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Length-Weight, Length-Length Relationship and Condition Factor of Freshwater Murrel, *Channa punctatus* from Northern and Eastern Regions of India

Ankur Kashyap, Madhu Awasthi, M. Arshad and M. Serajuddin

Department of Zoology, University of Lucknow, Lucknow-226007, Uttar Pradesh, India

Abstract: *Channa punctatus* (Bloch, 1793) is a freshwater common green spotted snake headed murrel distributed throughout the south-east Asian countries including India. Fishes were collected from three spatially and geographically different areas characterized by different environmental conditions. The length and weight in all the three populations was highly correlated (r = 0.9661 to 0.9928) and significant ($p<0.0001$). Fishes from River Gomti followed the cube law strictly as the weight of the fish was nearly equal to the cube of its length and the value of regression coefficient (b) for the length weight relationship was 3.026, whereas fishes from the pond of Kolkata and Malihabad did not followed the so called cube law with regression coefficient (b) value as 2.837 and 2.861 respectively. Thus, the length weight relationship in the current study indicated isometric growth (b=3) in the *C. punctatus* from River Gomti and negative allometric growth (b<3) in the fish from pond of Kolkata and Malihabad. Condition factor was found to be high for river Gomti fish than the pond populations indicating better environmental conditions in River Gomti. The length length relationship in all the three populations was also correlated (r= 0.9928 to 0.9661) and was highly significant ($p<0.0001$).

Key words: *Channa punctatus* · Length-weight relationship · Condition factor

INTRODUCTION

Length weight relationship in fish is one of the most important and studied parameter in fisheries science. It serves as a basic parameter for the calculation of unknown weight from known length or vice versa since weight is a function of length. The data of length weight relationship provides information that can be utilized in a number of fish biology studies. These relationships are helpful in estimating the growth rates, age structure and also to segregate the stocks of fish and thus find applications in many population dynamics studies [1]. The studies on length weight relationships are helpful in stock assessment models where fishery scientists convert growth-in-length estimations to growth-in-weight; apart from this, the relationships are also useful in comparison of life history and morphology of populations inhabiting different geographical regions [2-4]. The length weight relationship can also be used for rapid estimation of the crop production in aquaculture [5-10].

The condition factor (Fulton's condition factor) is an important parameter in fish biology which is used as an index of growth and feeding intensity in fishes [11, 12]. The condition factor (K) compares the wellbeing of a fish and is based on the hypothesis that heavier fish of a particular length are in better condition [13], which is considered to be helpful in indicating the suitability of a specific water body for the growth of fish [14]. The condition of fish is found to decrease with increase in the length of the fish [12, 15] and it also influences the reproductive cycle [16].

A survey of literature showed that a little information is available on length weight relationship of majority of tropical and sub-tropical fish species of India and moreover Kulbicki *et al.* [17] also pointed out that there is vast paucity of information of the length weight relationships of fish species. Moreover particularly there are no comparative reports of the length-weight relationships on *Channa punctatus* except the works carried out by Basheer *et al.* [18], Sarkar [19], Haniffa *et al.*

Corresponding Author: M. Serajuddin, Department of Zoology, University of Lucknow, Lucknow-226007, Uttar Pradesh, India.

[20], Jhan and Chandra [21], Serajuddin *et al.* [22], Kashyap *et al.* [23] and Kashyap *et al.* [24]. Therefore the present study was carried out in order to fill the paucity of information on the length-weight relationship of *C. punctatus* from different geographical sites.

MATERIALS AND METHODS

Length-Weight and Length-Length Relationship Studies: The samples were collected randomly from three different regions of India using cast and drag nets with the help of fisherman for studying the length-weight and length-length relationship in *C. punctatus*. These samples of *C. punctatus* were collected from River Gomti in the Lucknow region (26° 56" N 80° 43" E), Pond situated in the Malihabad Region (26° 92" N 80° 71" E) and from a pond situated in Kolkata (22° 34" N 88° 22" E). Altogether 220 fish samples were weighs with an electronic balance sensitive up to 0.001g and total length (TL) and standard length (SL) of fishes were measured to nearest mm with the help of fine calipers. The collected data were transformed into log. The length-weight and length-length equations were estimated using the method of least squares as suggested by Ricker [25]:

$$W = aL^b$$

where W is Body Weight in grams (g), L is Total Length in centimeters (cm), 'a' is intercept of regression line at Y when X=0 and 'b' is slope of regression line.

For practical use this equation is used in its Logarithmic form [14] as:

$$\text{Log } W = \text{Log } a + b \text{ Log TL}$$
$$\text{Log TL} = \text{Log } a + b \text{ Log SL}$$

All the statistical analysis was done with the help of software GraphPad Prism 5.

Study of Condition Factor: The condition factor (K) was used for comparing the well being and fatness of fish [26]. Fulton's Condition Factor [25] was calculated by using the formula:

$$K = W \times 100/L^3$$

where 'K' is Fulton's condition factor, 'W' is net wet weight (g) of fish and 'L' is standard length in cm. The factor 100 is used to bring K close to unity.

RESULTS AND DISCUSSION

The estimated parameters are given in Tables 1, 2, 3, 4 and 5. For the length-weight relationships the coefficient of correlation (r) varied between 0.9193 - 0.9859. The graphs of length-weight and length-length regression analysis of three populations are given in Figs. 1 and 3. All the values of regression coefficients (r) obtained in the present study were highly significant ($p<0.0001$). The values of 'b' ranged from 2.837 to 3.026 and was highly significant ($p<0.0001$). The growth pattern was found to be isometric ($b=3.0$) in *C. punctatus* population of River Gomti whereas, negative allometric growth ($b<3$) was observed in Kolkata and Malihabad pond populations. A strong linear significant ($p<0.05$) interrelationship was observed between linearized plot of log 'a' over 'b' (Fig. 2). The relationship between the total length and standard length was highly correlated in all the populations of *C. punctatus*. The logarithmic regression equations for the total length and standard length are given in Tables 3, 4 and Fig. 3. Significant ($p<0.0001$) and highly correlated length-length relationships were noted in all the populations of *C. punctatus* (Table 3). The values of coefficient of correlation (r) between length-length relationships ranged between 0.9661-0.9928 with maximum and minimum values were recorded in the population of River Gomti and Malihabad respectively. The linear regression and associated statistical parameters of total length with standard length are given in Table 4. The details of the descriptive analysis of total length are given in Table 5.

Condition factor (K) varied from 0.9916 to 1.065 in the three populations of *C. punctatus* and was found close to unity in all three populations. The value of condition factor (K) showed that all the individuals of different populations were in good condition. The highest value of condition factor (K) was recorded in the pond population of Malihabad which suggested the better environmental condition as compared to other water bodies studied.

Froese [6] stated that if several weight-length relationships are available for a species then plot of log 'a' over 'b' will form straight line and helps in detection of outliers. The length and weight relationship of *C. punctatus* was highly correlated (r = 0.9193 to 0.9859) but it did not follow the cube law strictly in the pond populations (Malihabad and Kolkata) and thus departed from the so called "cube law". LeCren's [14] concept of cube law hypothetically suggested that the value of 'b' for an ideal fish to be 3.0 which represents as isometric

Table 1: Logarithmic regression equation of weight on total length in *C. punctatus*

S. No.	Sampling Site	Logarithmic Regression Equation (Log W = Log a + b Log L)	Correlation Coefficient 'r'
1	River Gomti	Log W = -2.101 + 3.026 Log L	0.9750
2	Pond of Malihabad	Log W = -1.838 + 2.861 Log L	0.9859
3	Pond of Kolkata	Log W = -1.770 + 2.837 Log L	0.9193

Table 2: Parameters of logarithmic regression equation of length-weight relationship in *C. punctatus*

S.No.	Location	Intercept 'a'	95% CL of 'a'	Slope 'b'	95% CL of 'b'
1	River Gomti	0.0079	0.0054 - 0.0116	3.026	2.941- 3.223
2	Pond of Malihabad	0.0146	0.0111 - 0.0192	2.861	2.751 - 2.970
3	Pond of Kolkata	0.01725	0.007 - 0.0426	2.837	2.484 - 3.190

Table 3: Logarithmic regression equation of standard length on total length in *C. punctatus*

S.No.	Sampling Site	Logarithmic Regression Equation (Log TL = Log a + b Log SL)	Correlation Coefficient 'r'
1	River Gomti	Log W = -0.0598 + 0.9804 Log SL	0.9928
2	Pond of Malihabad	Log W = -0.0599 + 0.9738 Log SL	0.9792
3	Pond of Kolkata	Log W = 0.0314 + 0.8962 Log SL	0.9661

Table 4: Parameters of logarithmic regression equation of length-length relationship in *C. punctatus*

S.No.	Location	Intercept 'a'	95% CL of 'a'	Slope 'b'	95% CL of 'b'
1	River Gomti	0.8714	0.8178 - 0.9285	0.9804	0.9566 - 1.004
2	Pond of Malihabad	0.8712	0.778 - 0.9754	0.9738	0.9283 - 1.019
3	Pond of Kolkata	1.075	0.9001 - 1.2841	0.8962	0.8266 - 0.9657

Table 5: Description of size range and weight of *C. punctatus* in three sampling sites

Sampling Site	Sample Size	Minimum TL	Maximum TL	Mean TL	Standard Deviation	Condition Factor 'K'
River Gomti	100	10.20	21.00	14.57	2.25	1.13
Pond of Malihabad	70	8.40	15.50	12.04	1.84	1.03
Pond of Kolkata	50	15.30	10.50	12.90	1.29	0.99

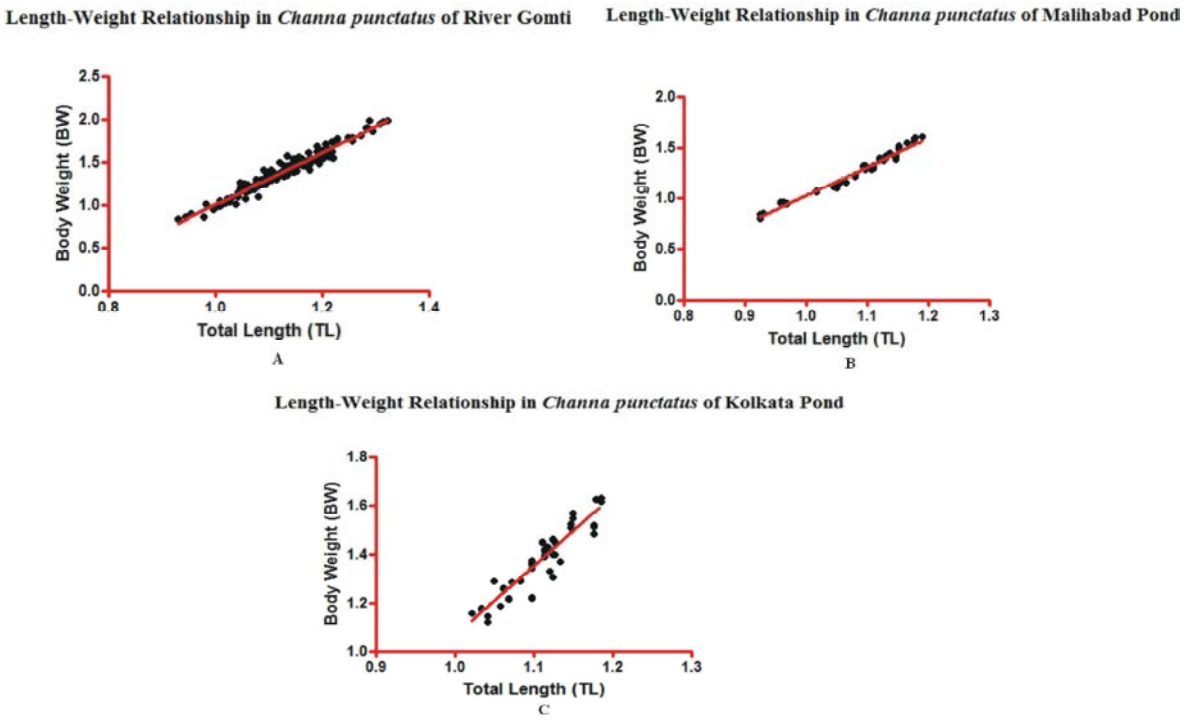

Fig. 1: Length-weight relationship in three populations of *C. punctatus* (A) River Gomti (B) Pond of Malihabad (C) Pond of Kolkata

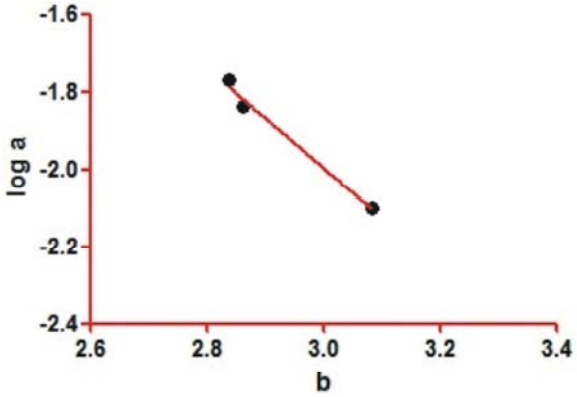

Fig. 2: Plot of log a over b for length-weight relationships in three populations of *C. punctatus*

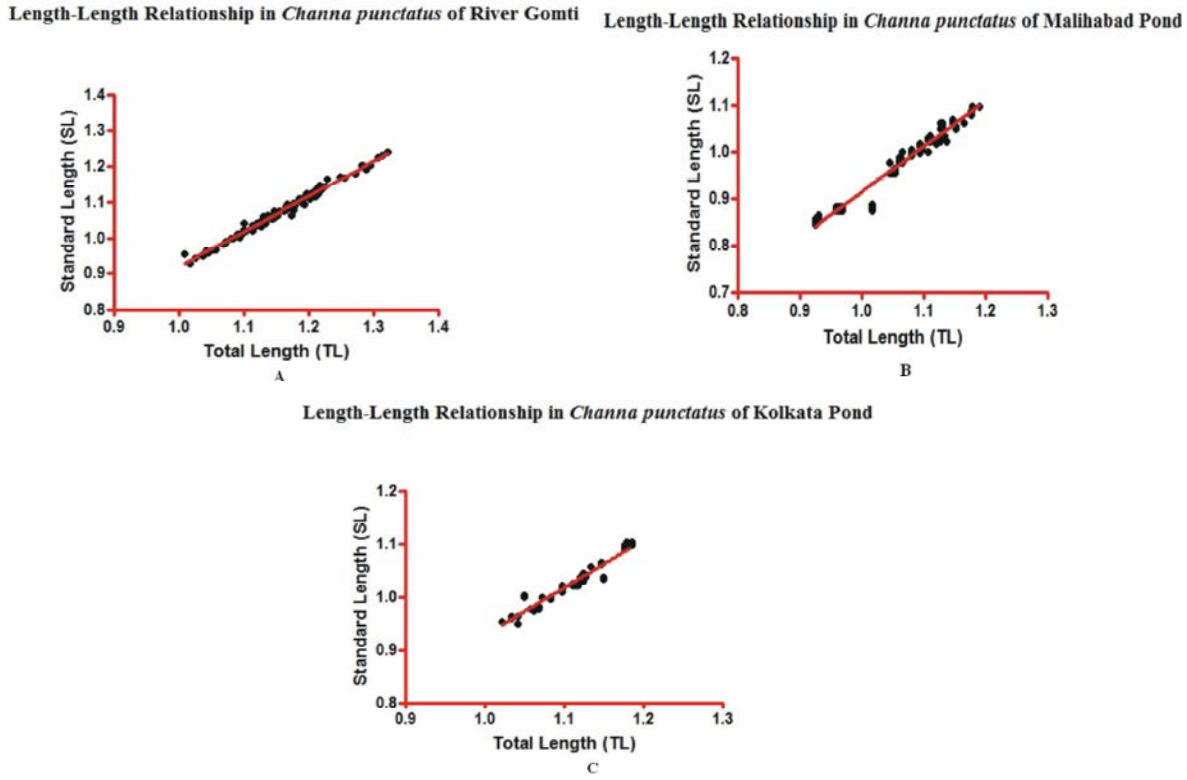

Fig. 3: Length-length relationship in three populations of *C. punctatus* (A) River Gomti (B) Pond of Malihabad (C) Pond of Kolkata

growth and it was used in the present study for the comparison purposes. The value of regression coefficient 'b' ranged from 2.837 to 3.026 in the present study. This departure from cube law in Malihabad and Kolkata populations is acceptable as it falls under the range of 2.0 to 4.0 which was suggested by many workers like Froese [6], Tesch [26] and Hile [27]. Another worker Carlander [28] also suggested the range of the value of 'b' should fall in between 2.5 to 3.5. Variation in value of exponent 'b' or regression coefficient 'b' can be attributed to the combinations of one or more factors such as availability of forage organisms to the fish [29], locality, maturity and metamorphosis [30], several other factors like area, season, stage of maturity, fish condition [9, 25], preservation method, differences in the observed length ranges of samples collected [31]. According to LeCren [14] ecological conditions of the habitats or variation in the physiology of animals or both are responsible for growth rate variation in same species from different localities.

In the current study, Isometric growth was noted in the *C. punctatus* population of River Gomti as the value of regression coefficient 'b' for the length weight relationship was found close to 3.0 following the 'cube law' but the fish from Kolkata and Malihabad pond did not followed the 'cube law' strictly and negative allometric growth was observed in them and the value of regression coefficient 'b' was less than 3. Isometric growth was also reported by various workers in a number of fishes. Pathak *et al.* [32], Achakzai [33], Serajuddin *et al.* [22], Ali *et al.* [34] and Kashyap *et al.* [24] reported isometric growth in *Macrognathus pancalus, Oreochromis mossambicus, C. punctatus* of River Varuna, *Tor putitora* and *C. punctatus* of River Gomti respectively. The workers such as Wootton [35] and Ujjania [36] emphasized that the isometric growth in fishes arises because the fish retains the same shape and its specific gravity does not change during its life time. This might be the reason for observed isometric growth in River Gomti population of *C. punctatus*. The other two populations (Pond of Kolkata and Pond of Malihabad) showed negative allometric growth as the value of regression coefficient 'b' was less than 3.0. According to Wootton [31] if the value of exponent 'b' is less than 3 then it indicates that the fish is lighter and in the case of heavier the value will be more than 3. Thus as the value of b increases, the size of fish also increases because the fish usually grows proportionally in all directions and the changes in fish weight are greater than the change in fish length and vice-versa. The variation in the value of 'b' is also attributed to the environmental factors such as overfishing, food competition and trophic potential of rivers and ponds. So, these factors may be responsible for the negative allometric growth of the fish [37]. The poor environmental conditions may be a reason for decrease in weight of *C. punctatus* of Kolkata and Malihabad population which showed negative allometric growth pattern. The change in the values of 'b' primarily depends on the body shape and fatness of the species. Cherif *et al*. [38] and Tesch [39] also reported that length-weight relationship can be affected by habitat and area rather than other factors such as seasonal effect, degree of stomach fullness and sex in fishes.

Condition factor, more precisely known as Fulton's condition factor (K) is also used widely in fish biology along with the length-weight relationship. It generally indicates the well being of the fish or the physiological state of the fish which include many parameters like reproductive capacity, life history stages. In the present study the mean condition factor (K) was found to be close to 1 (0.99 to 1.13) in all the three populations but it was maximum in the population of River Gomti followed by Pond of Malihabad and Kolkata pond (Table 5). The maximum value of condition factor (K) of River Gomti (lotic) showed the better environmental conditions than other lentic water bodies of the present study. This was also supported by the higher value of 'b' recorded in River Gomti population as compared to Malihabad and Kolkata populations where negative allometric growth was recorded which indicated poor increase in weight with respect to length.

CONCLUSION

The comparative study of length-weight, length-length and condition factor and length frequency distribution of the present study provided new insights in the size structure of *C. punctatus* in relation to environmental plasticity or genetic differentiation. Further investigations by common garden experiments on variations of length-weight and size structure in relation to environmental conditions or genetic differentiation of populations *C. punctatus* are needed to establish beyond doubt whether these parameters were genetically governed or not.

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