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# Length-weight relationship and condition factor of *Barilius ngawa* from head water of Thoubal River, Manipur, India

**Ch. Basudha, N Okendro Singh, N Gopimohan Singh and Ngalaton A**

**Abstract**
The present study aims to describe the length-weight relationship and condition factor of *Barilius ngawa,* Vishwanath & Manojkumar, 2002 from the head water of Thoubal River, at Litan, a tributaries of Chindwin river system at Ukhrul district of Manipur, India. A total of 89 *Barilius ngawa* were collected fortnightly during the period of one year from January 2015 to December 2015. The length of the fish ranges between 51.0 mm to 113.0 mm which was used for the present study. The estimated parameter 'b' (3.289) is significantly larger than the value of 3. Also, the average condition factor and the average relative condition factor are 1.839 and 1.0 respectively. Thus, the results indicate that the fish were thriving very well in the head water of Thoubal River and the environment was good for healthy development of *Barilius ngawa.*

**Keywords:** Isometric, *Barilius ngawa,* freshwater, condition factor and nonlinear model

## 1. Introduction

Length-weight relationship (LWR) is one of the most frequently used tool in the study of fish biology and fish stock assessment due to difficulties in getting data from the field (Ayoade, 2011; Froese, 2006; Sinovcic G, Franicevic M, Zorica B and Ciles-Kec V, 2004; Yousaf M, Salam A and Naeem M, 2009) [1, 5, 17, 20]. Weight can be estimated based on length obtained from length-frequency distribution. Besides this, the LWR can be used in setting yield equations for estimating the number of fish landed and comparing the population in space and time. Moreover, LWR is useful in comparison of isometric growth of fish among different regions or environments. It is well known that the LWR of fish is affected by several factors including habitat, area, seasonal effects, degree of stomach fullness, gonad maturity, sex, health, preservation techniques and differences in the observed length ranges of the specimen caught (Tesch, 1971) [18]. Further, another term 'condition factor' of fish is an indicator of physiological state of the fish in relation to its protection (Le Cren, 1951) [12]. It also provides information when comparing two populations living in certain feeding density, climate and other conditions (Weatherly and Gills, 1987) [19]. Thus, condition factor is considered as an important in understanding the life cycle of fish species and it also guides for a proper management of these species, hence, maintaining the equilibrium in the ecosystem (Imam TS, Bala U, Balarabe ML and Oyeyi TI, 2010) [11].

*Barilius ngawa,* Vishwanath and Manojkumar, 2002 is locally known as *ngawa* in Manipuri that distributed throughout the headwater of Chindwin River in Manipur. It is endemic to Manipur state. It is the freshwater species with the widest latitudinal range in the world (Hecht T, Uys W and Britz PJ, 1988) [8]. *Barilius* species inhabits well-oxygenated, medium-to-high gradient, moderate to fast-flowing rivers and tributaries with substrates of gravel, cobbles, larger boulders and exposed bedrock. It is a highly prized fish in Manipur. However, *Barilius ngawa*, due to their small in size are not regarded as economically important fish especially in comparison with other carps and cat fishes which attain much bigger sizes. But, decline in larger species in the current trend enhanced the importance of smaller species fetching a good price. Recently, such small fish species has been gaining momentum for many potential uses and growing commercial status as food and also in ornamental purposes even though it is smaller in size. Thus, the present study attempts to develop the length-weight relationship and to find a condition factor of *Barilius ngawa* from head water of Thoubal River in Manipur, India.

## 2. Material and Methods

*Barilius ngawa,* Vishwanath & Manojkumar, 2002 were collected from headwater of Thoubal River, Chindwin in Ukhrul district of Manipur, at Litan (24.95 N, 94.18 E & 25.19N 94.31E) fortnightly for a period of one year from January 2015 to December 2015. Fish were sampled using gill nets of different mesh sizes and were transported to the laboratory for measurements. A total of 89 fish whose size ranges between 51.0 mm to 113.0 mm were collected and examined. The length of the fishes were measured from their tip of the snout to the last ray of the caudal fin in millimeter (mm) and body weight (in gm) were measured using a single pan balance with 0.001 g sensivity.

The relationship between the length (L) in mm and weight (W) in gm of fish is expressed by following equation (Pauly, 1984) [15]:

$$W=aL^b \qquad (1)$$

Where 'a' and 'b' are the parameters of the above nonlinear model.

Levenberg-Marquardt method is the most widely used and reliable procedure for computing nonlinear least square estimates and is used in the present study.

Moreover, summary statistics like mean square error (MSE) and mean absolute error (MAE) are also calculated.

$$\text{MSE} = \sum_{t=1}^{n}\left(W_t - \hat{W}_t\right)^2 / n \qquad (2)$$

$$\text{MAE} = \sum_{t=1}^{n}\left|W_t - \hat{W}_t\right| / n \qquad (3)$$

Where,

$W_t$ = Observed fish weight (in gm);

$\hat{W}_t$ = Predicted fish weight (in gm);

n = number of observations & t = 1, 2..., n.

A better model has the least values of MSE and MAE. Further, residual analysis is recommended to check the assumptions made for the model. Thus, independence or the randomness assumption of the residuals is usually tested by using the run test procedure (Ratkowsky, 1990) [16]. The normality assumption of residuals is performed by Kolmogorov-Smirnov test in the present study. However, the normality assumption is not so stringent for selecting nonlinear models as their residuals may not follow normal distribution.

A change in 'condition factor' or 'K-factor' or 'Ponderal index' has been calculated as follows (Gomiero and Braga, 2005) [7]:

$$K = 100\ W / L^b \qquad (4)$$

The relative condition factor (Kn) of samples was also calculated as suggested by Le Cren (1951) [12] and the formula is given below:

$$Kn = W / aL^b \qquad (5)$$

## 3. Results and Discussion

The length-weight model given by equation (1) is fitted to the dataset. The statistical package SAS 9.2 is used for data analyses purposes. The estimates of parameter for the fitted model, goodness of fit statistics, results of residual analyses and values of condition factors are presented in Table-1. The parameters a and b are estimated with reasonably small values of asymptotic standard errors and the values of MSE (0.364) and MAE (0.406) are also very small which indicate that the appropriateness of the estimated parameters as well as the fitted model. Further, it is examined to find out whether the assumptions about residuals are satisfied or not. The run test $|Z|$ value (1.832) to check independence assumption of the residuals is below the critical value 1.96 of normal distribution at 5% level of significance ensures the suitability of the fitted model. Moreover, Kolmogorov-Smirnov test (for sample size, $n > 50$) is used to test the normality assumption of the residuals. Significance value (or, p-value of 0.006) for the residuals obtained under the model indicates that residuals are not normally distributed since $p<0.05$ but normality assumption is not so stringent in this case. Thus, the appropriateness of the fitted model to describe the length-weight relationship of ngawa is also illustrated in Fig.1 along with observed values. Isometric or allometric growth pattern of fish was also checked out for the parameters estimated by nonlinear model by setting a null hypothesis $H_0: b = 3$ against $H_1: b \neq 3$. The corresponding t-test statistic has shown that the fish growth does not follow isometric growth (since $|t|$ = 3.378 > Table value of $t_{5\%}$ for large sample size is 1.96). According to Hile (1936) [9] and Martin (1949) [14], the value of 'b' usually ranges between 2.5 and 4.0. Allen (1938) [3] suggested that the value of 'b' remains constant for ideal fish. The average values of condition factor (K) and relative condition factor (Kn) are also given in Table-1. The K value ranges between 0.729 – 3.999 and its average value is 1.839 which is also depicted in Fig.1. The K values show the increasing tendency as the size of the fish increases. In other words, condition of the fish improves as the length of the fish increases. Further, the Kn value ranges between 0.707 – 1.234 and its average is 1.0. However, Ajayi (1982) [2] observed K values lie between 0.77-0.81 for *Clarotes filamentosus* in lake Oguta, Nwadiaro and Okorie (1985) [13] also obtained K value ranged from 0.49 to 1.48 in Adoni river. Gayando and Pauly (1997) [6] reported that certain factors often affect the well-being of a fish. Further, fluctuation in Kn value might be either related to those parameters like feeding rhythms (Hile, 1948; Bal and Jones, 1960) [10, 4].

**Table 1:** Summary statistics of the fitted model to length-weight dataset of the fish (ngawa)

| ***Parameters Estimates*** | **Length-Weight Model: $W = aL^b$** |
|---|---|
| a | $2.527\times10^{-6}$ ($9.78\times10^{-7}$) |
| b | 3.289 ($8.57\times10^{-2}$) |
| *Goodness of fit Statistics* | |
| MSE | 0.364 |
| MAE | 0.406 |
| *Residual Analysis* | |
| Run Test \|Z\| value | 1.832 |
| Test p-value of Kolmogorov-Smirnov | 0.006 |
| *Condition Factors* | |
| Average Condition Factor (K) | 1.839 |
| Average Relative Condition Factor (Kn) | 1.000 |

*The corresponding asymptotic standard errors are shown in the parentheses.

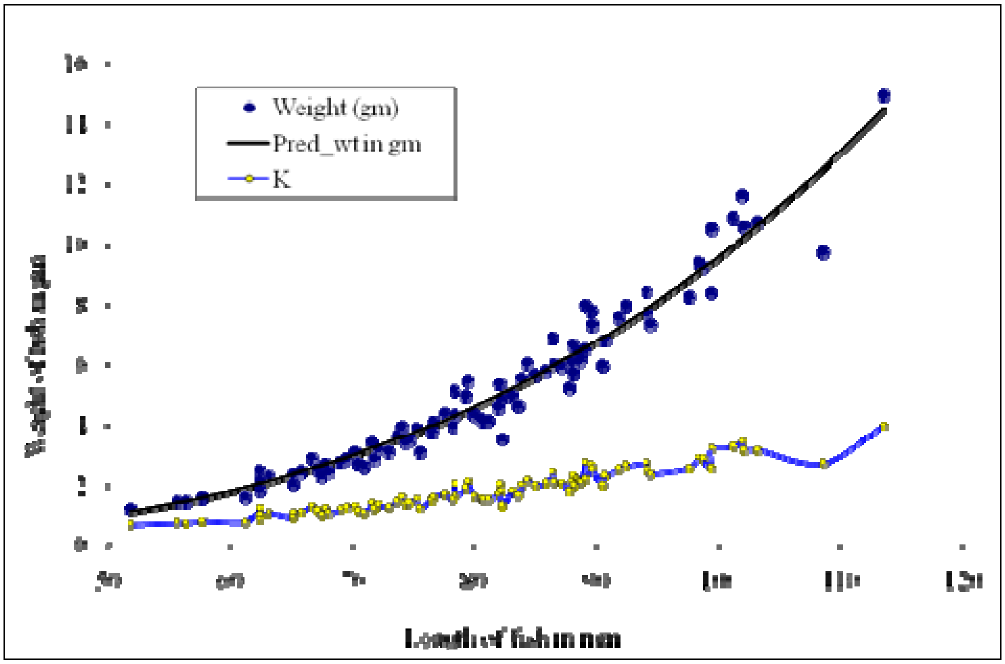


**Fig 1:** Showing the fitted length-weight model and the condition factor of the fish (ngawa)

## 4. Conclusion

We conclude that the results of the fitted nonlinear model showed the appropriateness to describe the length-weight relationship of ngawa. The results also indicated that the equilibrium constant does not obey the cube law since it significantly deviates from 3. The value of the estimated allometric parameter 'b' was found to be more than 3, an indication that the fish were thriving very well in the head water of Thoubal River. We conclude that the head water of Thoubal River, Manipur is a good aquatic environment for healthy development of this fish species.

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