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, allometry coefficient and constant of proportionality, length-weight relationship, India

**INTRODUCTION**


**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 ha. 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:

\[ W = \text{Weight of fish (g)} \]
\[ L = \text{Total length of fish (cm)} \]
\[ a = \text{Constant of proportionality} \]
\[ b = \text{Allometry coefficient} \]
Polynomial curve fitting: The general polynomial equation for the curve fitting is:

\[ Y = A + B_1 \times X + B_2 \times X^2 + B_3 \times X^3 + B_4 \times X^4 + B_5 \times X^5 \]

Where:
- \( Y \) = Dependent variable
- \( X \) = Independent variable
- \( A, B_1... \) = 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:

\[ W = -25.13216 - 0.012905 \times L + 0.38555 \times L \times L \]

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

\[ W = 348.00411 - 48.94579 \times L + 1.7498 \times L \times L \]

<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>Range of length (cm)</td>
<td>9.70-37.30</td>
<td>10.30-38.40</td>
<td></td>
</tr>
<tr>
<td>Minimum length (cm)</td>
<td>9.70</td>
<td>10.30</td>
<td></td>
</tr>
<tr>
<td>Maximum length (cm)</td>
<td>37.30</td>
<td>38.40</td>
<td></td>
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<tr>
<td>Weight of range (g)</td>
<td>12.98-505.80</td>
<td>13.64-1058.04</td>
<td></td>
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<tr>
<td>Minimum weight (g)</td>
<td>12.98</td>
<td>13.64</td>
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<tr>
<td>Maximum weight (g)</td>
<td>505.80</td>
<td>1058.04</td>
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</tr>
<tr>
<td>Range of b</td>
<td>2.80-2.91</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average values of b</td>
<td>2.90</td>
<td></td>
<td></td>
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</tbody>
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Table 1: The various measurement of *Cela coela*

<table>
<thead>
<tr>
<th>Years</th>
<th>Length</th>
<th>Weight</th>
<th>( a )</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006-2007</td>
<td>9.70</td>
<td>12.98</td>
<td>0.02</td>
<td>2.85</td>
</tr>
<tr>
<td></td>
<td>13.60</td>
<td>39.40</td>
<td>0.02</td>
<td>2.89</td>
</tr>
<tr>
<td></td>
<td>25.40</td>
<td>222.70</td>
<td>0.02</td>
<td>2.88</td>
</tr>
<tr>
<td></td>
<td>37.30</td>
<td>505.80</td>
<td>0.02</td>
<td>2.80</td>
</tr>
<tr>
<td>2007-2008</td>
<td>10.30</td>
<td>13.64</td>
<td>0.02</td>
<td>2.80</td>
</tr>
<tr>
<td></td>
<td>19.40</td>
<td>109.10</td>
<td>0.02</td>
<td>2.90</td>
</tr>
<tr>
<td></td>
<td>26.70</td>
<td>240.76</td>
<td>0.02</td>
<td>2.86</td>
</tr>
<tr>
<td></td>
<td>38.40</td>
<td>1058.04</td>
<td>0.02</td>
<td>2.98</td>
</tr>
<tr>
<td>Average</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2.85</td>
</tr>
</tbody>
</table>

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 metamorphosis, 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; Gonoaves et al., 1997; Morato et al., 2001; Stergiou and Moutopoulos, 2001; Ozaydın 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 \( b \) 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
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 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) calculated $b$ 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 through 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 nutrition condition of the environment of the fishes are the causes for this variation. According to Bagental and Tesch (1978), Gonealves 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 gonadal 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 condition 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:

$$W = A + B_1 * L + B_2 * L^2$$

Where:
- $r = 1$; regression co-efficient
- $A$, $B_1$ and $B_2$ = Constants

### REFERENCES


