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Length weight relationships and condition factors of Indian major carps in Jaisamand Lake (India)

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Abstract
The length weight relationship and condition factor of a fish provide the information on its growth and well-being of fish in the surrounding aquatic environment. In the present study these aspects have been investigated and elucidated with particular reference to the growth status and condition factor of three Indian major carps (*Catla catla, Labeo rohita* and *Cirrhinus mrigala*) in Jaisamand Lake (India). The morphometric data were collected from 119 specimens of each species during May 2005 to April 2006 and mean total length (54.081±1.139 cm, 51.601±0.754 cm and 51.723±0.541 cm) and mean weight (3197.971±157.814 gm, 1853.333±82.959 gm and 1701.250±52.123 gm) were observed for catla, rohu and mrigal, respectively. A strong linear relationship was observed between total length and weight variables. The value of regression coefficient (b) depicted isometric growth in mrigal, positive allometric growth in rohu and negative allometric growth in calta. The condition and relative condition factors were observed >1.0 which indicate the good conditions of all the three fish species in Jaisamand Lake. From this study it was concluded that the aquatic environment of Jaisamand Lake is fairly conducive for Indian major carps.

Keywords: Condition factor, Indian major carps, growth, length-weight relationships, and Jaisamand

1. Introduction
Length weight relationships ((LWR) provide basic information on fish biology and thus is useful to estimate the weight from length of individual fish (Forese, 1998; Koutrakis and Tsikliras, 2003) [9, 14]. This also helps to estimate fish crop biomass (Martin-Smith, 1996; Petrakis and Stergiou, 1995) [17, 22] and to convert growth -in- length equations to growth-in-weight for prediction of weight-at-age (Pauly, 1993) [21]. Similarly, it is also useful to calculate condition indices (Safran, 1992; Petrakis and Stergiou, 1995) [27, 22] and to compare the morphology of populations from different regions (Petrakis and Stergiou, 1995) [22]. This relationship can also be used to obtain information on the somatic growth condition of fish to find out whether it was isometric or allometric (LeCren, 1951; Ricker, 1975) [15, 25].
Number of fishery scientists around the world were inspired from the importance of length weight relationship and condition factor of fishes and this relationship was applied in marine and freshwater fishes. Such kind of study of Indian major carps in relation to growth parameters was earlier studied by (Patel *et al.,* 2014; Behera *et al.,* 2015; Gokhale *et al.,* 2015; Barrich and Kaur, 2015 and Verma, 2015) [20, 3, 10, 2, 32].
The objective of this study was to determine the length-weight relationships, condition factors and growth performance of Indian major carps as these informations will be helpful to management, conservation, culture and population comparison of the species under study.

2. Materials and Methods
The morphometric measurements (total length and standard length) were measured in centimeters and total body weight was observed in grams from total of 357 specimens. Thus, 119 of each specimens of Indian major carps (*Catla* catla, *Labeo rohita* and *Cirrhinus mrigala*) were collected from commercial landing center of Jaisamand Lake (Fig. 1) during May 2005 to April 2006. The total length (TL) was measured from tip of snout to extended tip of caudal fin and standard length (SL) was measured from tip of snout to caudal peduncle. Length based measurements were taken with the help of measuring board and measured the nearest 0.5 cm whereas body weight of individual fish was measured with the help of single pan balance and measured to the nearest 0.1 gm.

The length-weight relationship (LWR) between total length (TL, cm) and body weight (WT, g) was determined from transformed pooled data. The parameters *a* and *b* were estimated by linear regression equation given by LeCren (1951) [15] and Jones (2002) [13]. This equation is sometimes also referred as the length-weight key (Biswas, 1993) [5]:

$W = a L^b$
$\log W = \log a + b \log L$
Where:
a = coefficient related to body form,
b = exponent

The coefficient of correlation (r) was calculated following standard statistical procedure given by Snedecor and Cochran (1967) [28]
Condition factor (K) and relative condition factor (Kn) were determined for different length groups using length and weight data following the equation given by LeCren (1951) [15]:

$K = (W \times 100) / L^3$
$Kn = W / w$
Where:
W = Weight (gm) of fish
L = Standard length (cm) of fish
w = Calculated weight (gm) of fish
For statistical analysis computer package MS Excel 10 was used.

3. Result and Discussion

During the present investigation on LWR of Indian major carps in Jaisamand Lake, minimum total length (33.000 cm, 38.000 cm and 37.000 cm), maximum total length (69.500 cm, 72.000 cm and 64.000 cm) and its mean (54.081±1.139 cm, 51.601±0.754 cm and 51.723±0.541 cm) were observed for catla, rohu and mrigal, respectively (Table 1). Similarly, the minimum weight (700.0 gm, 500.0 gm and 600.0 gm), maximum weight (5700.0 gm, 4500.0 gm and 3100.0 gm) and mean weight (3197.971±157.814 gm, 1853.333±82.959 gm and 1701.250±52.123 gm) were observed for catla, rohu and mrigal, respectively (Table 1).
The correlation coefficient (r) was calculated from the logarithmic transformed data of total length and weight and observed to be 0.981, 0.967 and 0.946 for catla, rohu and mrigal, respectively. These values are suggesting that the variables (total length and weight) are highly correlated (Fig. 2a, 2b and 2c). Johal and Tandon (1983) [11] reported a strong linear relationship between total length and weight of *C. catla* from Govind Sagar. The strong relationship between total length and weight of Indian major carps were also reported by Ujjania (2012 & 2013) [30, 31], Das *el al*. (2013) [7] and Phulwade *et al.* (2015) [23].
In the present study, regression coefficient (b) for catla (2.600), rohu (3.160) and mrigal (3.019) were observed (Table 1). The value of b = 3 is considered suitable for an isometric growth and if it fluctuates from 3 then considered a sign of allometric growth. The findings of current study showed the isometric growth for mrigal and allometric growth for catla and rohu. According to Hile (1936) [11] and Martin (1949) [16] exponent value 'b' could lie within the range of 2.5 to 4.0. Beverten and Holt (1957) [4] reported that the deviation of this value from '3.0' is rare in adult. Soni *et al.* (1979) [29] reported an exponent value of 3.75 for *Cyprinus carpio* from a tropical lake and 1.5-2.17 for catla was reported by Sachidanandmurthy *et al.* (2013) [26] in Mysure Lake. Negi and Negi (2009) [19] and Negi (2013) [18] reported that value of regression coefficient was 3.0 from lake of Nainital India. Ujjania *et al.* (2013) [31] also reported regression coefficient 2.97-3.13 in rohu of different types of water bodies in southern Rajasthan.
Condition factor (K) and relative condition factor (Kn) are the important biological parameters which indicate the suitability of a specific water body for growth of fish (LeCren, 1951) [15]. Condition factor has been used as an index of growth and feeding intensity (Fagade, 1979) [8]. The condition factor (K) and relative condition factor (Kn) of Indian major carps were studied in present study and the values of K (1.854±0.030, 1.248±0.016 and 1.186±0.014) and Kn (1.005±0.012, 1.010±0.013 and 1.008±0.012) were observed for catla, rohu and mrigal respectively. The results of K and Kn were > 1.0 which indicated good condition of the fish in this water body. Condition factor decrease with increase in length (Bakare, 1970; Fagade 1979) [1, 8] and also influences the reproductive cycle in fish (Welcome, 1979) [33]. Chakraborty and Singh (1963) [6] and Rajbanshi *et al.* (1984) [24] estimated the relative conditions of the *Cirrhinus mrigala* from Allahabad and from Southern Rajasthan respectively. These authors have opined that it is mainly dependent upon the growth, maturity of gonads and length of fish. Johal and Tandon (1983) [12] have described the condition factor of *C. mrigala* from Sukhna Lake (Chandigarh) and results were similar to the present study. Similar findings on K and Kn were also reported by Ujjania *et al.* (2013) [31] for Indian major carp (rohu) in different water bodies of southern Rajasthan. Ujjania (20120) [30] reported >1.0 values of K and Kn for Indian major carps in Mahi Bajaj Sagar and these are very close to the observations of the current study.

Table 1: Length weight relationships of Indian major carps form Jaisamand Lake

Name of fish	Total Length (cm) Minimum-Maximum (Mean ± SE)	Weight (gm) Minimum-Maximum (Mean ± SE)	'n'	'b'	'a'	'r'
Catla	33.000-69.500 (54.081±1.139)	700.000-5700.000 (3197.971±157.814)	119	2.600	-1.049	0.981
Rohu	38.000-72.000 (51.601±0.754)	500.000-4500.000 (1853.333±82.959)	119	3.160	-2.181	0.967
Mrigal	37.300-64.000 (51.723±0.541)	600.000-3100.000 (1701.250±52.123)	119	3.019	-1.962	0.946

Table 2: Condition factor (K) and relative condition factor (Kn) of Indian major carps form Jaisamand Lake

Name of fish	'n'	Condition factor (K)			Relative condition factor (Kn)		
		Min	Max	Mean ± SE	Min	Max	Mean ± SE
Catla	119	1.385	3.006	1.854±0.030	0.757	1.377	1.005±0.012
Rohu	119	0.897	1.691	1.248±0.016	0.760	1.388	1.010±0.013
Mrigal	119	0.925	1.583	1.186±0.014	0.788	1.346	1.008±0.012

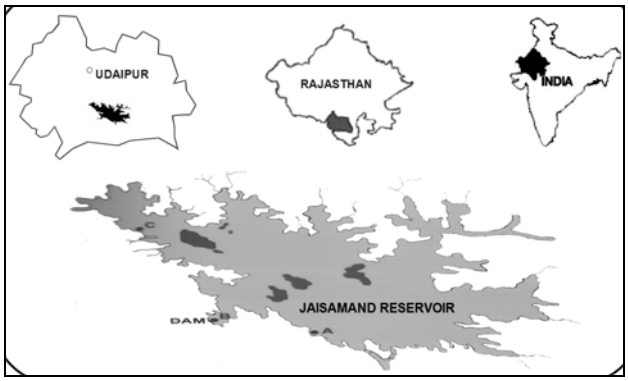

Fig 1: Map of study area

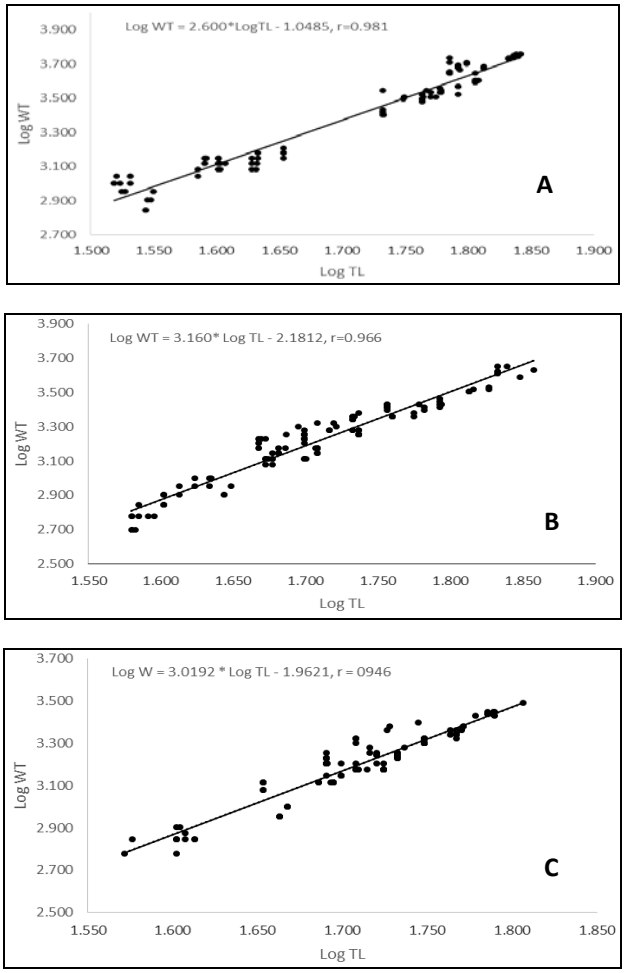

Fig 2: Length weight relationships of Indian major carps (A) catla,, (B) rohu and (C) mrigal

4. Conclusion

From the present study it can be concluded that the length and weight of the studied fish species could be highly correlated to each other. The regression coefficient 'b' shows the isometric and allometric growth of the Indian major carps. The values of condition factor and relative condition factor being >1.0 which show the good condition and wellbeing of the fish in Jaisamand Lake. It is also concluded that the aquatic environment of the Jaisamand Lake is quite conducive and suitable for the survival and growth of the Indian major carps. These results can be considered useful as baseline data for further monitoring the growth related data on the three species with possible changes in growth patterns due to rampant proliferation of invasive fish like Tilapia in Jaisamand Lake.

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