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LENGTH-WEIGHT RELATIONSHIP IN ADULT *Heteropneustes fossilis* FROM CULTURE POND

Md. Asaduzzaman Asad*, Dipak Kamal, Suman Kumar Saha and Zubaer Bin Mostafa

Fisheries and Marine Resource Technology Discipline, Khulna University, Khulna 9208, Bangladesh

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Abstract: Length-Weight relationship in adult (one year old) *Heteropneustes fossilis* collected from culture pond of *Batiaghata* in Khulna of Bangladesh was conducted during 1 June, 2007 to 2 July, 2007. The overall sex ratio of male to female was 1: 0.98. The total length was recorded in cm and the weight of the individuals was measured by means of a sensitive (3 decimal places) electric balance in g. The relationship indicated that weight of fish is directly related with the length of the species. A significant length-weight relationship was found for combined sex (R^2 = 0.943), male (R^2= 0.789) and female (R^2= 0.939) in respect to total length of the species. This indicated that they are positively correlated. The peak condition factor (K) value was found at (5.09±0.526), (6.138±.0.60) and (5.77±0.40) in 17-18.9cm, 11.5-12.4cm and 15.5-16.9 cm and relative condition factor (K_n) value was found at (1.09±0.129), (1.186±0.17) and (1.148±0.09) in 17-18.9 cm, 16.5-17.4 cm and 15.5-16.9 cm of total length class size for combined sex, male and female respectively. Regression coefficient values (b) were found at 2.13 and 4.97 for male and female respectively, these values were not significantly different from 3 (Isometric growth) ($p>0.05$) and mean b value was found at 3.5 which indicated that the growth of adult was positive allometric. To ensure the continuity of the biodiversity and to retain the species for future generation, proper management and culture techniques of these species should be encouraged

Keywords: Length-weight relationship, condition factor, *Heteropneustes fossilis,* culture pond

Introduction

The exact relationship between length and weight differs among fish species according to their inherent body shape, and within a species according to the condition (robustness) of individual fish. Among the air breathing-catfish, stinging catfish (*Heteropneuates fossilis*) is very popular and a high priced fish in Bangladesh. According to Das (1927), this fish is locally known as Shingi. The fish is considered to be highly nourishing, palatable and tasty and well preferable because of it less spine, less fat and high digestibility. Das (1927) also mentions that this Small Indigenous Species (SIS) has a high nutritional value in terms of both protein and micronutrients, vitamins and minerals. They contain large amount of calcium, iron and zinc. Owing to its taste, medicinal values and as can be marketed live, it fetches a high price. It can occur in al types of ponds and can survive for a very long time when kept in captivity with even small quantity of water, for it has massive paired sac-like pharyngeal lungs as accessory respiratory organs. Hossain *et al.* (*1994*) mentioned that among the fishing communities, small fish occupy an important position as a popular food item. According to Rubbi *et al.* (1987), fish is an excellent source of protein. Fish accounts for about 80% of the country's animal protein supply. Akteruzzaman *et al*. (1997) denoted that SIS have a high nutritional value in terms of both protein and presence of micronutrients, vitamins and minerals. They contain large amount of calcium and most likely also iron and zinc according to Tripathi (1997).

* Corresponding author: <asad_fmrt@yahoo.com

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Condition factors sometimes reflect food availability and growth within the weeks prior to sampling. But, condition factor is variable and dynamic. Individual fish within the same sample vary considerably, and the average condition factor of each population varies seasonally and yearly. Sex and gonad development are other important variables in some species according to James *et al*. (2000).

Condition factor (K) serves as a useful index of the nutritional and biological cycle viz. gonadal development, spawning etc. of the species. Relative condition factor (K_n) is used in estimating physical well being as well as nutritional and biological cycle. Rao *et al.,* (1987) mentioned that knowledge of length-weight relationship is essential to establish growth equation in production computation. It can also provide data of seasonal variation, multiple spawning and variation in food consumption by Rounsefell and Eveerhat (1953) and Lagler (1956). Application of length-weight relationship as a "Cube Law''to fish measurement had been carried out by many workers (Le Cren, 1951; Doha and Dewan,1967; Shafi and Quddus, 1974) but unfortunately very little prior information on length-weight relationship is available *H. fossilis.* So, the present study was conducted to study the length-weight relationship, condition factor and relative condition factor of adult adult *H. fossilis.*

Materials and Methods

Sample Collection: The study was conducted during in 1 June, 2007 to 2 July, 2007. One hundred and three specimens were collected from the culture pond of Batiaghata in Khulna of Bangladesh. The age of the fishes was about one year.

Measurement of total length, standard length and body weight: At first the specimen was washed thoroughly with the clean tap water. The sample was taken in a tray and dried with soft cotton cloth. The total length was recorded in centimeter (cm) from the tip of the snout to the end of the tail and standard length of the specimen was recorded in the same scale from tip of the snout to the base of the caudal fin. The weights of the specimens were measured by means of a sensitive (3 decimal places) electric balance in gram (g). For determining the length-weight relationship, condition factor, relative condition factor, total length-condition factor, total length-relative condition factor, of *H. fossilis,* " SPSS-12" software and Microsoft office 2007 were used the following formula was also applied with respect to available references.

Length weight relationship*:* The relationship between the length and weight of a fish is usually expressed by the equation $W=aL^b$ or logarithmically Log W=Log a + log b log L by Ricker (1973), where W is body weight (g), L is total length (cm), *a* is the intercept and *b* is the slope according to Beverton and Holt (1996). Sokal and Rohlf (1981) mentioned that the parameters *a* and *b* of the length-weight relationships were estimated by the least-square method based on the predictive or Type I linear regression model, using W as the dependent variable and L as the independent variable. Spiegel (1991) reports that the degree of adjustment of the model studied is assessed by the correlation coefficient (r). Student's t-test was applied to verify whether the declivity of regression (constant "b") presented a significant difference of 3.0, indicating the type of growth: isometric (b=3.0), positive allometric (b>3.0) or negative allometric (b<3.0) (In all cases a statistic al significance of at 5% was adopted.

Estimation of condition factor: The condition factor was calculated by using the following formula: $K = \frac{W \times 10^3}{L^3}$ by Hile (1996). Where, W = weight of the fish in g; L = length of fish in cm; K = condition factor and 10^3 = the factor bringing the ponderal index or condition factor near unity according to Carlander (1970).

Relative condition factor (K_n): In the present study, relative condition factor (K_n) was also determined. Because Le Cren (1951) recommends the relative condition (K_n) as preferable to K, as in the former, the effect of length and other correlated factors are eliminated.

Relative condition factor was calculated by using the following formula:

$$K_n = W/ W'$$

Where, W = Observed weight, W' = Calculated weight.

Results

Relationship between total length and total weight: For determining the length weight relationship, a total of 103 individuals were collected randomly. The overall sex ratio of male to female was found to be 1: 0.98 (Table 1).

Table 1. Length-weight of adult *Heteropneuates fossilis* collected from culture pond.

Sex	N	Body weight			Total length			Standard length		
		Min.	Max.	Mean±SD	Min.	Max.	Mean±SD	Min.	Max.	Mean±SD
Male	52	6.5	22.2	12.406±2.843	11.9	16.7	14.60±1.187	9.7	15.2	13.138±1.094
Female	51	24.1	64.2	36.349±10.315	15.8	23.6	19.163±10.315	14	21	17.35±1.814
Both	103	6.5	64.2	24.261±14.171	11.9	23.6	16.859±2.796	9.7	21.3	15.249±2.571

The regression line of weight on the total length was found to be linear and positive. Regression analysis showed significant positive correlation between total length and total weight (Table 2).

Relationship between total length and condition factor: There was no significant relationship found between total length and condition factor (Table 2); the co-efficient of correlation was tested at 1% level of significance.

Relationship between total length and relative condition factor: There was no any significant relationship found between total length and relative condition factor (Table 2) and co-efficient of correlation was tested at 1% level of significance.

Table 2. Length-weight relationship of adult *Heteropneuates fossilis.*

Sex	Relationship	a	b	R^2	R	t-value
Male	Total length-Body weight	-18.65	2.13	0.789	0.888	13.669*
	Log total length-Log body weight	-1.85	2.52	0.830	0.911	15.598*
	Standard length-Body weight	-16.72	2.21	0.723	0.850	11.421*
	Log standard length-Log body weight	-1.50	2.13	0.765	0.875	12.772*
	Total length-Condition factor	11.42	-0.50	0.32	0.564	-4.827*
	Total length-Relative condition factor	1.10	-0.01	0.007	0.081	-0.567**
Female	Total length-Body weight	-58.89	4.97	0.881	0.939	19.066*
	Log total length-Log body weight	-1.67	2.51	0.917	0.958	23.286*
	Standard length-Body weight	-53.29	5.17	0.825	0.9.8	15.199*
	Log standard length-Log body weight	-1.40	2.38	0.857	0.926	17.126*
	Total length-Condition factor	7.50	-0.13	0.248	0.498	-40.23*
	Total length-Relative condition factor	1.22	-0.01	0.043	0.208	-1.490**
Both	Total length-Body weight	-58.36	4.90	0.935	0.967	38.036*
	Log total length-Log body weight	-2.95	3.49	0.943	0.971	41.022*
	Standard length-Body weight	-56.23	5.28	0.916	0.957	33.227*
	Log standard length-Log body weight	-2.68	3.39	0.925	0.925	35.312*
	Total length-Condition factor	2.37	0.13	0.234	0.483	5.548*
	Total length-Relative condition factor	1.02	0.00	0.00	0.021	-0.210**

a, the intercepts of the relationship; b, the slope of the relationship; *R*, coefficient of correlation; R^2, regression fitness; * $p<0.005$ ** $p>0.005$

Relationship between length-weight according to class interval: Length-weight relationship of adult *H. fossilis* was compared according to class interval and was shown in Table 3, 4 and 5.

Table 3. According to class interval, mean total length (TL), standard length (SL), observed weight, calculated weight, their logarithm value, condition factor (c.f) and relative condition factor (r.c.f) of adult *H. fossilis* (N= 103) (Combined sex).

Class limit	n	TL (cm)	ST (cm)	Observed Weight(g)	Calculated wt (g)	Log TL	Log SL	Log Observe wt	c.f(K)	r.c.f (Kn)
11-12.9	4	12.10±0.141	10.60±0.107	7.32±0.550	6.83±0.275	1.08±.005	1.02±0.025	0.86±.033	4.14±0.398	1.07±0.107
13-14.9	30	14.15±0.475	12.86±0.506	11.36±1.15	11.86±1.36	1.15±0.014	1.11±0.17	1.05±0.043	4.01±0.437	0.96±0.115
15-16.9	24	15.95±0.476	14.35±0.454	17.50±1.86	17.97±1.86	1.20±0.12	1.15±0.013	1.23±0.103	4.28±0.952	0.971±0.21
17-18.9	16	17.75±0.66	15.90±0.77	28.41±2.09	26.19±3.43	1.24±0.01	1.20±0.02	1.45±0.033	5.09±0.526	1.09±0.129
19-20.9	19	19.94±0.672	18.17±0.451	38.53±3.86	39.27±4.59	1.29±0.01	1.25±0.01	1.58±0.04	4.85±0.35	0.98±0.078
21-22.5	8	21.30±0.177	19.31±0.33	49.18±4.43	49.16±1.42	1.32±.003	1.28±.007	1.69±0.41	5.08±0.399	0.99±.077
23-24.9	2	23.55±.070	21.3±.00	64.15±0.73	69.78±0.73	1.37±.001	1.32±.000	1.80±0.001	4.91±0.038	0.91±0.008

Table 4. According to class interval, mean total length (TL), standard length (SL), observed weight, calculated weight, their logarithm value, condition factor (c.f) and relative condition factor (r.c.f) of adult *H. fossilis* (N=52) (Male).

Class limit	n	TL (cm)	ST (cm)	Observed Weight(g)	Calculated wt (g)	Log TL	Log SL	Log Observe wt	c.f(K)	r.c.f (Kn)
11.5-12.4	4	12.10±.0.141	10.60±.0.60	7.325±.0.550	7.12±.0.301	1.08±.0.005	1.024±.0.02	0.863±.0.03	6.138±.0.60	1.03±.0.105
12.5-13.4	3	13.4±0.00	12.23±0.305	11.23±1.209	9.89±0.00	1.127±0.00	1.08±0.01	1.048±0.04	4.95±1.968	1.135±0.12
13.5-14.4	16	13.98±0.35	12.71±0.36	11.20±1.125	11.13±0.74	1.14±0.01	1.10±0.012	1.04±0.04	4.019±0.7	1.006±0.07
14.5-15.4	15	14.78±0.31	13.41±0.34	12.13±1.35	12.84±0.67	1.16±0.009	1.127±0.01	1.08±0.049	3.81±0.81	0.94±0.08
15.5-16.4	12	15.99±0.34	14.32±0.2	15.1±1.44	15.41±0.74	1.20±0.009	1.15±0.006	1.17±0.04	3.48±0.72	0.97±0.07
16.5-17.4	2	16.6±0.14	14.95±0.35	19.85±3.32	16.7±0.30	1.22±0.003	1.174±0.01	1.29±0.07	3.913±1.20	1.186±0.17

Table 5. According to class interval, mean total length (TL), standard length (SL), observed weight, calculated weight, their logarithm value, condition factor (c.f) and relative condition factor (r.c.f) of adult *H. fossilis* (N=51) (Female)

Class limit	n	TL (cm)	ST (cm)	Observed Weight(g)	Calculated wt (g)	Log TL	Log SL	Log Observe wt	c.f(K)	r.c.f (Kn)
15.5-16.9	6	16.11±0.39	14.70±0.20	24.20±0.08	21.±20	1.20±0.01	1.167±0.005	1.38±0.001	5.77±0.40	1.148±0.09
17-18.4	13	17.53±0.52	15.73±0.652	27.98±0.52	28.27±2.58	1.24±0.012	1.196±0.017	1.44±0.033	5.187±0.52	0.995±0.102
18.5-19.9	11	19.109±0.33	17.51±0.746	34.08±2.70	36.08±1.68	1.28±0.007	1.24±0.019	1.53±0.035	4.86±0.231	0.943±0.04
20-21.4	17	20.72±0.485	18.74±0.579	43.37±5.37	44.105±2.41	1.31±0.01	1.272±0.013	1.634±0.053	4.85±0.44	0.981±0.092
21.5-22.9	2	21.5±0.00	19.30±0.283	52.10±.0.00	47.96±0.00	1.33±0.00	1.285±0.006	1.71±0.00	5.23±0.00	1.086±0.00
23-24.4	2	23.55±0.07	21.30±0.00	64.15±0.07	58.15±0.351	1.37±0.001	1.32±0.00	1.80±0.004	4.90±0.038	1.103±0.005

Discussion

Regression coefficient values (b) computed were 2.13 and 4.97 for male and female of *H. fossilis* respectively, although the values were not significantly different from 3 (Isometric growth) ($p>0.05$) and mean b value was found at 3.5 which indicated that the growth of the adult *H. fossilis* was positive allometric according to Spiegel (1991).

According to Pauly and Gayanilo (1997), *b* values may range from 2.5 to 3.5 suggesting that the result of this study was valid.

The arithmetic values of total length are plotted against corresponding weight and the regression lines were delineated as straight line relationship. The relationship indicated that weight of fish was directly related with the length of the species. A significant length-weight

relationship was found (R^2 = 0.93; R=0.967) in respect to total length of *H. fossilis* for combined sex, (R^2=0.789; R=0.888) for male and (R^2=0.88; R=0.939) for female. This indicated that they were positively correlated. The significance coefficient of correlation between the measurements-length and body weight of *H. fossilis* in the present study agreed well with the results reported for *Trichirus savala* (Bashirullah and Kader 1970); *Gobiodes rubicundus* (Kader 1984); *Gudusia chapra* (Jhingram, 1968); *Thryssa hamiltonii* and *T. mystax* (Hussain and Ali, 1987).

The condition factor is not constant in great majority of fishes. In nature it has been found to vary in individual of a species of population. It fluctuates periodically with season of the year which may be due to heavy feeding, spawning and rebuilding of reproductive system. In the present study no significant relationship between total length and condition factor was found. Significant sexual differences in length and weight were observed in this species. The significant differences in slope of length weight relationship between females and males could be due to this difference of length and weight in sexes. The weight of female was found higher than male of the same size in this study (Table 4 and Table 5).

The length-weight relationship in fishes can be affected by a number of factors including season, habitat, gonad maturity, sex, diet and stomach fullness, health and preservation techniques and differences in the length ranges of the specimen caught (Tesh, 1971; Wootton, 1998), which were not accounted for in this study. Thus, differences in length-weight relationships between this and other studies could potentially be attributed to the combination of one or more of the above factors.

Conclusion

The species of *H. fossilis* was abundant in the nature, however, changes in the environment and other factors are threatening for their existence. To ensure the continuity of the biodiversity and to retain the species for future generation, proper management and culture techniques of this species should be encouraged. This investigation, however, will provide basic information on the biology of these species. The data can also be used as a guideline for promoting fish consumption and further detailed studies. The major limitation of the present study is the small sample size. Therefore, further year round study is needed.

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