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Second Order Polynomial Curve Fitting for Length-Weight Relationship of *Cirrhina mrigala* from Munj Sagar Talab Dhar, Madhya Pradesh, India

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Abstract: The *Cirrhina mrigala* the Munj Sagar Talab Dhar was studied for its weight-length relationship for the period of Nov. 2006 to Oct. 2008. Length-Weight Relationship (LWR) is useful in *Cirrhina mrigala* was 2.869. Statistical method such as co-relation, smoothing of data, regression and cluster analysis and polynomial curve fitting are helpful in predicting and planning of the ecosystem. The second order polynomial was found to be a best fit for LWR in present study.

Key words: *Cirrhina mrigala*, second order polynomial, allometery coefficient and constant of proportionality, length-weight relationship, India

INTRODUCTION

The length-weight relationship is very important for proper exploitation and management of the population of fish species. To obtain the relationship between total length and body weight are very much essential for stabilization of taxonomic characters of the specie. Among the freshwater fishes, length-weight relationship has been done by many researchers, viz., *Labeo rohita* and *Cirrhinus mrigala* (Ham.) by Khan and Hussain (1941), Jhingran (1952), Chakrborty and Singh (1963), *Tilapia mosambica* by Doha and Dewan (1967), *Trichiurus lepturus* by Narasimham (1970), *Catfish* by Majumdar (1971), *Clarias batrachus* by Sinha (1973), *Oreinus plangiostomus* by Quadri and Mir (1980) *Rhinomugil corsula* by Sugunan and Vinci (1981), *Labeo calbasu* by Vinci and Sugunan (1981), *Alia coila* by Alam *et al.* (1994), *Chanda nama* and *Chanda ranga* by Iqbal *et al.* (1996), *Botia lohachata* by Mortuza and Mokarrama (2000), *Cirrhinus mrigala* (Ham.) by Solanki *et al.* (2004), *Rhinomugil corsula* by Mortuza and Rahman (2006), *Rita rita* by Laghari *et al.* (2009) and *Catla catla* and *Labeorohita* by Dagaonkar and Prakash (2009).

MATERIALS AND METHODS

About the water body: Munj Sagar is located in the district Dhar. It was excavated by Vakpati Munja (993AD) who was the famous rulers of Paramaras dynasty. Munja was a great general, a poet of repute and a great patron of art and literature. Munj Sagar Talab is geographically located at 22°30'06.67" North latitude and 75°17'42.67" East latitude. It covers an area of about 49.596 h. The altitude of Munj Sagar Talab is 554 m. In year 2005, it was deepen by removing the bottom soil. This water body was basically constructed for drinking water purpose but now-a-days, its water is mainly utilize for irrigation and fish culture.

Length-weight relationship: The Length-Weight Relationship (LWR) of *Cirrhina mrigala* were determined. These fish were collected from Munj Sagar Talab. They were collected using cast nets with mesh size of 10 mm. Total length (cm) of individual fish was taken from the tip of the snout to the extended tip of the caudal fin using a measuring board. Body weight was taken to the nearest gram using a top Mark electronic balance after blot-drying of excess water from the body. Length-weight relationship was expressed by the following equation:

$$W = aL^b$$

And was logarithmically transformed into:

$$\log W = \log a + b \log L$$

Where:
W = Weight of fish (g)
L = Total length of fish (cm)
a = Constant of proportionality
b = Allometry coefficient

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Polynomial curve fitting: The general polynomial equation for the curve fitting is:

$$Y = A + B1 * X + B2 * X^2 + B3 * X^3 + B4 * X^4 + B5 * X^5$$

Where:

Y = Dependent variable
X = Independent variable
A, B1... = Numerical coefficient

The numerical coefficient of earlier equation were calculated by the method of least square method with the help of Origin 6.0 software.

RESULTS AND DISCUSSION

Length-weight relationship: Length-weight relationship in *Cirrhina mrigala* are reported in Table 1 and 2.

Second order polynomial equation: Constant for the second order polynomial, observe and predicted were reported in Table 3 and shown in Fig. 1 and 2. Second order polynomial equation for *Cirrhina mrigala* for the period 2006-2007 are as follows:

$$W = -25.13216 - 0.012905 * L + 0.38555 * L * L$$

Second order polynomial equation for *Cirrhina mrigala* for the period 2007-2008 are as follows:

$$W = 348.00411 - 48.94579 * L + 1.7498 * L * L$$

Table 1: The various measurement of *Catla catla*

	Measurments	
Characterstics	2006-2007	2007-2008
Range of length (cm)	9.70-37.30	10.30-38.40
Minimum length (cm)	9.70	10.30
Maximum length (cm)	37.30	38.40
Weight of range (g)	12.98-505.80	13.64-1058.04
Minimum weight (g)	12.98	13.64
Maximum weight (g)	505.80	1058.04
Range of b		2.89-2.91
Average values of b		2.90

Table 2: Length-weight relationship of *Cirrhina mrigala* of Munj Sagar Talab, Dhar Madhya Pradesh with constant and allometery coefficient

Years	Length	Weight	a	B
2006-2007	9.70	12.98	0.02	2.85
	13.60	39.40	0.02	2.89
	25.40	222.70	0.02	2.88
	37.30	505.80	0.02	2.80
2007-2008	10.30	13.64	0.02	2.80
	19.40	109.10	0.02	2.90
	26.70	240.76	0.02	2.86
	38.40	1058.04	0.02	2.98
Average	-	-	-	2.85

Length-Weight Relationship (LWR) are useful in fishery management for both applied and basic uses (Pitcher and Hart, 1982). The study of length-weight relationship of fishes is vital importance to the fishery in setting up yield equation in the study of population dynamics, taxonomic differences, events in life history like metaphorphosis, maturity (Le Cren, 1951). Length-weight relationship allow fisheries scientists to convert growth-in-length equation to growth-in-weight in stock assessment models (Dulcic and Kraljevic, 1996; Goncalves *et al*., 1997; Morato *et al*., 2001; Stergiou and Moutopoulos, 2001; Ozaydin and Taskavah, 2007).

According to Hile (1936) and Martin (1949), the value of b usually lies between 2.5 and 4.0 suggested that the value of b remains constant at 3.0 for an ideal fish. Tesch (1968) viewed the value of b3 which indicates the specific gravity of the tissue remains constant through its life for an ideal fish. Probably due to this reason, the b value is

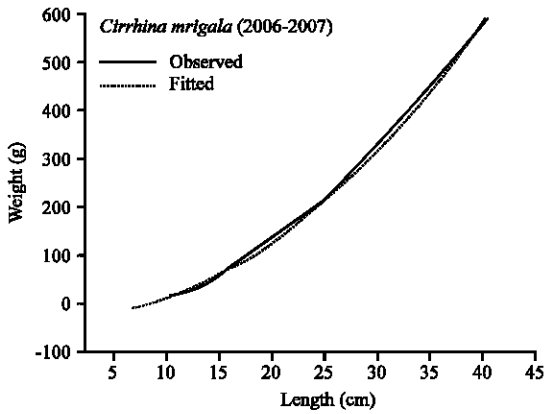

Fig. 1: Observed and calculated value curve of *Cirrhina mrigala* (2006-2007)

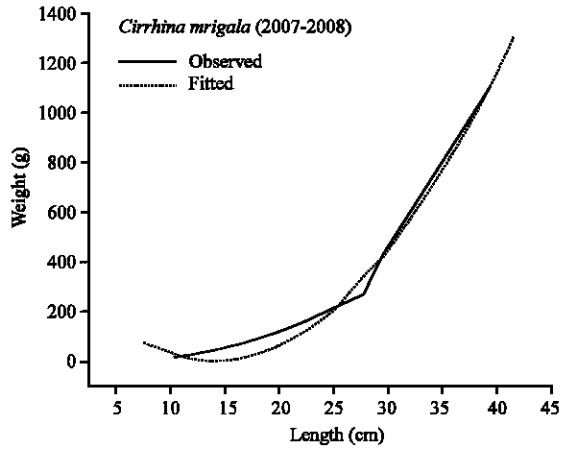

Fig. 2: Observed and calculated value curve of *Cirrhina mrigala* (2007-2008)

Table 3: Values of Constants for second order polynomial fit for lower of *Cirrhina mrigala* and observed and predicted values of weight at Munj Sagar Talab, Dhar

Years	A	B1	B2	Observed	Predicted	R
2006-2007	-25.13216	-0.012095	0.38555	12.98	11.0260	0.99975
				39.64	46.0140	
				222.70	223.8286	
				505.80	510.8280	
2007-2008	348.00411	-48.94579	1.74897	13.64	29.5000	0.99220
				109.10	57.0165	
				240.76	288.5700	
				1058.04	1048.6830	

found to be very close to 3 in many cases. The value of b for *Cirrhina mrigala* reported by many researchers. Javaid and Akram (1972) reported the b value equal to 4.56. Chakrborty and Singh (1963) reported the value of >3. Ahmed and Saha (1996) estimated the value of <3 during their study (b = 2.657). Jha (2010) calculate b value of the same fish from 2 different pond; Rohani and Karon pond as 2.6922 and 2.7173, respectively. In the present study, the value for b for *Cirrhina mrigala* was 2.869 which is <3 and thus corroborate with finding of previous researchers.

Depending on the deviation of b value from 3 fishes can be classified into three groups b = 3, where the body form of fish remains constant b<3 when fish becomes more slender as the length increases and b>3 when fish grows more slouter with increase of length (allometric) with these fact researchers conclude that growth of *Cirrhina mrigala* in Munj Sagar Talab may be considered to be allometric.

Depart from the cubic law in the present study may be due to fact that the fish normally do not retain same shape of the body throught their life span. Sinha (1973) and Das (1982) suggested that seasonal fluctuation in environmental parameters, physiological condition of the fish at the time of collection, gonad development and nutriation condition of the environment of the fishes are the causes for this variation. According to Bagenal and Tesch (1978), Goncalves *et al.* (1997), Taskavak and Bilecenoglu (2001) and Ozaydin and Taskavah (2007), the value of b may vary seasonally and even daily and between habitats. Present researchers also agree with the statement of these researchers that the length-weight relationship in fish is affected by number of factors including gondal maturity, sex, stomach fullness, health and preservation techniques, as well as season and habitat. Present study lead us to conclude that physico-chemical and biological conidtion of Munj Sagar is not optimum for the growth of fishes and shows that still there is a need of lot of management in the physico-chemical and biological parameters in Munj Sagar Talab is required to get the value b = 3 or more which is good sign of growth.

Polynomial curve fitting may be considered, as a mathematical tool which help us in finding a value of a variable (dependent) with another known variable (independent). A polynomial curve fitting is said to be a best fit if the value of regression coefficient (r) is 1 or near to 1. In the present study, several order of polynomial fitting was tried among the different parameters using the Origin 6.0 software. The second order polynomial was found to be a best fit for LWR.

CONCLUSION

As the observed and predicted value are almost same and r = 1, hence researcher proposes the use of second order polynomial equation to determine the Length-Weight Relationship (LWR) as:

$$W = A + B1 * L + B2 * L * L$$

Where:

r = 1; regression co-efficient
A, B1 and 2 = Constants

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