

Seasonal Variation of Length-Weight Relationships and Fulton's Condition Factor of Five Small Indigenous Freshwater Fish Species

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ABSTRACT

This study evaluated the length-weight relationship (LWR) and Fulton's condition factor of five small indigenous fish species (n=623); namely, *Puntius sophore*, *Trichogaster fasciata*, *Lepidocephalichthys guntea*, *Amblypharyngodon mola* and *Chanda nama* captured during 2018 to 2019 from 10 freshwater bodies of West Bengal, India. For establishing LWR according to seasonal variations, fish were grouped according to the season. The result showed that growth coefficient values varied between 3.875 and 2.337, and the condition factor values ranged between 2.12 and 0.67, which can be due to different environmental conditions. The length-weight relationships were highly correlated in all studied species throughout the seasons. The average condition factor values reflected the good condition of fish in the studied ponds. This study provided baseline data on the length-weight relationship and condition factor of the selected species, which can be used to assess grow-out stocks in a similar environment.

INTRODUCTION

Length-weight relationships and condition factor play the most important role in fishery research (Jin *et al.*, 2015). The length-weight relationship is useful in comparing morphometric parameters, understanding fish health and the composition of fish landing and overall growth potentiality of fish (Gupta & Tripathi, 2017). On the other hand, the condition factor is used to measure the condition of the individual fish (Le Cren, 1951; Froese, 2006). The parameter is based on the assumption that heavier fish of a particular length is superior in physiological state. Besides, it can be employed to find out the growth and feeding intensity of fish as well as the status of the water body where they grow (Fagade, 1979; Luff & Bailey, 2000; Anene, 2005). There are several intrinsic (i.e., food in gut, organic reserves of the body and the development of reproductive stages) as well as extrinsic (i.e., variability in food and environment) factors that

influence the fish physiology, growth and well-being (Nikolsky, 1969; Rodriguez *et al.*, 2017), which can be assessed indirectly through length-weight relationship and Fulton's condition factor.

Small indigenous freshwater fish species (SIFs) are rich sources of protein, fatty acids, vitamins and minerals (Mandal & Nandi, 2015; Nandi & Saikia, 2016). The DHA (Docosahexaenoic acid) and EPA (Eicosapentaenoic acid) in SIFs have a range of health benefits in the remedy of cardiac diseases. In addition to balanced nutrition, they are supplementary income sources for the rural Indian population (Dey *et al.*, 2017). However, unfortunately, these fish species are often excluded from studies since they occupy a lower trophic hierarchy, compared to large-sized fishes. At the same time, they are reported to be under serious threat (Angermeier, 1995; Olden *et al.*, 2007) due to predation (MacRae & Jackson, 2001), habitat loss and fragmentation (Hanski, 2013; Arthington *et al.*, 2016). These factors make them more vulnerable to extreme changes in the environment (Matthews & Marsh-Matthews, 2003). In such a situation, these fishes are drawing attention as companion crops of carp-polyculture practice (Nandi *et al.*, 2012). Jena *et al.* (2019) studied the length-weight relationship of four indigenous species of fish from Northeast India, but there is no report on SIFs. The information on the 'length-weight relationships' and 'condition factor' of SIFs may provide necessary inputs to appropriately select the species for such carp-polyculture practice. At least five fish species *Puntius sophore* (Hamilton, 1822), *Trichogaster fasciata* (Bloch & Schneider, 1801), *Lepidocephalichthys guntea* (Hamilton, 1822), *Amblypharyngodon mola* (Hamilton, 1822) and *Chanda nama* (Hamilton, 1822) from small freshwater bodies were therefore studied to determine the length-weight relationships (LWRs) and condition factors

MATERIALS AND METHODS

1. Study area

Fish (n=623) were collected from 10 freshwater ponds throughout the period of 2018-2019. The ponds were in the northern part of West Bengal, Jalpaiguri district (26.6835° N, 88.7689° E) (Fig. 1). Only those small fishes with 70% or more catch per effort were considered for analysis. Fishes were caught by using cast net and immediately transferred to an ice box after mildly treated with anaesthetic (MS222) and then taken to the laboratory for morphometric measurement. Fish were identified according to Talwar and Jhingran (1991). Length measurements were done to the nearest 0.01cm as total length (TL) from mouth to the end of the caudal fin, and weight measurement was conducted to the nearest 0.001g.

2. Length-weight relationships (LWR)

Length and weight were measured by the log transformation of the equation $W = aL^b$.

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

In the equation, 'a' represents the coefficient of body shape and 'b' represents the slope of the relationship or growth coefficient, and its values can be smaller or larger (negative or positive allometric growth) or equal to 3 (isometric growth) (Karachle & Stergiou, 2012), where W is the weight in grams, and L is the total length in cm.

For establishing LWR according to seasonal variations, fish were grouped as pre-monsoon (March-June), monsoon (July-September) and post-monsoon (October-February) seasons according to the season during which they were caught. In order to check whether seasonal fish growth was statistically different from isometric growth (Null Hypotheses: $b=3$), a Student t-test was also performed.

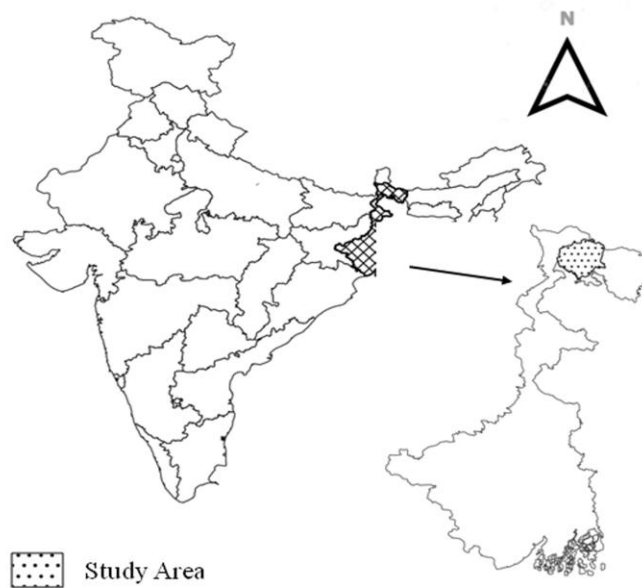


Fig. 1. Map of India (not to scale) showing sampling area in West Bengal

3. Fulton's condition factor (K)

Condition factor decreases with the increase in length. Thus, the variation of fish physiological status can be compared between populations living in different feeding or climatic conditions. The condition factor was determined using the following expression:

$$K = 100 \times W/L^3 \quad (\text{Froese, 2006})$$

While, determining the length-weight relationship, correlation coefficient and condition factor for each species were considered; whereas, the sexes were out of concern since fish cannot be sexually differentiated throughout the year except during the breeding season. The statistical analyses were performed using Minitab 19 and PAST 2.17 software.

RESULTS

In this study, length and weight of 623 individuals from 5 species (*Puntius sophore*, *Trichogaster fasciata*, *Lepidocephalichthys guntea*, *Amblypharyngodon mola* and *Chanda nama*) belonging to 5 families (Cyprinidae, Osphronemidae, Cobitidae, Danionidae and Ambassidae) were recorded.

Table 1. Descriptive and other statistical parameters of L-W relationship for small indigenous freshwater fish species

Family: Species	Seasons (N)	Length range (cm)	Co-efficient of regression		r ² (%)	P1	P2	r	K
			a	b					
<u>Cyprinidae:</u> <i>Puntius sophore</i> (Hamilton, 1822)	PrM (89)	9.6-5.5	-2.454	3.68	92.6	0.05	0.46	0.96	1.37
	M (82)	10.6-3.9	-1.968	3.13	96.2	0.06		0.98	1.4
	PM (46)	9-5.2	-1.808	2.85	98.1	0.03		0.99	1.2
<u>Osphronemida e:</u> <i>Trichogaster fasciata</i> (Bloch & Schneider, 1801)	PrM (18)	5.35-3.1	-1.986	3.51	98.7	0.03	0.39	0.99	2.12
	M (24)	7.6-3.45	-1.654	2.94	99.3	0.03		0.99	2.03
	PM (21)	8.5-3.3	-1.804	3.10	99.2	0.04		0.99	1.82
<u>Cobitidae:</u> <i>Lepidocephal ichthys guntea</i> (Hamilton, 1822)	PrM (18)	7.3-6.69	-2.918	3.88	98.4	0.01	0.31	0.99	0.67
	M (22)	8.18-4.9	-2.302	2.96	95.4	0.05		0.97	0.84
	PM (19)	6.7-4.25	-2.302	3.25	96	0.04		0.98	0.77
<u>Danionidae:</u> <i>Amblypharyn godon mola</i> (Hamilton, 1822)	PrM (28)	7.6-5.05	-2.236	3.27	92.8	0.06	0.03	0.9	0.97
	M (72)	8.9-4.6	-2.139	3.17	92.1	0.04		0.9	0.97
	PM (24)	6.6-4.5	-2.274	3.29	87.5	0.07		0.93	0.92
<u>Ambassidae:</u> <i>Chanda nama</i> (Hamilton, 1822)	PrM (19)	7.9-4.2	-2.218	3.25	90.7	0.07	0.587	0.95	0.93
	M (22)	6-4	-1.568	2.34	73.4	0.07		0.86	0.93
	PM (24)	4.9-3.8	-1.945	2.89	96.6	0.01		0.98	0.97

PrM: Pre-monsoon; M: Monsoon; PM: Post-monsoon; N: Number of individuals; r²: Coefficient of determination; P1: Significance of regression; P2: Significance of difference in b values among seasons; r: Correlation coefficients; K: Fulton's condition factor.

(t-test was conducted to verify if there is any significant difference from consensus b=3)

In the preliminary graphical analysis process, few outliers were detected and removed from the final dataset. After this step, linear regression was performed by putting fish log

weight as response and log length as predictor. The constants (a & b) and adjusted coefficient of determination (r^2) values for each season were recorded for each species. The values of b varied within 3.875 and 2.337. Correlation coefficient (r) between fish length and weight were also determined using Pearson's correlation test, which showed a very strong correlation (> 0.8). The condition factor values varied between 2.12 & 0.67. The t-test result showed no significant variation in isometric growth, except *A. mola* (Table 1).

DISCUSSION

The values of b from all small fish species were within 2.5 to 3.5 (except two cases with values > 3.5) and within the range suggested by **Carlander (1969)**. **Froese (2006)** classified fish specimens into those with $b=3$ constituting the small specimens with the same shape and condition such as the large specimens; those with $b > 3$ for the large specimens having increased more in height or width than in length and finally those with $b < 3$, representing the large specimens that changed their body shape to become more elongated or small specimens in better nutritional conditions at the time of sampling. Except *Chanda nama* during monsoon, this study showed that all the small fish species had isometric (≈ 3.0) or positive allometric growth (> 3.0). In case of positive allometric growth, the weight of an organism increases more than length (**Wootton, 1992**).

Seasonally, in the present study, the b value was > 3 (positive allometric growth) in the pre-monsoon season (March-June) for almost all species. Similar result was reported in the study of **Das et al. (2018)**, conducted on *A. mola*; however, growth was negative allometric. Conversely, the present study showed positively allometric growth for *A. mola* throughout all seasons which was significantly different from isometric growth. Except *A. mola*, the seasonal growth coefficient values of all the other species did not show significant different from their isometric growth. The highest value of b has been recorded for *L. guntea* during pre-monsoon, 3.875 with r value 0.992. Similar result for combined sexes of *L. guntea* was reported in the study of **Biswas et al. (2018)**. **Gupta and Tripathi (2017)** found the b values of *P. sophore* varying between 2.95 & 3.23 in the river system (Ganga, Gomti and Sai). In the present study, the average b value was 3.221, which is within the range of **Gupta and Tripathi (2017)**. On the other hand, **Sarkar et al. (2013)** with respect to the river system recorded b values of *P. sophore* varying between 1.94 & 1.86, for *T. fasciata* between 1.47-1.81 and for *C. nama* 1.54-1.93. However, these results are different from the obtained result in this study. Thus, *A. mola* and *P. sophore* attains better growth in the freshwater system like the one sampled. These two small fish species may stand as potential candidate for culture with carp-polyculture system.

Furthermore, the overall values of condition factor in this study indicate healthy and good condition of small fish species in pond environments. In most cases, the lowest value obtained during post-spawning (Post-monsoon) period is attributed to low feeding intensity and ovarian degeneration during winter (**Giosa *et al.*, 2014**).

In conclusion, it can be said that the studied small freshwater fishes maintain more or less positive allometric growth throughout the year, irrespective of seasonal variation. This is rare in the case of large-sized fishes. Although some variations were detected in the growth parameter of fish species in relation to seasonal change, it is not significantly different.

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