Length-Weight relationship and condition factor of *Semiplotus semiplotus* (McClelland, 1839) from Dikrong River, Arunachal Pradesh, India

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Abstract- The length -weight relationship and condition factor (K) of *Semiplotus semiplotus* (McClelland, 1839), were studied for an economically important species of food fish from the Dikrong river system of mountainous state of Arunachal Pradesh, India. A total of 120 specimens were randomly collected using cast net and related contraptions from the water bodies and length (mm) and weight (g) of each of the specimen was measured following standard equipments. The result revealed that length- weight of the species followed the cube-law indicating an isometric growth pattern of the species in its natural habitat. The length –weight regression equation for the species in general can be expressed as Log W = -2.7259+3.04269logTLand the length-weight regression equations of males, females and juveniles respectively were Log W = -2.7242+ 3.0926log TL, Log W = -2.7635+ 3.2592 log TL and Log W = -1.2375 + 2.6135 log TL having r value respectively 0.90674 , 0.98107,0.959 for each cases . All these values indicate positive correlation between length and weight in *Semiplotus semiplotus* in regard to their sex as well as growth stages. General wellbeing of the fish is found to be good, as indicated by the values of condition factor, which were nearer to or greater than 1.

Index Terms- *Semiplotus*, Dikrong river, condition factor, isometric growth.

I. Introduction

The generation of information on length-weight relationship of any species of fish has great significant in fish biology and has several applications in the subject. The parameters like general well-being of any fish species either in its natural habitat or cultivable environment, comparison of growth pattern, onset of maturity spawning, fecundity *etc*., can be assessed with the help of length –weight relation and condition factor[21],[38]. *Semiplotus semiplotus* (McClelland, 1839) wild endemic cyprinidae fish species distributed all the river system of Arunachal Pradesh, very scanty biological information is available still. Moreover, this cyprinid fish is most preferred food fish of the people of the state and the population of this fish is rapidly declining in its habitat probably due to over exploitation along with indiscriminate habitat destruction for various developmental activities. An approach towards conservation and management of the population of this particular fish species demands the generation of information for its length-weight relationship and condition factor from its natural habitat. Estimation of the population size of a fish stock for the purpose of its rational exploitation often requires knowledge of these relationships [21], [11]. Length–weight relationships can also be used to know the growth pattern of the fish in the culture system. It is also used to estimate fish biomass from length frequency distributions, infer fish condition, and to compare life history and morphological aspects of fish populations inhabiting different region [31], [38]. Length-weight relationship establishes the mathematical relationship between length and weight of fish [6]. Inter-conversions of these variables are required for setting up of yield equations, hence leads to information about the body forms of different groups of fishes and its growth pattern. Length-weight relationship also provides information on the changes in the well being of the fishes that happens during their life cycle. This can be estimated by comparing the expected weight estimated by using the length-weight relationship with actual weight of fish. Like other morphometric measurements, length-weight relationships may change during the events of life cycle like metamorphosis, growth and onset of maturity [21].Length-weight relationships can be used as character for differentiation of taxonomic units. An already established length-weight relationship will be useful for assessing the data that contains only length frequency measurements. This relationship can be used in setting up of yield equations, estimate the number of fishes landed and for comparing the population over space and time [5].The relative condition factor in preference to condition factor as the latter is influenced by many environmental and biological factors [21]. Condition factor measures the deviation from a hypothetical ideal fish whereas relative condition factor measures the deviation from the average weight or length of fish. The relationship between the length (L) and weight (W) of a fish is usually expressed by the equation $W=aL^b$. Values of the exponent 'b' provide information on fish growth. When b=3, increase in weight is isometric. When the value of b is other than 3, weight increase is allometric (positive if b>3, negative if b<3.This parameters (a, b) are important in stock assessment studies. Generally, in fishes the growth pattern follows the cube law indicating isomeric growth [7], [19]. In such cases, the exponential value must be exactly 3.However; environmental stressors may affect the actual relationship between length and weight changing the ideal value [21],[23], [28], [14], [35], [30].Length-weight relationship and condition factor of various fishes have been reported earlier[21], [20], [26],[29], [36], [37], [12],[9], [10],[3],[27].

With the above backdrop, a research activities was designed to find out length-weight relationship and condition factor *in-situ* for the *Semiplotus semiplotus* a potential food fishes for mountain aquaculture so that comparison of well being of the fish can be compared with the population under captive condition expressing values in numerical terms *i.e.,* condition of health, relative strength, fatness *etc*., compared to in-*situ* habitat. This article describes the whole study the in detail which seems to be valuable information for the fishery biologists, conservation specialist and aquaculture specialists trying to develop hill aquaculture in eastern Himalayan region of India.

II. Materials and Methods

The sampling of fishes were carried out in the river Dikrong, flowing within the latitude 27°08'19" N and longitude 93°44'51" E having average elevation of 120 meter from the mean sea level in state of Arunachal Pradesh and finally drained into the river Brahmaputra in Assam. The Dikrong River is one of the major tributary of Brahmaputra drainage system in the states having diversified fish species including moderate population of a cyprinid species *Semiplotus semiplotus*. A total of 120 fish samples including male, female and juveniles of *Semiplotus semiplotus* were collected from November 2011 to December 2012. (29 males and 40 females and 51 juveniles), ranging from 80.0mm-285.0 mm cm in total length (TL) and 6.5g to 330g in weight were used for the length-weight analysis. Fishes were caught by gill nets and cast nets. The samples were transported to the laboratory in oxygenated polythene bags. Dead fishes were kept in deep freezer. Prior to weight and length measurements the fishes were taken out from the freezer and allowed to thaw. Length of fish was measured to the nearest 1.0 mm and weight up to 0.1 g. The fishes were then sexed by observing the gonads after dissection. . Total length (cm) of each fish was taken from the tip of the snout to the extended tip of the caudal fin using digital calipers. Body weight (g) of each fish was taken to the nearest to 1.0 g using a electronic balance (Kern)

The relationship between the length (L) and weight (W) of a fish is first proposed by Huxley (1924) the allometric growth formula to describe the relationship between length and in the form $W=aL^b$, Where W stands for weight,L for length ,a is a constant and b the exponent. The equation expressed logarithmically as suggested by Le Cren (1951)- LogW=Loga+blogL, where 'a' is a constant being initial growth and 'b' is the growth coefficient.

The values of constant a and b were estimated from the log transformed values of length and weight to log W = log a + b log L, via least square linear regression. All the statistical analysis was done in Excel 2007

A) Condition factor and Relative condition factor: Individual variation from general length-weight relationships have been studied under the general name condition [21].Such changes in condition factor or "K-factor" or ponderal index, which has been calculated by using Hille (1936)[15] and Backman (1948) [4] proposed the following
Formula to determine the condition factor (K)

$$K=W\times100/L^3$$

Where, K=Condition factor
W=weight of the fish and
L=Length of the fish

The number 100 is a factor to bring the ponderal index (K) to near unity [8].The condition factor of a fish is influenced by the seasonal changes of gonads and also by the feeding intensity.

The relative condition (Kn) of each size group was estimated by the equation Kn=W\w used by Weatherly (1972) [41] and others, where W= observed weight, w= mean weight of each size group calculated from length- weight relationship. All the statistical analysis was done in Excel 2007.

III. Results

The entire sexed length-weight data of *Semiplotus semiplotus* were pooled in to a single equation which was calculated as:
LogW= −2.7259+3.04269logTL (r=0.9421)
Where, W = Total weight; TL = Total length; r = Correlation coefficient

The calculated correlation coefficient (0.9421) showed a positive correlation between length and weight of the fish. The parabolic equation was $W=0.00191023L^{3.042}$ .The value of 3.043 obtained for b clearly indicated that the length-weight relationship follow the cube law showing isometric growth of the species in it natural habitat

Parabolic and logarithmic graph prepared separately for male, female and juvenile from the collected data showed a straight line relationship in each of the cases of males and females and parabolic line showed in the case of juveniles (Fig. 4 and 5).Various descriptive statistical parameters and relevant equations on length-weight relationship of *Semiplotus semiplotus* are presented in Table 1

A) Length-weight relationship in males, females and Juveniles:

The length-weight relationship in males was based on the examination of specimens ranging from 132 to 285 mm and that in females from 212 to273 mm in total length. The regression equation for male *Semiplotus semiplotus* was estimated to be Log W = -2.7242+ 3.0926log TL (r = 0.90674) .The regression equation for females estimated was: Log W = -2.7635+ 3.2592 log TL (r= 0.98107).The length-weight relationship in juveniles of *Semiplotus semiplotus* was based on the examination of specimens ranging from 80 to 116 mm in total length. The regression equation for juvenile was estimated as: Log W = -1.2375 + 2.6135 log TL (r = 0.959).

B) Condition factor and Relative condition factor:

The condition factors (K) and Relative condition factor (Kn) have been calculated for each 10 mm length groups and the results are presented in Table 2.and Figure 6 .The 'K' value showed its peak in length group IX (161-170mm) and lowest value showed in length group II (91-100).The relative condition factor is varies from 0.9-2.0

Discussion

Length-weight relationship establishes the mathematical relationship between length and weight of fish [6]. Inter-conversions of these variables are required for setting up of yield equations, hence leads to information about the body forms of different groups of fishes and its growth pattern. Length-weight relationship also provides information on the changes in the well being of the fishes that happens during their life cycle. This can be estimated by comparing the expected weight estimated by using the length-weight relationship with actual weight of fish. Like other morphometric measurements, length-weight relationships may change during the events of life cycle like metamorphosis, growth and onset of maturity [21].

The values of length-weight regression coefficient "b" for *Semiplotus semiplotus* males (3.0926), females (3.2592) and sexes combined (3.0426) were indicate the isometric growth pattern of the fish. The 'b' value of juvenile indicate negative allometric (b>3) growth pattern. The value of regression co-efficient (b) usually lies between 2.5 and 4.0 [15]. The value of 'b' might be in between 2.0 and 4.0[40]. However, a variation in 'b' value may occur due to different environmental factors. An intraspecific difference in the power function 'b' of length in relation to body weight in *Rita rita*, *Sardinella albella, Sardinella gibbosa* and *Acrossocheilus hexagonolepis,* respectively at different stages of their growth[20], [34], [9]. The 'b' values is greater than 3 in the case of *Labeo rohita* was observed by many biologist [12], [17], [18]. Isometric pattern of growth was also observed by Narejo *et al*. (2002) in *Monopterus cuchia* [27].The value of regression coefficient was reported in *Labeo calbasu* was 3 from Loni River, in Madhya Pradesh, India [29].Similar observations were also reported in *Garra gotyle* from river Bhagirathi, in *Strongylura leiura, Ablennes lians,* and in *A. hexagonolepis* and in *Nemipterus japonicas* [10], [33], [9],[32] .Similar results were also reported for b in males and females of *A. hexagonolepis* and in *Monopterus cuchia* ,[9], [27]. The value of regression coefficient in *Labeo calbasu* as 3.0 from Loni reservoir, M. P. India [29]. The value of regression coefficient wass recorded as 3.16 for *Hilsa* males and females from Iraq[1].The values of 'b' was reported as 3.16 for males and 3.20 for females in *Labeo bata* from Bangladesh[3].The value of 'b' was calculated as 3.02 for males and 3.03 for females in *Tenualosa ilisha* from Pakistan[27]. However, a variation in 'b' value may occur due to difference in environmental factors. The value of 'b' remains constant at 3.0 for an ideal fish [2].

The 'b' value of juveniles of *Semiplotus semiplotus* was observed negative allometric growth pattern (b>3) (2.6135) and the values was found to be greater than '3' and equal to '3'(3.2592) in case of females and males(3.0926) due to environmental condition, food competition,trophic potential of the river etc. The seasonal changes, notably the period during and immediately after spawning, affect the length-weight relationship. Weight of the gut contents may also alter fish weights, depending upon the food ingested just before weighting [25].

The correlation coefficient of male, female, juvenile and pooled data (Table: 1) showed a very high degree of correlation between length and weight in *Semiplotus semiplotus.* The similar type of observations was observed in *Labeo rohita* from Ganga basin in India [24].

The condition factor of *Semiplotus semiplotus* showed variation in different length groups, it was noticed that the K was higher when fish entered into the maturation phase (Figure.6). The length group 161-280mm showed highest K value because of maturity stages of the fish ranges in this lengths. K showed slightly lower values in the juvenile length group and after spawning groups. The environmental factors, food supply and parasitism have great influence on the health of the fish [21]. The differences in condition factors seasonally could be attributed to low feeding intensity and degeneration of ovaries during winter and high feeding intensity and full development of gonads during summer months. Comparatively high values of K during winters could be attributed to high deposition of fats as preparation for the coming breeding season. The values of relative condition factor Kn showed fluctuations in all size groups of males and females. The highest Kn values observed in the length group IX (161mm-170mm) (Figure.6).

The members of one population sampled on a single date, there may be considerable variation in condition with length. Fish populations display considerable variations in average condition, reflecting normal seasonal fluctuations in their metabolic balance and in the pattern of maturation and subsequent release of reproductive products (Goswami, 2008). It has been reported that feeding intensity may also influence the 'K'factor (Wheatherley, 1972).

The present studies provide the first hand information about the growth pattern and relative conditions of *Semiplotus semiplotus* from its in-situ habitat. This study will help biologists to know the status of this fish and develop culture technology in natural waters and will be useful for the fishery biologists and conservation biologist, for successful development, management, production and ultimate conservation of the most preferred food fishes of the states.

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Figures:

Figure 1: *Semiplotus semiplotus* (Male)

Figure 2: *Semiplotus semiplotus* (Female)

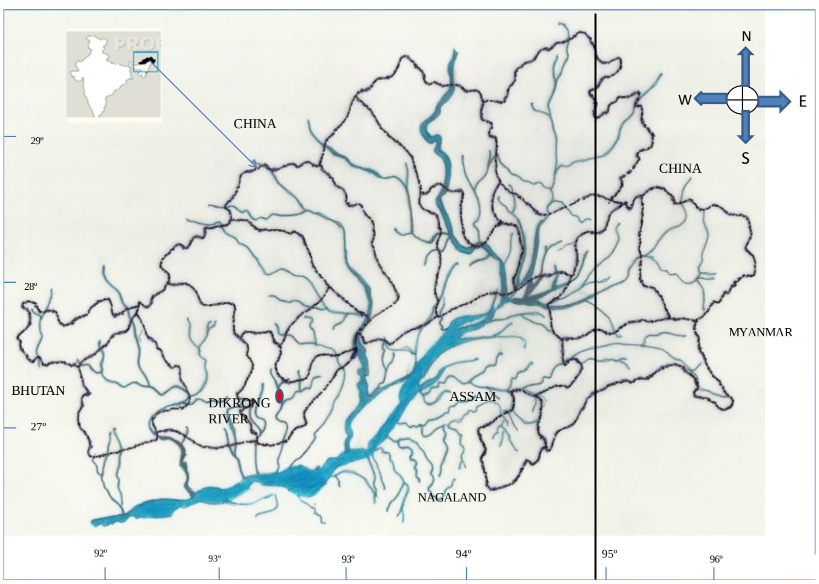

Figure 3: Map showing the sampling sites of *Semiplotus semiplotus.*

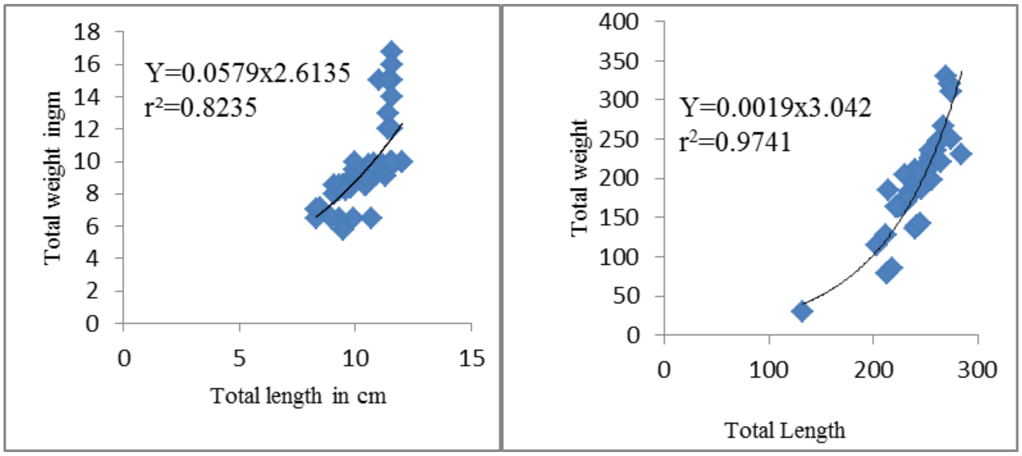

Figure 4: Length-Weight relationship of juveniles and sexed groups.

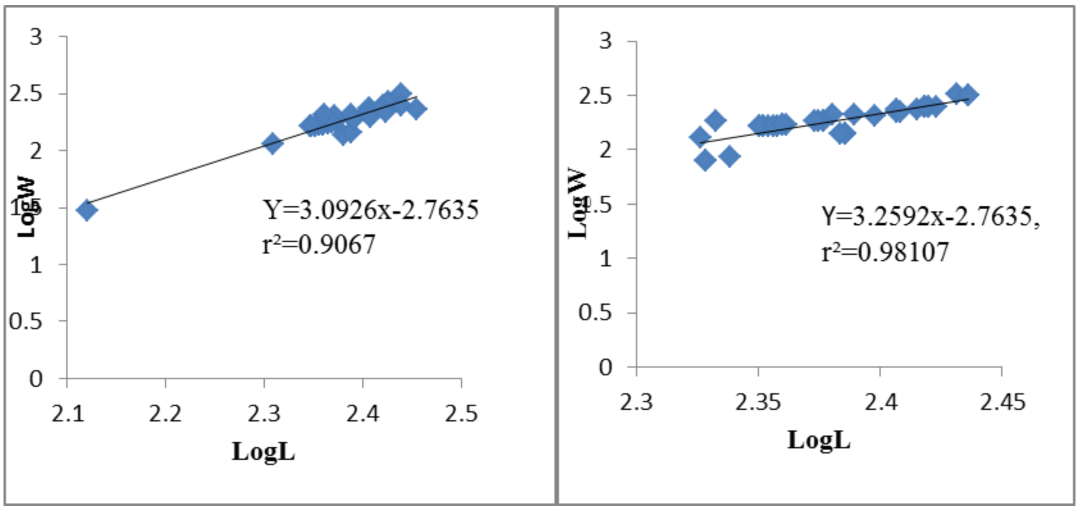

Figure 5: Length-weight relationship of males and females of *Semiplotus semiplotus.*

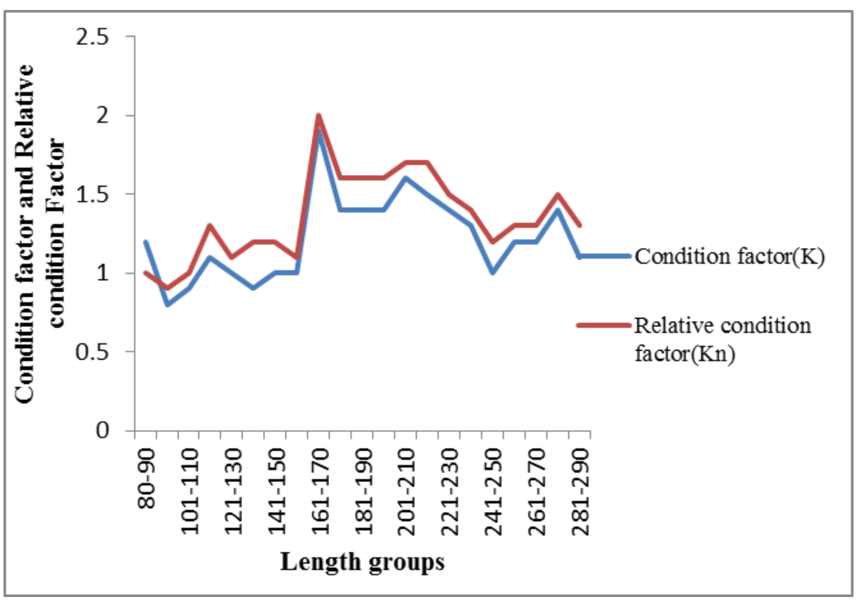

Figure: 6.Condition factor (K) and Relative Condition factor (Kn) of different size groups of *Semiplotus semiplotus.*

Tables:

Table1: Descriptive statistics and estimated parameters of length-weight relationships for *Semiplotus semiplotus* from Dikrong River Arunachal Pradesh, India.

Sample	Sample Size	Length range(mm)	b value	a value	R^2	95% CL of b	Parabolic equation
Female	40	212-273	3.2592	0.0017	0.9810	3.504-2.99	$W=0.0017365L^{3.2592}$
Male	29	132-285	3.0926	0.0019	0.9067	3.344-2.835	$W=0.00190L^{3.0926}$
Pooled (Sexed	69	132-285	3.0426	0.0019	0.9421	3.33-2.8212	$W=0.00191023L^{3.042}$
Juveniles (Unsexed	51	80-116	2.6135	0.057	0.959	2.867-2.358	$W=0.0579L^{2.6135}$

Table 2: Condition factor (K) and Relative Condition factor (Kn) in different length groups of *Semiplotus semiplotus.*

Sample size group(mm)	Condition factor(K) (mean ±SE)	Relative condition factor(Kn)(mean ± SE)
I.80-90	1.2±0.01	1.0±0.01
II.91-100	0.8±0.04	0.9±0.03
III.101-110	0.9±0.04	1.0±0.04
IV.111-120	1.1±0.04	1.3±0.05
V.121-130	1.0±0.01	1.1±0.01
VI.131-140	0.9±0.01	1.2±0.03
VII.141-150	1±0.01	1.2±0.01
VIII.151-160	1±0.01	1.1±0.02
IX.161-170	1.9±0.03	2.0±0.01
X.171-180	1.4±0.04	1.6±0.03
XI.181-190	1.4±0.04	1.6±0.01
XII.191-200	1.4±0.07	1.6±0.01
XIII.201-210	1.6±0.09	1.7±0.01
XIV.211-220	1.5±0.01	1.7±0.03
XV.221-230	1.4±0.1	1.5±0.02
XVI.231-240	1.3±0.05	1.4±0.05
XVII.241-250	1±0.08	1.2±0.06
XVIII.251-260	1.2±0.03	1.3±0.03
XIX.261-270	1.2±0.02	1.3±0.01
XX.271-280	1.4±0.05	1.5±0.05
XXI.281-290	1.1±0.07	1.3±0.01