

Length-weight Relationship, Growth Pattern and Condition Factor of the Silver Catfish *Chrysichthys nigrodigitatus* (Lacepède, 1803) from Lower River Benue, Nigeria

Edem, Edem Thomas^{1*}, Ofunama, Preye² and Eyo, Victor Oscar²

¹Fisheries and Aquaculture Programme, Department of Zoology and Environmental Biology, University of Calabar, P.M.B. 1115, Calabar, Cross River State, Nigeria.

²Department of Fisheries and Aquaculture, Faculty of Environmental Management and Pollution, Nigeria Maritime University, Okerenkoko, Delta State, Nigeria.

Authors' contributions

This work was carried out in collaboration between all authors. Author EET designed the study, wrote the protocol and wrote the first draft of the manuscript. Authors OP and EVO performed the statistical analysis, managed the analyses and literature searches of the study. All authors read and approved the final manuscript.

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ABSTRACT

This study was carried out to evaluate the length-weight relationship, growth pattern and condition factor of the Silver catfish *Chrysichthys nigrodigitatus* from the Lower River Benue Makurdi, Nigeria. A total of 200 freshly caught specimens of *C. nigrodigitatus* were collected between July 2013 and September 2013 from the catches of the artisanal fisheries at landing points in Wadata Market, Makurdi. Results obtained showed that the "b" value for the males was 1.6067 while that of the females was 1.6791 and combined sexes 1.7371, indicating a negative allometric growth for this species. Correlation coefficient (r) obtained for males (0.9651), 0.9517 (females) and 0.9329 (pooled sexes) showed a positive significant relationship between length and weight of *C. nigrodigitatus*. Monthly mean condition factor (K), indicate that *C. nigrodigitatus* were in good physiological health condition. In conclusion, the baseline data on the length-weight relationship,

*Corresponding author: Email: Edemthomas15@gmail.com;

condition factor of *C. nigrodigitatus* from the lower River Benue provided in this study is crucial in the sustainable management of this species in the River. Also, these findings will be useful in evaluating the population dynamics, stock and the aquaculture potential of *C. nigrodigitatus* for future purpose.

Keywords: *Chrysichthys nigrodigitatus*; length-weight relationship; growth pattern; condition factor and lower river Benue.

1. INTRODUCTION

Fish is highly nutritious, so even small quantities can improve people's diets [1]. They can provide vital nutrients absent in typical starchy staples which dominate the diet of poor people [2]. Fish provides about 20 percent of animal protein intake [3] in 127 developing countries and this can reach 90 percent in Small Island Developing States (SIDS) or coastal areas [2]. Although aquaculture has been contributing an increasingly significant proportion of fish over recent decades, approximately two-thirds of fish are still caught in capture fisheries [4]. Length-weight relationship (LWR) of fish is an important growth index that is used as a sustainable management tool in fisheries science. According to Abowei and Davies [5], length-weight relationship (LWR) is vital in estimating the average weight of fish at a given length group. Length-weight relationship data (LWR) are very useful in growth rate estimation. According to Kolher et al. [6], LWRs are needed to estimate length and age structures of fish. Length-weight relationship is applied by fisheries scientists to convert growth in-length equations to growth-in-weight in stock assessment models [7] and [8], and also to estimate biomass from length frequency distributions [9]. Length-weight relationship data (LWR) are also used in comparing life history and morphological aspects of fish populations inhabiting different regions [8]. Growth is defined as the change in length or weight or both with increasing age [10]. To estimate the growth rates, length, age structures and other components in fish population dynamics, length and weight data are required [10]. Its relevance is emphasized when making estimates of the normal weight of an organism at a given length group and in evaluating the physiological well-being of the population of the fish [11]. It can provide data on the stock composition, life mortality, span, production and growth of the population [10]. According to Bagenal and Tesch, [12] condition factor (K) which compares the well-being of an animal is based on the fact that fish with so much weight (degree of fatness) of a certain length are in

better physiological state. It can be used as an index of growth and feeding intensity [13]. When it is higher than 1, it shows that fish is doing well in that environment while values above 2.9 are reported for matured fishes. The importance of condition factor in fisheries science is related to growth, health status and feeding intensity in various fish species [14]. Bagenal and Tesch [12] hypothesized that heavier fish of a given length are in better condition. Condition factor helps in understanding the life cycle of fish species and it also crucial in management of the species, hence maintaining the equilibrium in the ecosystem [15]. The silver catfish *Chrysichthys nigrodigitatus* (Lacepède, 1803) is a popular food fish that is widely distributed among tropical rivers and freshwater lakes of Western and Central Africa [16]. *C. nigrodigitatus* is an important food fish to the inhabitants of the lower Benue river because of its protein content, good taste and high meat quality. Due to the intensification of the capture of this species to meet the demand by consumers, its population has declined in the study area. Little or no attention is paid to its declining population due to scarcity of crucial information such as its biology which could in making managerial decisions for *C. nigrodigitatus* fishery and its aquaculture potentials. Therefore, the objective of this study is to determine the length-weight relationship, growth pattern and condition factor of *C. nigrodigitatus* from the lower river Benue, which could be useful in the sustainable exploitation of this species.

2. MATERIALS AND METHODS

2.1 Study Area Description

This study was carried out in Makurdi, the capital of Benue state of Nigeria. The state is bounded by Taraba to the East, Nassarawa to the North, Kogi to the West, Enugu to the southeast and Cross River to the South. This area lies between latitude and longitude 7.7322°N and 8.5391°E. River Benue, as the second largest river in Nigeria, has significant influence on the commercial activities of the area. Inhabitants of



Fig. 1. *Chrysichthys nigrodigitatus*

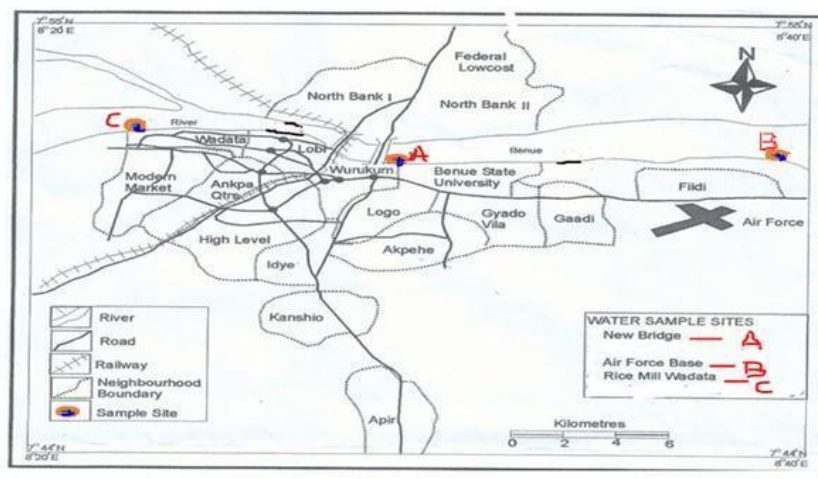


Fig. 2. Map showing River Benue

the river take fishing as a means of livelihood because of the numerous and diverse fish that abound in the River. Fig. 2 shows the map of the study area where *C. nigrodigitatus* samples were collected.

2.2 Collection and Identification of the Silver Catfish (*C. nigrodigitatus*) from the Lower River Benue

A total of 200 freshly caught *C. nigrodigitatus* were bought from fish landings of artisanal fisheries at Wadata market in Makurdi, Benue state between July and September, 2013. Fish samples were transported in ice-packed containers to the Fisheries and Aquaculture laboratory, University of Agriculture, Makurdi for identification and biometric measurement. Identification of *C. nigrodigitatus* was made using identification key given by Fischer et al. [17] and Schneider [18].

2.3 Measurements of Biometric Indices

Biometric parameters measured for each specimen were Total length (TL-cm) and Total weight (TW-g). Total length (TL-cm) was measured using from the tip of the mouth to the end of the caudal fin to nearest 0.1 cm using measuring board. Total weight (TW-g) was measured to the nearest 0.1 g using Metlar-2000D electronic weighing balance. The sex of each specimen was also determined to separate males from females. Measurements, sex determination and condition factor were carried out in the laboratory.

2.4 Length-Weight Relationship

Length weight relationship of *C. nigrodigitatus* from the lower river Benue was estimated using Pauly [19] equation as follows:

$$W = aL^b$$

Where W is the total weight (TW-g), L is the total length (TL- cm), 'a' is the intercept and 'b' the growth exponent. A logarithm transformation given below was used to obtain a linear relationship.

$$\text{Log } W = \text{Log } a + b \text{ Log } L$$

2.5 Condition Factor (K)

Fulton's condition factor (K) of *C. nigrodigitatus* was calculated using Pauly [19] equation, $K = W/L^3 \times 100$, where W is the total weight (TW-g), L is the Total length (TL-cm) and 3 is a constant.

2.6 Statistical Analysis

Values of regression coefficient 'b' intercept 'a' and coefficient of correlation 'r' in Length-Weight relationship (LWR) of *C. nigrodigitatus* from the Lower River Benue were determined by linear and power regressions.

3. RESULTS

3.1 Length-Weight Relationship of the Silver Catfish (*C. nigrodigitatus*) from the Lower River Benue

The length-weight relationship and correlation coefficient (r) for male, female and pooled sex of *C. nigrodigitatus* from the Lower Benue River

were logarithmically transformed as depicted in Figs. 3-5. The value of 'b' for the male was 1.6067 while that of the female was 1.6791, for combined sexes the value was 1.7371. The correlation coefficients (r) were 0.9651, 0.9517 and 0.9329 for male, female and combined sexes respectively.

3.2 Fulton's Condition Factor (K) of *C. nigrodigitatus* from the Lower River Benue

Fulton's condition factor (K) determined for two hundred (200) specimens of *C. nigrodigitatus* (Table 1) showed that mean condition factor of male and female *C. nigrodigitatus* in July was 2.11 ± 0.06 and 2.08 ± 0.05 ; August was 1.91 ± 0.07 and 1.96 ± 0.06 while September was 1.97 ± 0.06 and 1.92 ± 0.13 respectively. For pooled sex of *C. nigrodigitatus*, condition factor was 2.10 ± 0.02 (July), 1.57 ± 0.05 (August) and 1.95 ± 0.03 (September).

4. DISCUSSION

Length- weight relationship is useful in providing reliable data on the relative well-being and growth patterns of fish [14]. In length-weight studies, the regression coefficient (b-value) indicates the growth pattern in fish (isometric or allometric) which is reported to vary between stocks of same species [14] and [20].

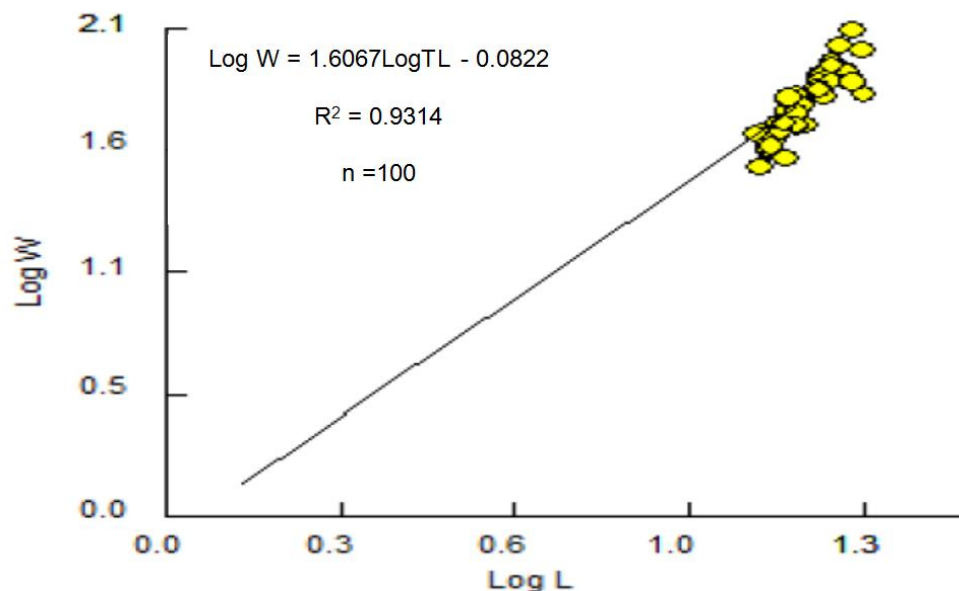


Fig. 3. Length-weight relationship of male *C. nigrodigitatus* obtained from River Benue

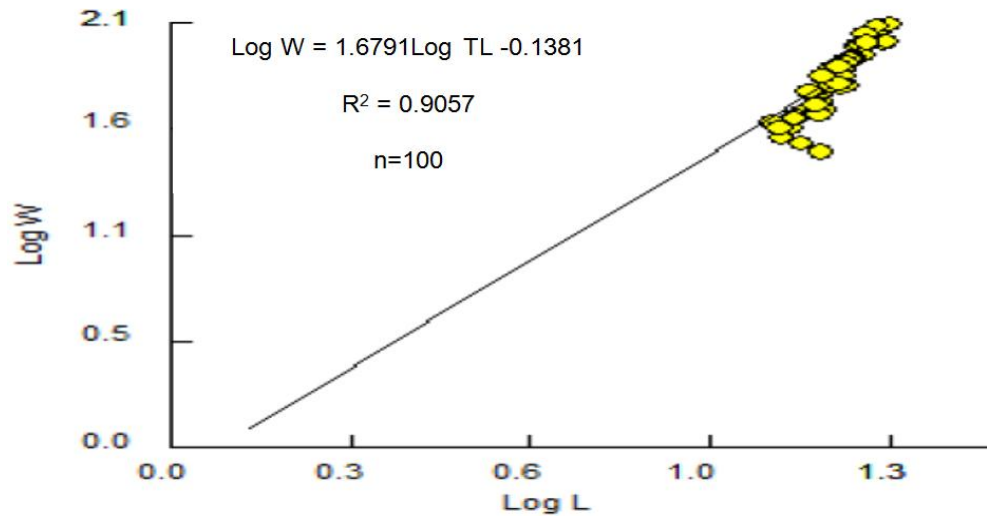


Fig. 4. Length-weight relationship of female *C. nigrodigitatus* obtained from River Benue

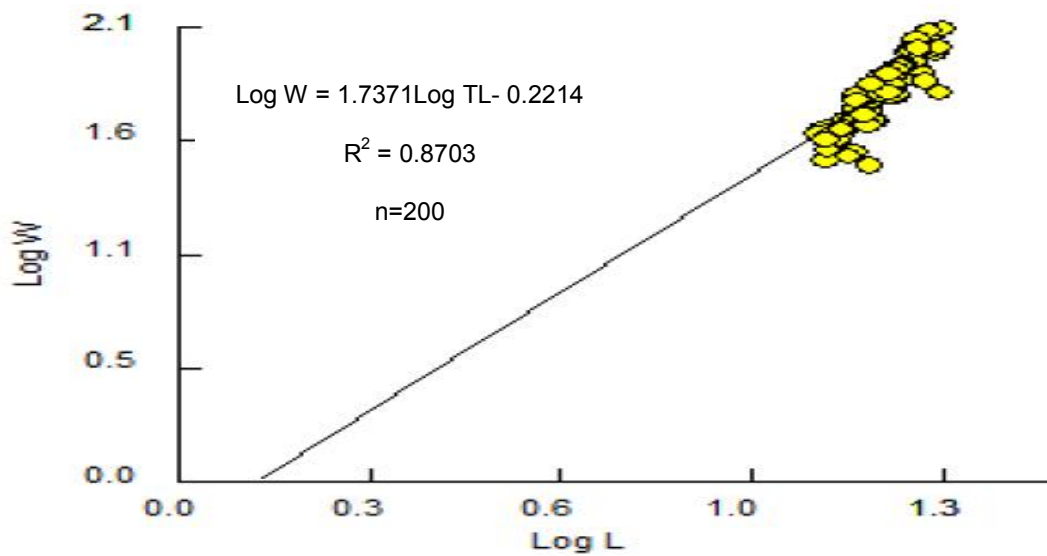


Fig. 5. Length-weight relationship of combined sexes *C. nigrodigitatus* obtained from River Benue

Table 1. The monthly mean condition factor of *C. nigrodigitatus* from the Lower River Benue

Month	Male	Female	Pooled Sex
July	2.11±0.06 ^a	2.08±0.05 ^a	2.10±0.02 ^a
August	1.19±0.07 ^a	1.96±0.06 ^a	1.57±0.05 ^a
September	1.97±0.06 ^a	1.92±0.13 ^a	1.95±0.03 ^a

The condition factor was subjected to T-test to determine difference between the sexes for the species studied

When 'b' value is less than 3, it indicates a negative allometric growth in fish, when greater than 3, it indicates a positive allometric growth and when 'b' value is equal to 3, it indicates an

isometric growth pattern in fish [21]. Deviation from isometric growth is commonly observed in most aquatic organisms which changes shape as they grow [22]. In this study, 'b' values for male,

female and both sexes were 1.6067, 1.6791 and 1.7371 respectively indicating a negative allometric growth pattern. The 'b' value obtained in this study is similar to results obtained from Ogamba et al. [23] who reported a negative allometric growth pattern ($b = 0.0536$) for *C. nigrodigitatus* collected from Odi River, Niger Delta, Nigeria. Also, a similar finding was reported by Uneke [24] from Ebonyi River, South Eastern Nigeria. According to [25], fish exhibiting a negative allometric growth pattern tends to become thinner as they increase in length. Asuquo et al. [14] explained that when fish species exhibit a negative allometric growth pattern, some conventional fish population dynamic models which assumes isometry in fish growth ($b = 3$) cannot be useful in analyzing the population of such species. Uneke [26] also reported that LWR is an important factor in the biological study of fishes which is greatly affected by many factors related to population variability and thus may be responsible for the above variables in the LWR values. Findings of this study agrees with findings of Abowei and Hart [27] who reported a negative allometric growth pattern function from Amassoma River flood plains. According to Lagler et al. [28], such variations in growth parameters documented for different fish species could be attributed to sex, maturity, developmental stage, season and harsh environmental conditions. Froese [29] opined that length-weight parameters of fish are influenced by both intrinsic and extrinsic factors such as diet, season, stomach fullness, health, preservation techniques, habitat, sex, gonad maturity and annual variation in environmental conditions. Also, "b" value in fish can be affected by sample size, habitat suitability, fishing activities, individual metabolism, age and maturity [30,31]. In this study, a positive significant ($P < 0.05$) correlation coefficient (r) obtained for *C. nigrodigitatus* (0.965, 0.952 and 0.933) indicates a strong association between the total length and total weight of the fish [32]. Condition factor is an important index used in fisheries science to ascertain the relative well-being of fish species. Condition factor which could be used to reflect the health status of water bodies is influenced by factors such as age, sex, food availability, and environmental conditions. Low condition factor in fish may be attributed to poor environmental conditions and reduced availability of food and prey items [33] and [34]. Findings of this study shows that *C. nigrodigitatus* in the Lower River Benue was in a better condition which could be attributed to availability of food.

5. CONCLUSION

In conclusion, the baseline data on length-weight relationship and condition factor of *C. nigrodigitatus* from the Lower River Benue provided in this study is crucial in the sustainable management of this species in the River. Also, these findings will be useful in evaluating the population dynamics, stock and the aquaculture potential of *C. nigrodigitatus* for future purpose.

ETHICAL APPROVAL

As per international standard or university standard ethical approval has been collected and preserved by the authors.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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