International Journal of Fisheries and Aquatic Studies 2015; 2(5): 147-150

ISSN: 2347-5129
IJFAS 2015; 2(5): 147-150

www.fisheriesjournal.com
Received: 16-02-2015
Accepted: 26-03-2015

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Studies on length –weight relationship and condition factor of *Salmophasia bacaila* (Hamilton) from the lower stretch of river Yamuna at Allahabad

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Abstract
The present investigation is concerned with the study of length-weight relationship, condition factor and relative condition factor of *Salmophasia bacaila* from the river Yamuna at Allahabad, India. A total of 858 specimens of *S. bacaila* in the size range of 3.4 to 15.2 cm were randomly collected from Jan'2007-Dec'2008. The value of exponent (b) for males, females and pooled data were estimated as 2.8272, 2.8268 and 2.8608 respectively. Regression coefficient (b) of *S. bacaila* did not differ significantly between the sexes and in different season. The value of condition factor (K) for males, females and pooled were higher in smaller length group. The Kn value was maximum (1.08) in April and minimum (0.87) in September. The b values were significantly different from '3', thus indicating about allometric growth. Kn value are related to the maturity cycle and spawning in this species.

Keywords: *Salmophasia bacaila* (Ham.), river Yamuna, length-weight relationship and condition factor.

1. Introduction
The length-weight relationship of fish is an important piece of information, required for most computations performed in fisheries stock assessment, but often not available when needed. In fact, not enough attention is generally given to the analysis of the field data from which the parameter of such relationship can be estimated. This relationship is helpful for estimating the weight of a fish given length and can be used in studies of gonad development, rate of feeding, metamorphosis, maturity and condition [1]. Besides this, the LWR can also be used in setting in yield equations for estimating the number of fish landed and comparing the population in space and time [2-4]. In addition, morphometric comparisons can be made between species and populations [5, 6], as well as calculating relative condition factors of individuals in a population [7].

The LWR of fishes can be 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 [8]. The length-weight relationship provides an opportunity to calculate an index used by fisheries biologists to compare the "condition factor" or "well-being" of a fish [9]. This index is condition factor K, provides information like suitability of environment, differential growth of different ages, breeding behavior, spawning, relative fatness and well-being, etc. Fish with a high value of K are heavy for its length, while fish with a low K value are lighter [9].

Salmophasia bacaila (Ham.) is a small indigenous fish of India. It is commonly known as chilhawa, and is abundantly found in the inland tropical water bodies of India [26]. *S. bacaila* (Ham.), because of their comparatively small size were not regarded as economically important fish especially in comparison with major carps and cat fishes which attain much bigger sizes. But decline in larger species enhanced the importance of smaller species fetching good price [27]. In India, despite the many potential uses and growing commercial status of smaller species, very little is so far known of their biology. To the best of the knowledge there is no previous information on length-weight relationship (LWR), condition factor (K) and relative condition factor (Kn) of *S. bacaila* from the river Yamuna in India, therefor present study was carried to estimate the LWR, K and Kn of *S. bacaila*, which would be a useful and new information for other researchers working on smaller fishes.

2. Materials and Methods

Fish samples of *S. bacaila* were collected monthly during January 2007 to December 2008 from the river Yamuna at Allahabad. A total of 858 specimens of *S. bacaila* ranging from 3.4 to 15.2 cm were used for the analysis. Length of fishes was measured to the nearest mm using a measuring board and weight with the help of an electronic balance to the nearest milligram. The relationship between length and weight of a fish can be expressed as $W = al^b$, where w is the weight (gm), l is the length (cm), a and b are constants. The relationship was calculated as given by Le Cren [1], transforming $W = al^b$ into a straight-line using log-log transformation, b and a were estimated using the method of least squares [10]. The transformed form of the equation will be given as:

log w = log a + b log l

To see whether the species followed the cube law the values of the exponent 'b' was tested against '3' using statistical tests. To linearize the relationship log-log transformation was used and the results of regression analysis are presented in Table 1. For the purpose of analysis males, females and pooled data were considered separately.

The condition factor was derived using the formula [1]:

$$K = \frac{W}{L^3} \cdot 10^2$$

Where K = co-efficient of condition and the multiplying factor 10^2 was used to bring the value around unity.

The relative condition factor (Kn) was calculated employing the formula [11] $K_n = \frac{w}{\hat{w}}$

Where, w is the observed weight and, $\hat{w}$ is the estimated weight for the observed length based on the length-weight relationship. Fluctuation in K_n were examined at different months of the year. The data was analyzed using statistical software STATA 10.

3. Results and Discussion

The length-weight relationships were computed, separately for males, females and combined. The scattered plot for length and weight for *S. bacaila* has been presented in Fig. 1. Scattered plot showed that length and weight followed a parabolic relationship. The data on length and weight was transformed to logarithmic form and regression analysis was performed by using the method of least squares.

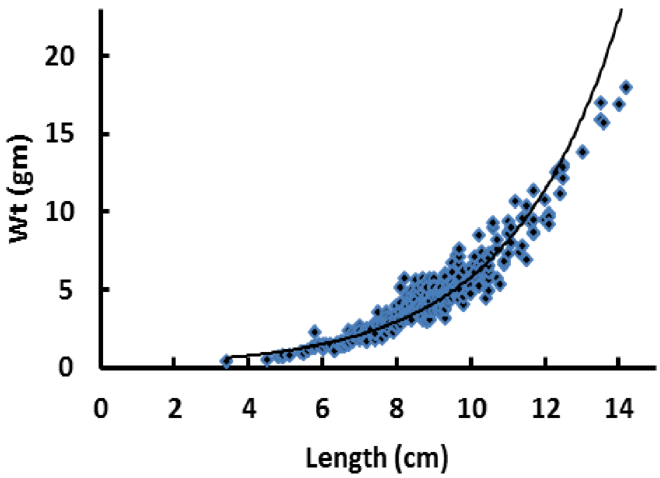

Fig 1: Length-weight relationship of *S. bacaila* (pooled)

Table 1: Regression analysis of data on log length and log weight for *S. bacaila* (Ham.)

reg logw logl (Pooled data)					
logw	Coef.	Std. Err.	95% Confidence interval		R^2
logl	2.8608	0.0478	2.7668	2.9549	0.9227
constant	-2.0818	0.0456	-2.1715	-1.9921	
reg logw logl if sex=male					
logl	2.8272	0.0767	2.6751	2.9793	0.9296
constant	-2.0487	0.0729	-2.1932	-1.9041	
reg logw logl if sex=female					
logl	2.8268	0.0822	2.6637	2.9899	0.9227
constant	-2.0336	0.0799	-2.1922	-1.8750	

On the basis of results the parabolic relationship for weight and length were obtained as:

Male Log W= -2.0487 + 2.8272 log l
(r = 0.9642) or $W = 0.0089\ l^{2.8272}$
Female Log W= -2.0336 + 2.8268 log l
(r =0.9606) or $W = 0.0092\ l^{2.8268}$
Pooled Log W= -2.0818 + 2.8608 log l
(r = 0.9606) or $W = 0.0083\ l^{2.8608}$

The regression equation of males and females subjected to analysis of covariance showed insignificant differences in 'b' values therefore, for further analysis a common equation was used.

Hile [1] and Martin [12] observed that the value of the regression coefficient "n" usually lies between 2.5 and 4.0 and for ideal fish maintain the shape n=3. As noted from the above equations the values of regression coefficient for male (2.8272), female (2.8268) and pooled sexes (2.8608) in the present analysis exhibited a negative allometric growth for both sexes and in the pooled samples, which means they tend to become thinner as they grow larger. Dahare [13] reported the value of exponent 'b' of *C. bacaila* from the river Wainganga, Maharashtra found to be less than 3 for male (2.9086), female (2.6478) and pooled samples (2.8097).

Table 2: Length group wise K values for *S. bacaila*

Length (cm)	Pooled	Male	Female
4-5	0.68		
5-6	0.65	0.65	0.73
6-7	0.64	0.67	0.66
7-8	0.61	0.63	0.64
8-9	0.65	0.64	0.68
9-10	0.59	0.60	0.57
10-11	0.60	0.62	0.62
11-12	0.59	0.56	0.64
12-13	0.60	0.59	0.62
13-14	0.63		0.63
14-15	0.58		0.58

To see the impact of seasons, the data was divided into three seasons, Mar-Jun (summer), Jul-Oct (monsoon) and Nov-Feb (winter) and analysed for length weight relationship. The analysis revealed that the regression coefficients between log l and log w did not differ significantly across the three seasons.

The condition factor or Ponderal index, or co-efficient of correlation expresses the condition of a fish, such as the degree of well being, relative robustness, plumpness or fatness in numerical terms. The condition factor (K) values obtained for different size groups of males, females and pooled samples of *S. bacaila* are presented in Table 2.

The values did not reflect much variation (0.56 to 0.73), however, the K values higher in smaller length groups it shows smaller fishes are in better physiological condition as compare to higher length groups, the maximum (0.73) value observed in the size group 5-6 cm. It has been shown that a fat fish of a given species indicates a higher condition factor than a thin fish of the same species, being equal in length. It has also been demonstrated that the condition factor for fishes having cylindrical body, such as eel, is observed much less than unity whereas fishes of more corpulent form register more than unity.

In *S. bacaila,* the fluctuation in K with length revealed that the trend in fluctuation was more or less similar in pooled as well as in both the sexes and values declined with increase in length. The highest value of K in female fishes were observed in the length groups of 5-6 cm which might be due to active feeding and maturation of gonads of young once, the minimum was observed in the length groups 9-10 cm which might be due to the first spawning of the fish afterward fish showed better condition up to length of 14 cm, it could be related to active feeding and recovery from the strain of spawning. In the length group 14-15 cm the values declined might be due to second spawning of fish. As reported by earlier workers [14-16]) *S. bacaila* has prolonged breeding period. The higher length groups of male also showed low values. In the pooled samples the lowest K value was also observed in the length group 14-15 cm.

Alam *et al.* [17] from Bangladesh found that the condition factor of *L. calbasu* for male showed an inverse relationship with length. Smaller fishes had higher condition values while bigger fishes had smaller values. It may be due to higher metabolic activity. Similar observations have been recorded by various authors in case of *L. calbasu* [18] from Ghaghra river of Uttar Pradesh, India and *Brycinus nurse* species from Asa reservoir, Nigeria [19]. Gairola *et al.* [20] investigated bionomics of economically important fishes, *Barilius bendelisis* and *Puntius ticto* from diverse ecological situations and the growth was found to be allometric. The differences between the regression coefficients within and between sex and size classes were significantly different. For *P. ticto* the peak K values for smaller (<8.0.cm) size, provided evidence of intensive feeding and rapid growth.

Hart [21] observed that, since the adolescent fishes have higher K values than the older fishes, the increase and decrease in K values related to the increasing length can be employed to determine the size at first maturity. Le Cren [1] observed that the condition factor forms an important part of fishery research and often used to provide information about feeding, spawning and other aspects related to the well-being of the fish.

Suryawanshi and Wagh [22] conducted a study on ponderal index of *P. kolus* and showed that the index followed a pattern of seasonal cycle related for feeding intensity and spawning activity. Monthly variations in ‘K’ values synchronized with the feeding intensity of the fish. Bhatnagar [23] while studying condition factor in *P. kolus* stated that the monthly variation in ‘K’ values indicated the spawning season of the fish. A decline in the value denoted the beginning of spawning as the downward trend may be due to increased metabolic strain [24].

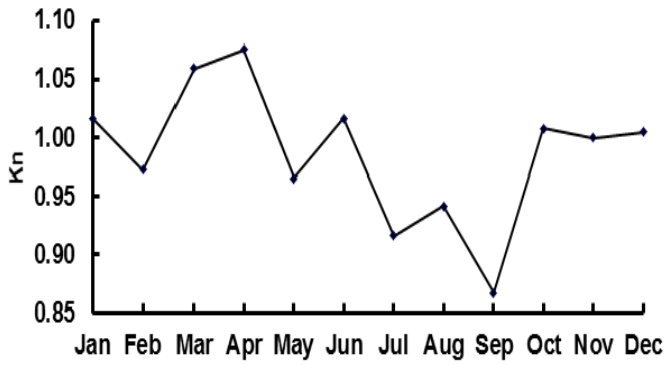

Fig 2: Monthly fluctuation in condition factor (K_n) for *S. bacaila*

Fig. 2 showed a regular increasing and decreasing pattern, but with minor changes. The fish showed maximum (1.08) in the month of April and minimum (0.87) in September.

The lowest K_n value was observed in September which may be attributed to the peak spawning period of the species and their contribution increases in catches. Parameswaran *et al*. [15] have reported that April to July period is spawning season of the species in Assam; and June to September in northern India. Lower K_n values were also observed in the months of February, May July and August which might be due to the stray spawning activity of the fishes. Qasim and Qayyum [15] reported the spawning period of *S. bacaila* from June to September. Khan [25] presented the LWR, condition index and feeding habits of *L. calbasu* from Tilaiya reservoir, Bihar, and observed that fish showed an allometric growth. The value of K_n showed peaks during winter and spring seasons when fat deposition take place and a decline was observed during breeding season. Khan [25] concluded that the reservoir conditions are not conducive to good growth of this species.

4. Conclusion

Computation of length-weight equation for *S. bacaila* revealed that the regression coefficient (n) for male and female were statistically not significant. A general length- weight equation, derived for both the sexes indicated that the value of regression coefficient was found < 3, therefore it is negatively allometric. The environmental conditions and water quality may be responsible for this departure. The variation in Kn value in different months are attributed to spawning and variations in feeding due to the availability of choose food or absence of the same.

5. Acknowledgement

Authors are thankful to the authorities of CIFRI, Allahabad, for providing the facilities and Dr. R.K.Tyagi, Principal Scientist, CIFRI, for his encouragement and support during my research work.

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