachata*, Šantić *et al.* (2006) in *Trachurus mediterraneus* and Dadzie *et al.* (2008) in *Parastromateus niger.* Niimi and Morgan (1980) suggested that the variation in the morphometric characters among the same species may occur due to ecological factors. So, from the above morphometric studies more reliable characters have been come out to know the growth pattern of the specimens. The study presented the basic information on length-length relationships, length-weight relationships and condition factors of two freshwater barbs which would be useful for fishery managers as well as the sustainable management. Findings of the present work will help in further research of the other freshwater barbs of Bangladesh as well as other countries of the world.

REFERENCES
Afroze S., Hossain M.A. and Parween S. (1992). Notes on the size frequency distribution and length-weight relationship of freshwater fish *Amblypharyngodon mola* (Hamilton) (Cypriniformes: Cyprinidae). *Univ. J. Zool. Rajshahi Univ*.10 & 11: 103-104.
Aguirre H., Amezcua F., Madria-Vera J. and Soto C. (2008). Length-weight relationship for 21 fish species from a coastal lagoon in the southwestern Gulf of California. *J. Appl. Ichthyol*. 24: 91-92.
Alam M.R., Mortuza M.G. Islam M.S. and Hossain M.A. (1994). Notes on the size frequency distribution and length-weight relationship of the freshwater fish *Ailiacoilia* (Hamilton-Buchanan) (Siluriformes:Schibeidea). *Univ. J. Zool. Rajshahi Univ*. 13: 69-70.
Allen K.R. (1938). Some observations on the biology of the trout (*Salmotruatta*) in Windermere. *J. Anim. Ecol*. 7: 333-349.
Arshad A., Jimmy A., Amin S.M.N., Siddik B.J. and Harah Z.M. (2008). Length-weight and length-length relationships of five fish species collected from sea grass beds of the Sungai Pulai estuary, Peninsular Malaysia. *J. Appl. Ichthyol*. 24: 328-329.
Bhuiyan A.S. and Biswas B. (1982). Studies on the morphometry of *Puntius chola* (Hamilton-Buchanan) (Cyprinidae: Cypriniformes).*Univ. J. Zool. Rajshahi Univ*. 1:29-34.
Cicek E., Avsar D., Yeldan H. and Ozutok M. (2006). Length-weight relationships for 31 teleost fishes caught by bottom trawl net in the Babadillimani Bight (Northeastern Mediterranean). *J. Appl. Ichthyol*. 22: 290-292.

Dadzie S., Abou-Seedo F. and Manyala J.O. (2008). Length–length relationship, length–weight relationship, gonadosomatic index, condition factor, size at maturity and fecundity of *Parastromateus niger* (Carangidae) in Kuwaiti waters. *J. Appl. Ichthyol.* 24: 334-336.

Dars B.A., Narejo N.T. and Awan K.R. (2012). Morphometric, meristic characters and their relationship in *Channa punctatus* (Bloch) from River Indus near Jamshoro Sindh, Pakistan. *Sindh Univ. Res. Jour. (Sci. Ser.).* 44(1): 91-96.

DoF. (2012). Sharonika, JatioMatshya Saptaho-2012 (in Bengali), Department of Fisheries, Ministry of Fisheries and Livestock, Government of People Republic of Bangladesh, 144 pp.

Doha S. and Dewan S. (1967). Studies on the Biology of *Tilapia*, Length weight relationship and condition factors. *Pak. J. Sci.* 19: 14-23.

Esmaeili H.R. and Ebrahimi M. (2006). Length-weight relationships of some freshwater fishes of Iran. *J. Appl. Ichthyol*. 22: 326-329.

Ferreira S., Sousa R., Delgado J., Carvalho D. and Chada T. (2008). Weight-length relationships for demersal fish species caught of the Madeira archipelago (Eastern-central Atlantic). *J. Appl. Ichthyol*. 24: 93-95.

Froese R. (2006). Cube law, condition factor and weight length relationship: history, meta-analysis and recommendations. *J. Appl. Ichthyol*. 22: 241-253.

Hoque M.A. and Hossain M.A. (1992). Length-weight relationship and condition factor of the cat fish *Mystus vittatus* (Bloch) (Cypriniformes: Bagridae). *Univ. j. zool. Rajshahi Univ.* 11: 113-114.

Hossain M.Y., Ahmed Z.F., Leunda P.M., Islam A.K.M.R., Jasmine S., Oscoz J., Miranda R. and Ohtomi J. (2006). Length-weight and length-length relationships of some small indigenous fish species from the Mathabhanga River, Southwestern Bangladesh. *J. Appl. Ichthyol.* 22: 301-303.

IUCN Bangladesh. (2000). Red Book of Threatened Fishes of Bangladesh. IUCN-The World Conservation Union, xii+116 pp.

Johal M.S., Chahal J.S., Kingra J.S. and Joir R.S. (1989). On the morphometry of *Colisa fasciata* from Punjab, India (Perciformes: Anabantidae). *Vest. Cs. Spolec. Zool*. 53: 241-248.

Kiran B.R., Puttaiah E.T. and Kumar K.H. (2004). Length weight relationship of feather back, *Notopterus notopterus* (Pallas) from Jannapura pond, Karnataka, India. *Zoos' Print Journal*, 19(4): 1449-1450.

Lai H.L. and Helser T. (2004). Linear mixed-effects models for weight-length relationships. *Fish. Res.*70: 377-387.

LeCern E.D. (1951). Length-weight relationship and seasonal cycle in gonad weight and condition in the perch (*Perca fluviatilis*). *J. Anim. Ecol*. 20: 201-219.

Mortuza M.G. and Mokarrama N.T. (2000). Notes on the length-weight relationship and condition factor of mud loach *Botia lohachata* (Chaudhuri) (Cypriniformes:Cobitidae). *Univ. J.. Zool. Rajshahi Univ*. 19: 113-114.

Moutopoulos D.K. and Stergiou K.I. (2002). Length–weight and length–length relationships of fish species from the Aegean Sea (Greece). *J. Appl. Ichthyol.*18: 200-203.

Niimi A.J. and Morgan S.L. (1980). Morphometric examination of the gills of Walleye, Stizostedion *Vitreum vitreum* (Mitchill) and rainbow trout, *Salmo gairdneri* Richardson. *J. Fish. Biol.*16: 685-692.

Oscoz J., Campos F. and Escala M.C. (2005). Weight-length relationships of some fish species of the Iberian Peninsula. *J. Appl. Ichthyol*. 21: 73-74.

Pitcher T.J. and Hart P.J.B. (1982). *Fisheries Ecology.* London, Croom Helm. 414pp.

Rahman A.K.A. (2005). Freshwater Fishes of Bangladesh (2nd Edition). The Zoological Society of Bangladesh, Dhaka. 394p.

Ricker W.E. (1963). Hand book of computation for biological statistic of fish population. *Fish Bd Canada Bull, No. 119*. Reprint (Ed.), Queens printer Ottawa, p.300.

Šantić M., Pallaoro A. and Jardas I. (2006). Co-variation of gonadosomatic index and parameters of length-weight relationships of Mediterranean horse mackerel, *Trachurus mediterraneus* (Steindachner, 1868), in the eastern Adriatic Sea. *J. Appl. Ichthyol*. 22: 214-217.

Sinovčić **G., Franicevic M., Zorica B. and Cikes-Kec V. (2004).** Length–weight and length–length relationships for 10 pelagic fish species from the Adriatic Sea (Croatia). *J. Appl. Ichthyol*. 20: 156-158.

Tandon K.K., Johal M.S. and Bala S. (1993). Mophometry of *Cirrhinus reba* (Hamilton) from Kanjli wetland, Punjab. *Indian Res. Bull.Punjab.Univ. Sci*. 43(1-4): 73-78.

Tarkan A.S., Gaygusuz O., Acypynar H., Gursoy C. and Ozulug M. (2006). Length-weight relationship of fishes from the Marmara region (NW-Turkey). *J. Appl. Ichthyol*. 22: 217-273.