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Length weight relationship and condition factor of selected freshwater fish species found in River Ganga, Gomti and Rapti, India

U.K. Sarkar*, G.E. Khan, A. Dabas, A.K. Pathak, J.I. Mir, S.C. Rebello, A. Pal and S.P. Singh

National Bureau of Fish Genetic Resources, Lucknow- 226 002, India

**Corresponding Author email : usarkar1@rediffmail.com*

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Abstract

This study is based on the length-weight relationships (LWRs) of 2148 fishes, belonging to 8 families, 12 genera and 15 freshwater fish species (*Wallago attu, Rita rita, Sperata seenghala, Sperata aor, Mastacembalus armatus, Macrognathus puncalus, Gudusia chapra, Clupisoma garua, Puntius sophore, Puntius ticto, Rasbora daniconius, Amblypharyngodon mola, Chanda nama, Colisa faciatus and Colisa sota*) captured from river Ganga, Gomti and Rapti during May 2011 to March 2012. The growth coefficient (*b*) values varied between 1.30 and 3.07, with the mean $b = 2.03$ at $p < 0.001$. The condition factor (K) varied considerably from 0.76 and 2.95, with a mean K = 1.43 which may be attributed to different environmental conditions of the river basin. The objective was to evaluate the pattern of LWRs and condition factors of the freshwater fish species of the main Ganga and tributaries which serves as baseline for other tropical Indian rivers and tributaries.

Key words

Condition factor, Fish species, Ganga river basin, Length weight relationship

Introduction

Fisheries management and research often require the use of biometric relationships in order to transform data collected in the field into appropriate indices (Ecoutin and Albaret, 2003). Length-weight relationship (LWR) of fishes are important in fisheries and fish biology because they allow the estimation of the average weight of the fish of a given length group by establishing a mathematical relation between them (Sarkar *et al.,* 2008; Mir *et al*., 2012). Like any other morphometric characters, the LWR can be used as a character for the differentiation of taxonomic units and the relationship changes with the various developmental events in life such as metamorphosis, growth and onset of maturity (Thomas *et al*., 2003). Besides this, LWR can also be used in setting yield equations for estimating the number of fish landed and comparing the population in space and time (Singh *et al*., 2011). LWR parameters (*a* and *b*) are useful in fisheries science in many ways: to estimate weight of individual fish from its length, to calculate condition indices, to compare life history and morphology of populations belonging to different regions (Sani *et al*., 2010) and to study ontogenetic allometric changes (Teixeira de Mello *et al*., 2006). Furthermore, the empirical relationship between the length and weight of the fish enhances the knowledge of the natural history of commercially important fish species, thus making the conservation possible. Fulton's condition factor (K) is widely used in fisheries and fish biology studies. This factor is calculated from the relationship between the weight of a fish and its length, with the intention of describing the "condition" of that individual fish (Froese, 2006). Different values in K of a fish indicate the state of sexual maturity, the degree of food sources availability, age and sex of some species (Anibeze, 2000). These relationships are also an important component of FishBase (Froese and Pauly, 2012). In addition, the data on length and weight can also provide important clues on climate and environmental changes, and change in human subsistence practices. Regression data are available for most European and North American freshwater fishes, but are lacking for most tropical

fish (Dubey *et al*., 2012; Mir *et al*., 2012). In the Ganga basin, there are limited studies on the LWRs and condition factor of fishes (Sarkar *et al*., 2008; Mir *et al*., 2012).

To the best of our knowledge, no previous reports of length-weight and condition factor on some of these species is available from the selected rivers. Further, Fish Base database (Froese and Pauly, 2012) showed no record of LWR and condition factor for four fish species (*S. seenghala*, *C. garua*, *P. ticto* and *C. nama*). Therefore, this study provides baseline information on some important ornamental and food fishes, which may serve as a tool for management and conservation practices.

Materials and Methods

Sample collection : Our study estimates LWRs of 15 indigenous freshwater species including both food fishes (*W. attu*, *R. rita*, *S. seenghala*, *S. aor*, *M. armatus*, *C. garua* and *C. sota*) as well as aquarium fishes *viz*., *M. armatus*, *M. pancalus*, *P. sophore*, *P. ticto*, *R. daniconius*, *C. nama* and *C. sota* (Froese and Pauly, 2012) belonging to eight families (Siluridae, Bagaridae, Mastacembalidae, Clupidae, Schilibidae, Cyprinidae, Ambassidae, Osphonimidae) from three least explored rivers of Ganga basin. Fishes were captured from three rivers *viz*. Ganga (25°44.900' N, 084°09.208' E and 28°11.305' N, 078°23.797' E), Gomti (28°36.720' N 080°07.017' E) and Rapti (26°44.204' N 083°20.660' E) from May 2011 to March 2012. Altogether 2148 samples were collected using various fishing gears such as drag nets, cast nets and gillnets. After collection, specimens were preserved in 10% formalin solution, identified according to Jayaram (1981) and Talwar and Jhingran (1991), and then measured. Total length (TL) of each fish was taken from the tip of the snout (mouth closed) to the extended tip of the caudal fin nearest 0.1 mm by digital caliper (Mitutiyo) and weighed to the nearest 0.01 g (total weight) by digital weighing machine (ACCULAB Sartorious Group). Some species were far more abundant than others, thus the sample size varied accordingly.

Length-weight relationship (LWR) : The relationship between length and weight of fish was analyzed by measuring length and weight of fish specimens collected from study area. The statistical relationship between these parameters of fishes were established by using the parabolic equation by Froese (2006)

$$W = aL^b$$

Where, W = weight of fish (g), L =length of fish (mm), a = constant and b = an exponential expressing relationship between length-weight.

The relationship ($W = aL^b$) when converted into the logarithmic form gives a straight line relationship graphically

$$\text{Log } W = \text{Log } a + b \text{ Log } L$$

Where b represents the slope of the line, Log a is a constant.

Condition factor (K) : Condition factor is used for comparing the condition, fatness, or well-being (Mir *et al*., 2012) of fish, based on the assumption that heavier fish of a given length are in better condition. The coefficient of condition K was calculated using Fulton (1904)

$$K = W*100\, l^{-3}$$

Where, W = weight (g), l = length (cm) and 100 is a factor to bring the value of K near unity. To compare the variation among different species in three rivers, 95% confidence limits were determined.

Results and Discussion

Sample size, minimum and maximum length and maximum reported length from the database of FishBase (Froese and Pauly, 2012) for each species as well as LWR, coefficient of determination (r^2), slope regression (b), 95% confidence range for b, a (intercept of regression) with 95% confidence range are presented in Table 1. A total of 2148 specimens of 15 fish species belonging to eight families were sampled: *Wallago attu, Rita rita*, *Sperata seenghala*, *Sperata aor*, *Mastacembalus armatus*, *Macrognathus puncalus*, *Gudusia chapra*, *Clupisoma garua, Puntius sophore*, *Puntius ticto*, *Rasbora daniconius*, *Amblypharyngodon mola, Chanda nama*, *Colisa faciatus* and *Colisa sota*. The calculated linear regression indicates significant differences between the slopes of the LWR among species.

In the present study, values of b varied from 1.53 for *C. sota* to 2.61 for *M. armatus* in the Ganga River, 1.32 for *R. rita* to 3.07 for *S. seenghala* in the Gomti River and 1.30 for *S. seenghala* to 2.66 for *W. attu* in the river Rapti. The mean b value for all species was 2.00 in the Ganga, 2.05 in the Gomti and 2.03 in the Rapti. The coefficient of determination (r^2) for Ganga River ranged from 0.91 (*C. nama*) to 0.98 (*P. ticto* and *R. daniconius*), with a median value of 0.95; in River Gomti the value of r^2 ranged from 0.91 (*G. chapra*) to 0.98 (*P. sophore*), with a median value of 0.95 and for river Rapti it ranged from 0.92 (*C. sota* and *R. rita*) to 0.99 (*P. ticto*) with a median value of 0.96. All linear regressions were statistically significant ($P<0.05$). The value of b for same species among three rivers showed a slight variation. For Ganga River the value of b in *W. attu* was found to be 2.02, for River Gomti it was 2.22 and for river Rapti it was 2.66. In *R. rita* it ranged from 1.32 (Gomti) and 2.54 (Rapti) for *S. seenghala* and was highest in Gomti (3.07) and lowest in Rapti (1.30). Similar pattern of variation was noticed in other species as shown in Table 1.

Table 1 : Sample size, maximum reported length from the database of FishBase (Froese and Pauly, 2012) for each species, LWR, coefficient of determination (r2), slope regression (b), 95% confidence range for *b*, *a* (intercept of regression) with 95% confidence range.

Family	Species	Number of fishes collected	Mean length (cm)	Max. known fish base length (cm)	*a*	*b*	95% CL of *a*	95% CL of *b*	R^2
Siluridae	*Wallago attu* (GA)	40	49.31(18-76)	240	1.92	2.02	1.86-1.98	1.87-2.19	0.94
	Wallago attu (GO)	126	43.98(25.7-105)		1.96	2.22	1.90-2.03	1.92-2.38	0.94
	Wallago attu (RA)	30	42.28(24-57)		1.14	2.66	1.01-1.28	2.03-2.98	0.95
Bagaridae	*Rita rita* (GA)	41	19.85(9.4-42)	150	1.84	1.78	1.79-1.90	1.18-2.24	0.91
	Rita rita (GO)	116	18.77(15-35)		1.65	1.32	1.62-1.69	1.30-1.84	0.93
	Rita rita (RA)	22	25.21(15-44)		2.78	2.54	2.25-3.31	2.23-2.87	0.96
	Sperata seenghala (GA)	30	27.25(15-69)	150	1.19	1.91	1.03-1.42	1.22-2.21	0.93
	Sperata seenghala (GO)	92	35.86(20-67)		-5.43	3.07	-5.86to-4.99	2.89-3.24	0.93
	Sperata seenghala (RA)	28	22.72(12-46)		-3.43	1.30	-2.91to-3.93	1.09-1.50	0.93
	Sperata aor (GA)	28	20.641(10-15)	180	2.37	2.30	2.19-2.75	1.81-2.68	0.95
	Sperata aor (GO)	56	32.03(14-48)		-2.37	2.30	-2.59to-2.15	2.01-2.98	0.95
	Sperata aor (RA	44	24.93(14.1-40)		-4.88	2.22	-4.54to-5.92	1.99-2.60	0.92
Mastace	*Mastacembelus armatus* (GA)	32	41.05(32-55)	90	1.61	2.65	1.53-1.99	2.12-2.98	0.95
mbelidae	*Mastacembelus armatus* (GO)	76	38.85(30-60)		-1.61	2.22	-1.83to-1.39	2.19-2.96	0.95
	Mastacembalus armatus (RA)	25	36.75(31-42)		2.33	2.61	1.92- 2.85	2.14-2.90	0.96
	Macrognathus pancalus (GA)	35	13.45(11.5-17.3)	18	2.67	2.21	2.50-2.98	2.10-2.62	0.97
	Macrognathus pancalus (GO)	36	12.55(10.2-16.5)		3.29	2.11	3.20-3.38	1.94-2.52	0.97
	Macrognathus pancalus (RA)	29	12.23(10.3-18.3)		2.33	2.34	2.05-2.73	2.00-2.72	0.97
Clupidae	*Gudusia chapra* (GA)	40	12(4.2-17.6)	20	2.32	2.06	2.11-2.59	1.95-2.46	0.97
	Gudusia chapra (GO)	56	11(3.5-14.7)		2.44	2.16	2.02-2.68	1.89-2.78	0.95
	Gudusia chapra (RA)	62	7.87(4.5-11.5)		3.64	1.98	3.22-3.95	1.35-2.67	0.97
Schilib	*Clupisoma garua* (GA)	25	16.39(7-38)	60.9	-3.32	2.53	-3.17to-4.01	2.20-2.93	0.98
idae	*Clupisoma garua* (GO)	34	15.28(6-33)		-5.34	2.41	-5.66to-5.01	2.17-2.98	0.98
	Clupisoma garua (RA)	50	16.22(7.3-29.8)		-2.42	2.22	-2.21to-2.68	2.13-2.75	0.99
Cyprin	*Puntius sophore* (GA)	25	7.30(5.8-8.5)	18	3.50	1.92	2.81-2.94	1.14-2.43	0.98
idae	*Puntius sophore* (GO)	51	7.768(3.5-10.8)		-4.28	1.94	-4.91to-3.65	1.16-2.33	0.96
	Puntius sophore (RA)	60	7.16(4.5-8.9)		2.51	1.86	2.31-2.87	1.61-2.13	0.98
	Puntius ticto (GA)	40	6.37(4.2-9.2)	10	-2.59	1.93	-2.24 to-2.99	1.33-2.11	0.95
	Puntius ticto (GO)	50	5.52(4-8.5)		-3.78	1.74	-4.38 to-3.19	1.03-2.11	0.91
	Puntius ticto (RA)	45	6.33(3.9-8.4)		-2.34	1.93	-2.08 to-2.65	1.67-2.03	0.95
	Rasbora daniconius (GA)	40	4.54(3.4-8.5)	15	-2.23	1.99	-2.46 to-1.99	1.86-2.25	0.95
	Rasbora daniconius (GO)	35	5.54(3.5-8)		-1.33	1.90	-1.20 to-1.96	1.76-2.16	0.94
	Rasbora daniconius (RA)	65	5.63(3.26-8.33)		-2.12	1.92	-1.98 to-2.43	1.65-2.13	0.97
	Amblypharyngodon mola (GA)	36	3.64(1.67-11.10)	20	-2.21	1.92	-2.07 to-2.43	1.14-2.21	0.96
	Amblypharyngodon mola (GO)	38	4.59(1.8-10.1)		-4.33	1.82	-5.09 to-3.56	1.07-2.10	0.95
	Amblypharyngodon mola (RA)	50	3.32(2.32-10.32)		-2.21	1.91	-2.02to-2.58	1.54-2.12	0.93
Ambas	*Chanda nama* (GA)	70	4.33(2.8-9.1)	11	2.12	1.54	2.00-2.33	1.17-2.21	0.94
sidae	*Chanda nama* (GO)	80	4.60(3-8.7)		3.07	1.93	2.96-3.33	1.27-2.14	0.93
	Chanda nama (RA)	22	5.4(3.2-8.7)		-3.0	1.71	-3.72 to -2.88	1.02-1.97	0.92
Osphron	*Colisa fasciatus* (GA)	30	3.24(2.1-9.6)	12.5	2.21	1.77	2.00-2.73	1.35-1.97	0.94
imidae	*Colisa fasciatus* (GO)	38	5.32(3.2-8.8)		1.11	1.81	1.00-1.43	1.19-1.93	0.92
	Colisa fasciatus (RA)	25	6.94(5.8-8.5)		-2.68	1.47	2.41-2.98	1.00-1.78	0.93
	Colisa sota (GA)	43	3.53(2.1-5.5)	7	2.47	1.53	2.11-2.84	1.24-1.68	0.97
	Colisa sota (GO)	120	3.41(2.2-5)		2.68	1.47	2.61-2.95	0.92-1.78	0.96
	Colisa sota (RA)	32	4.41(2.3-5.7)		2.54	1.77	2.21-2.84	1.12-1.93	0.97

GA : Ganga main channel; GO : river Gomti; RA: river Rapti; *a*: intercept; *b*: slope; R^2: coefficient of determination; K: Condition factor;

Out of 15 studied species, information on LWR was not available for four species in the FishBase database (Froese and Pauly, 2012). Review of literature showed that in most fishes *b* values ranged from 2.7 to 3.3 (Abdallah, 2002). The *b* values of the present study conform with the studies of earlier researchers (Sarkar *et al.,* 2008; Mir *et al*., 2012). Our study also corroborated with the study of LWRs reported by Sani *et al*. (2010) for different freshwater species (*G. chapra*, *W. attu*, *S. aor*, *S. seenghala*, *C. gurua*, *M. armatus*, *P. sophore*) from Gomti and Betwa rivers in Uttar Pradesh. In another study, Gupta *et al*. (2011) reported *b* values ranging from 2.81-3.32 ($r^2 > 0.90$) from the river Gomti in northern India in an endangered species *Ompok pabda* (Hamilton). Khan *et al*. (2012) showed isometric growth 2.5-3.5 in *Channa marulius* and *Heteropneustis fossilis* in Ganga basin. Positive allometric growth was recorded in *Wallago attu, Sperata and Sperata seenghala* (Khan *et al*., 2011). Hossain *et al*. (2006) reported positive allometric growth in *Amblypharyngodon mola*, *Macrognathus pancalus* and *Puntius sophore* from the

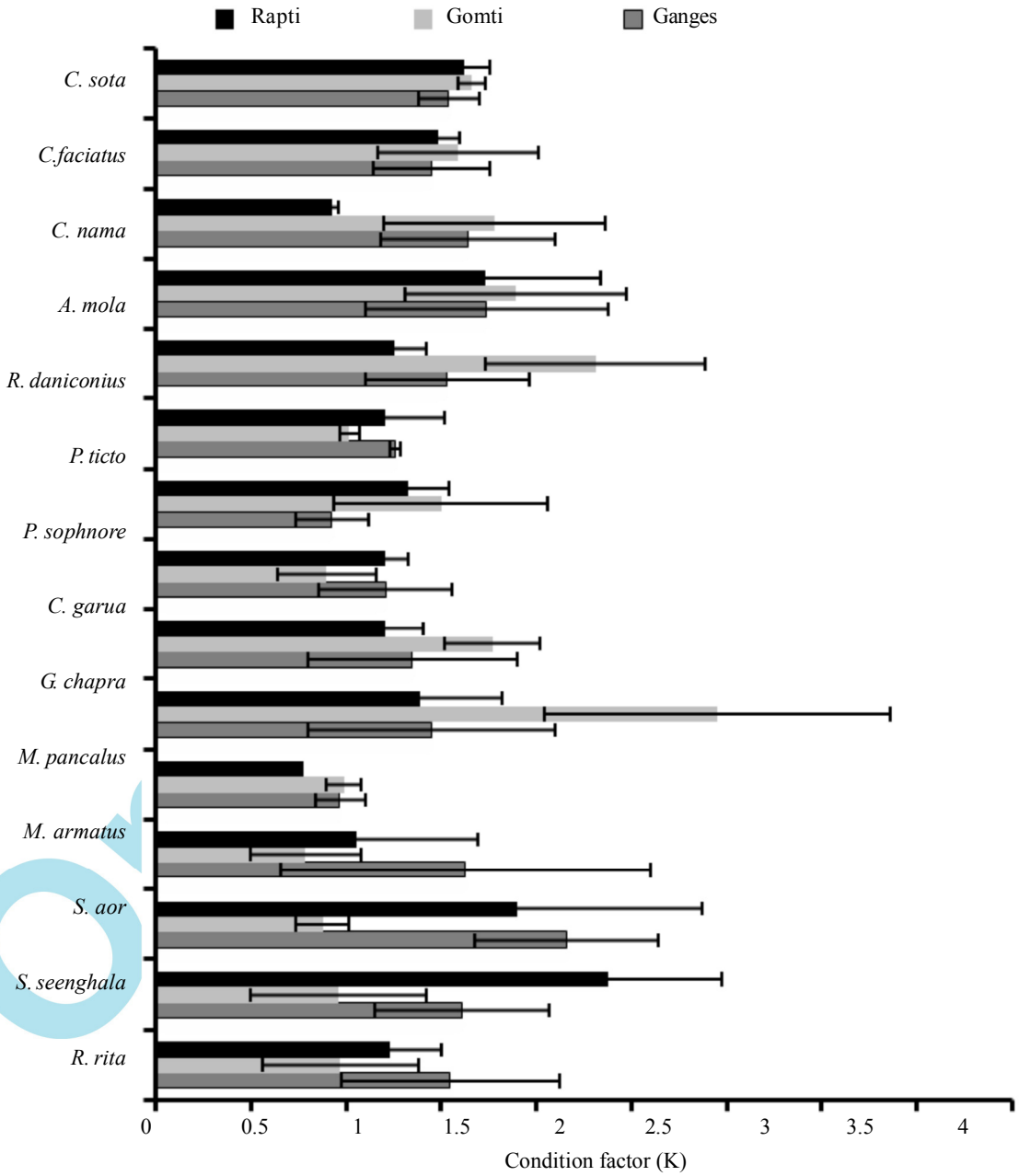

Fig. 1 : Variation of condition factor (K) of 15 fish species among three different rivers of Ganga basin

Mathabhanga river, Southwestern Bangladesh.

According to Goncalves *et al*. (1997) and Ozaydin *et al*. (2007), the parameter *b* unlikely may vary seasonally, and even daily, and between habitats. We observed slight variation in growth coefficient of same species among three rivers, *b* of *C. sota* was higher in River Rapti and lower in river Gomti; for *C. nama* it was higher in river Gomti and lower in river Ganga, similar kind of observations were made for other species like *Rita rita*, which showed higher *b* in river Ganga but lower in river Gomti and for *Mastacembalus armatus b* higher in river Ganga and lower in Gomti river.

Difference in *b* values can be attributed to the combination of one or more factors such as: number of specimens examined; area / seasonal effect; habitat; degree of stomach fullness; gonadal maturity; sex; health and general fish condition; preservation technique; and differences in the observed length ranges of the specimens caught (Wooten, 1998), all of these were not accounted in this study.

The condition factor in river Ganga was lowest in *P. sophore* (0.93±0.19) and highest in *S. seenghala* (2.16±0.48); in river Gomti it was minimum in *S. aor* (0.97±0.29) and maximum in *M. pancalus* (2.95±0.91) and for river Rapti it was lowest in *M. armatus* (0.76±0.01) and highest in *R. rita* (2.38±0.59) as shown in Fig. 1 and all the values were significant at $p<0.05$. Average condition factor of the different species in three rivers was similar but showed significant variation between same species among these rivers. It was highest for *Macrognathus pancalus* in river Gomti, for *Wallago attu* in river Rapti, *Sperata seenghala* in river Ganga. This may be due to the dissimilar food availability and random seasonal collection of the samples throughout the year. All the studied regressions were highly significant ($p< 0.001$) with the coefficient of determination in the range of 0.91 to 0.98, which corroborated with the study of Isa *et al*. (2010) in seven catfishes. Mir *et al*. (2012) reported similar type of observations in *Labeo rohita* from Ganga basin in India.

In conclusion, this study provides the first basic and baseline information on the LWR of 15 indigenous fishes of commercial importance from these selected three rivers, that would be beneficial for fishery biologists and conservationists to impose adequate regulations for sustainable fishery management and conservation of biodiversity for these rivers as well as for other rivers of the Ganga basin in India.

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