International Journal of Fisheries and Aquatic Studies 2019; 7(6): 21-25

E-ISSN: 2347-5129
P-ISSN: 2394-0506
(ICV-Poland) Impact Value: 5.62
(GIF) Impact Factor: 0.549
IJFAS 2019; 7(6): 21-25

www.fisheriesjournal.com
Received: 11-09-2019
Accepted: 15-10-2019

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Length-weight relationships and condition factor of *Oreochromis niloticus* and *Citharinus citharus* in lower river Benue, Nigeria

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Abstract
The length-weight relationship and condition factor of two fishes were studied so as to infer the conditions of the Lower River Benue suitable for fish habitation. The species of fish selected (*O. niloticus* and *C. citharus*) are known to be harden and prolific. 114 samples of *O. niloticus* and 104 samples of *C. citharus* were obtained from the Wurukum landing site at Makurdi. The LWR protocol were administered on the samples and the results obtained indicated that the growth pattern (b) for *O. niloticus* (0.332: female and 0.365: male) and *C. citharus* (1.458: female and 1.421: male) were negative allometric and markedly far from isometric growth pattern (3). It was also established that the condition factors of the two species: *O. niloticus* (1.48±0.13: female and 1.32±0.09: male) and *C. citharus* (1.57: female ±0.11 and 1.34±0.11: male) were lower than values obtained of the same species in other water bodies. It was concluded that the comparatively lower values recorded in this study were as a result of the unfavorable water physicochemistry and food scarcity in Lower River Benue.

Keywords: Length-weight relationship, condition factor, river benue, *Oreochromis niloticus, Citharinus citharus*

Introduction

The relationship between length and weight has been referred by [1] as very important key which was widely used in fish biology with several purposes. This useful tool provides important information concerning the structure and function of fish population. The morphometric relationships between length and weight can be used to assess the well-being of individuals and to determine possible differences between separate unit stocks of the same species [2] Length–weight relationships provide useful information on fish species within a given geographic region [3, 4]. In fish, size is generally more biologically relevant than age, mainly because several ecological and physiological factors are more size-dependent than they are age-dependent. Therefore, variability in size has important implications in fisheries science and population dynamics [5] and is one of the most common measurements in fisheries data [6]. The Length–weight relationship of a species allows the interconversion of these two parameters. In biological studies Length–weight relationships allow the assessment of seasonal variations in fish growth and the calculation of condition indexes [7], which is frequently used in the analysis of ontogenic changes [8] for between-region life-history comparisons [9]as well as to identify the spawning season [10] In fisheries studies WLRs have many different uses, including the estimation of weight from length [11] and of weight-atage [12], as well as the conversion of growth-in-length equations to growth in-weight [13]. The importance of these variable cannot be over emphasized because they reflect the physiological state of the fish as they are affected by intrinsic (gonadal development, organic reserves, presence or absence of food in the gut) and extrinsic (food availability, environmental variability) factors [14] hence, could be used to access the general wellbeing [15]. It is essential to conduct the length-weight analysis of a stock in order to assess the changes that occur in their growth vis-à-vis the ever-changing ecological conditions. Fish found in tropical and sub-tropical water system experience frequency growth fluctuation due to factors such as food composition changes, environment changes, rate of spawning to mentioned but few, length-weight and length weight relationship can be used to assess the influence of these factors in fish.

Oreochromis niloticus and *Citharinus citharus* are common fish species in the tropics. They are inherently tolerant to unfavourable ecological changes (water volume, food availability and physico-chemistry). Because of this, they are abundant in the inland waters of Nigeria. It is noteworthy to mention too that they are not of high economic values (due to numerous bones and comparatively small sizes) and because of their low exploitation aiding their persistent inhabitation in water, their length-weight parameters are sufficient indicators of the well-being of other fish stocks.

Materials and Methods

Fish samples were obtained from fishermen at the landing site behind the Wadata market which lies between longitude 8^o and 9^{o}east and latitude 7^o and 8^{o}North. The Lower Benue River is the course of the Benue River that runs within Benue and Kogi States of Nigeria [16].

The sex ratio was determined by counting the number of male and female specimen of each species caught in the period of study. The fish of various species were separated into male and female using specific features that were peculiar to different sexes. The features used were sizes, reproductive organs and presence nubs on the abdominal segment [17].

A total of two hundred (200) fresh fish samples were collected. Each sample was measured for standard length (SL) while the body weight was measured in grams using a top loading balance (Adam AFP4100L).

Length-weight relationship was calculated using the equation

$W= aL^b$ [18]

Where W= Body weight of fish (g)

L = Standard length of fish (cm)

a= constant (regression constant)

b= an exponent

Transformed to logarithmic form as:

Log W= Log a + b Log L

The condition factor or ponderal index (k) values was calculated using Fulton's condition factor formula [19]

$$K= \frac{100W}{SL}$$

Where K= Condition factor

W= weight (g)

SL = Standard Length of fish (cm)

Results

The variations by sex of body parameters and condition factor of *Citharinus citharus* is presented in Table 1. The sex ratio (male: female) was 1:1.17. The mean weight of female and male were 146.81±5.81g and 140.98±5.54g.The mean total length of female and male was 26.8±3.37g and 22.70±0.57g while the mean standard length of female and male was 19.15±0.61g and 18.09±0.54g. The condition factors shows of female and male for *Citharinus citharus* were 1.57±0.11 and 1.34±0.11 respectively. The mean weight, mean total length, mean standard length and condition factor were not statistically significant (p>0.05) between sexes although they were numerically higher in the female sex.

Table 1: Variation of body parameters and condition factor of *Citharinus citharus* by sex from lower river benue

	Sex				
Body Parameters	**Female**	**Male**	**Df**	**T-Value**	**P-Value**
Number	55	47	-	-	-
Sex Ratio	1.17	1	-	-	-
Minimum Standard Length (cm)	18.00	36.00	-	-	-
Maximum Standard Length (cm)	18.00	34.40	-	-	-
Minimum Weight (g)	97.30	101.80	-	-	-
Maximum Weight (g)	252.50	246.30	-	-	-
Mean Weight (g)	146.81±5.81	140.98±5.54	99	0.75	0.470
Mean Total Length (cm)	26.88±3.37	22.70±0.57	57	1.22	0.228
Mean Standard Length (cm)	19.15±0.61	18.09±0.54	99	1.25	0.203
Condition Factor	1.57±0.11	1.34±0.11	99	1.42	0.160

*indicates statistical significance at 0.05%

Table 2 present the results of the sex variation of *Oreochromis niloticus* in lower River Benue.

The sex ratio of male to female was 1:2.93. The mean weight of the female and male were 36.42±2.51g and 24.99±4.09g. The mean total length of female and male were 12.42±0.28cm and 10.70±0.50cm respectively. Their mean standard length of female and male for *Oreochromis niloticus* were 10.09±0.25cm and 8.54±0.42cm. The condition factors of female and male for *Oreochromis niloticus* were 1.48±0.13 and 1.32±0.09 respectively. All the other body parameters were statistically significant (p<0.05) between sexes.

Table 2: Variation of body parameters and condition factor of *Oreochromis niloticus* by sex from lower river benue

	Sex				
Body Parameters	**Female**	**Male**	**Df**	**T-Value**	**P-Value**
Number	85	29	-	-	-
Sex Ratio	2.93	1	-	-	-
Minimum Standard Length (cm)	6.00	5.20	-	-	-
Maximum Standard Length (cm)	15.70	14.40	-	-	-
Minimum Weight (g)	7.70	5.10	-	-	-
Maximum Weight (g)	121.70	112.30	-	-	-
Mean Weight (g)	36.42±2.51	24.99±4.09	50	2.38	0.021*

Mean Total Length (cm)	12.42±0.28	10.70±0.50	47	2.97	0.005*
Mean Standard Length (cm)	10.09±0.25	8.54±0.42	49	3.18	0.003*
Condition Factor	1.48±0.13	1.32±0.09	106	1.03	0.307

*indicates statistical significance at 0.05%

The length-weight relationship of *Oreochromis niloticus* and *Citharinus citharus* are presented in Table 3. The values of a (intercept) for *Citharinus citharus* female and male were 0.160 and 0.216 respectively, while *Oreochromis niloticus* had 0.499 and 0.445 for female and male respectively. The b values (growth pattern) of female and male for *Citharinus citharus* were 1.458 and 1.421, while those of *Oreochromis niloticus* for female and male were 0.332 and 0.365 respectively. The growth pattern for both sexes of the two species of fish indicated negative allometric growth. The regression coefficient (R^2) of *C. citharus* (female: 0.915; male: 0.892) and *O. niloticus* (female: 0.825; male: 0.963) were high.

Table 3: Length-weight regression parameters of *Oreochromis niloticus* and *Citharinus citharus* from lower river benue

Species	Sex	N	a	Growth exponent (b)	Regression Coefficient (R^2)
Citharinus citharus	Female	55	0.160	1.458	0.915
	Male	47	0.216	1.421	0.890
Oreochromis niloticus	Female	85	0.499	0.332	0.825
	Male	29	0.445	0.365	0.963

N = Number of sample size, a = intercept of regression line, b = slope of regression line, R^2 = Regression coefficient

Discussions

Many authors had earlier opined that length-weight relationships can vary significantly even within the same species as it is affected by factors such as sexes, season variation, growth phases, stomach contents, gonadal development, as well as health [20, 21, 22, 23, 15]. For both of *C. citharus* and *O. niloticus*, the female sex had larger mean weights than the male. This was due to the gonadal weights that were more gravid in the female than in males. In addition, the feeding intensity of females tended to be higher so as to cope with their reproductive tasks. *O. niloticus*is particularly known to be mouth-brooders and during incubation period, their feeding is cut down resulting to weight loss. In corollary, the female of both species had better condition factor than the males.

According to [24], a negative allometric growth implies that the fish is becoming tinnier as it increases in weight; hence, the fishes become slender. An isometric length-weight relationship on the other hand implies that the weight of these fishes increases at approximately the same rate as the length [25]. The intercept (a) of *O. niloticus in* this study (0.499 female, 0.445 male) was markedly higher than that recorded in the work of *O. niloticus* (-1.425) by [26] in Ona Lake Asaba, Nigeria. The growth pattern (b) in this study (0.332 female, 0.365 male) was negative allometric growth and far from the isometric value (3). It was also lower than the value recorded by [26]. [27]. also reported the a and b values of *C. citharus* in Lake Kainji as -2.90 and 1.20 respectively while 4.41 and 1.25 were recorded for *O. niloticus*. This suggested the unfavorability of the growth conditions of *O niloticus* as the growth pattern was far from isometric pattern. Although *C. citharus* also had negative allometric growth (1.458 female, 1.421 male), the values were still far below the isometric growth (3).The b values obtained in this study all fell out of the range (2.5-4.0) postulated by [28] of most fish species. As stated by [29] and [30] these variations are attributable to a myriad of ecosystem changes that impairs a three-dimensional growth of the fish. Prominent among these conditions that are peculiar to Lower River Benue warranting this condition are the water level (which prompts water physicochemistry) as a result of siltation and shortage and/or unavailability of food in the ecosystem.

According to [31] and [32] condition factor (K) is often used to describe the "well-being or condition of fatness of the fish". This is based on the assumption that fatness in relation to a particular length implies better physiological conditions in the fish [33] it usually gives information about the physiological state of the fish in relation to some environmental changes [2]. Hence, this phenomenon has been exploited in many studies as an important index for monitoring feeding intensity as well as growth rates in many fishes [34]. Generally, a condition factor close to, or above 1 is desirable [26]. The condition factor of *O. niloticus* (1.48 female, 1.32 male) and *C. citharus* (1.57 female, 1.34 male) were low comparable to the values reported by [35] of *C. citharus* in Anambra River basin (2.75) and [36] of *O. niloticus* in Gbedikere lake. According to [37] condition factor of fish are affected by many of the factors previously highlighted earlier for the variations in the values of "b" in this study (i.e. strain, species, stress, sexes, availability of feeds, water quality etc.). Hence, this could justify the differences between the observation of the present study and those of previous studies on different fishes under different experimental conditions [38]. This suffices the argument that the condition factors of these species was sub-optimal and could be considered as sufficient stress indicators of Lower River Benue. Considering their *r-life-strategy*, the condition of these species read from their growth pattern can be majorly attributed to the exogenous factors regulating growth as reflected in ecological conditions.

In conclusions, it is essential to state that *C. citharus* and *O. niloticus* are hardened. This enables them to have high tolerance threshold. As reflected in their condition factors, it may be concluded that Lower River Benue is stressed and may need to undergo habitat rejuvenation in order to improve its carrying capacity of the composite flora and fauna.

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