Length- weight relationship and condition factor of different sexes of *Clarias gariepinus* and *Oreochromis niloticus* from Calabar River, South-Eastern Nigeria.

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ABSTRACT

Length-weight relationships and condition indices of the 2 fish species was studied. 50 *Clarias gariepinus* and 50 *Oreochromis niloticus* samples were used for the study. The sex ratio were 1:1 (*C. gariepinus*) and 1:2 (*O. niloticus*). Male, female and combined sex of *C. gariepinus* exhibited a positive allometric growth, with "b" values of 3.040 (male), 3.505 (female) and 3.474 (combined sex). Male, female and combined sex of *O. niloticus* exhibited a negative allometric growth with "b" values of 1.994 (male), 2.573 (female) and 2.652 (combined sex). The mean total length of *O. niloticus* were 25.49 ± 5.33cm (male), 24.06 ± 8.19cm (female), 24.77 ± 6.76cm (combined sex). The mean weight of *O. niloticus* were 299.89 ± 158.06g (male), 257.99 ± 114.40g (female), 278.94 ± 136.23g (combined). The mean total length of *C. gariepinus* were 21.96 ± 2.598cm (male), 22.40 ± 3.512 cm (female), 22.18 ± 3.055cm (combined sex). The mean weight of *C. gariepinus* were 85.96 ± 34.49g (male), 88.10 ± 37.21g (female), 87.03 ± 35.85g (combined). Mean condition factor of *C. gariepinus* were 0.778 ± 0.120 (male), 0.748 ± 0.125 (female), and 0.764 ± 0.123 (combined sex). Mean condition factor of *O. niloticus* were 2.052 ± 2.038 (male), 2.741 ± 3.090 (female), and 2.355 ± 2.533 (combined sex). The condition factor revealed that *O. niloticus* of both sex were in good physiological state of well-being, whereas *C. gariepinus* was not in a good physiological state of well-being.

Keywords: Length, Weight, condition factor, *Clarias gariepinus*, *Oreochromis niloticus*, Calabar River

1. INTRODUCTION

Clarias gariepinus (African sharp tooth catfish) belongs to the clariidae family. They could also be described as air-breathing catfishes. It is a large eel-like fish with a white belly and dark gray or black colour at the back. It can grow and attain a maximum weight of 60kg (130Ib) and total length of 1.7m (5ft 7In) [1]. Their bodies are slender, flat bony headed, posses a broad and terminal mouth with four (4) pairs of barbells. Their pectoral fins have spines and also posses gill arches with its breathing organs [1]. They feed on dead and living animal matter, posses wide mouth, which allows them to swallow large prey whole [2]. They are carnivorous predators that

feed on Tilapia zillii, molluscs and other small fishes. *Oreochromis niloticus*, generally called Nile tilapia is a species of tilapia, a cichlid fish native to Africa from Egypt south to East and central Africa, and as far West as Gambia. The tilapia has distinctive, regular, vertical strips extending as far down the body as the bottom edge of the caudal fin, with variable colouration. Adults reach up to 60cm (24 in) in length and up to 4.3kg (9.5 lb). It is an omnivore, feeding on plankton as well as on higher plants [3].

Fish plays an important role in the development of a nation [4]. Apart from being a cheap source of highly nutritive protein, it also contains other essential nutrients required by the body [5]. In fisheries managements, the condition factor (K) reflects the well-being of fish and gives information on physiological state in relation to its welfare [6]. Condition factor compares the well-being of fish and is based on the hypothesis that heavier fish of a given length are in better condition [7]. Condition factor is also a useful index for the monitoring of feeding intensity, age and growth rates in fish [8]. It is strongly influenced by both biotic and abiotic environmental conditions and can be used as an index to assess status of aquatic ecosystem in which fish live. Fulton's condition factor is widely used in fisheries and general fish biology studies. This factor is calculated from the relationship between the weight of a fish and its length, with the intention of describing the condition of that individual [9]. Condition index may be used to determine the reproductive time of fish species without sacrificing the organisms, and this could be a valuable tool to develop monitoring programs for the species fisheries and culture programs [10]. The study of condition factor is important to understand the life cycle of fish species, and contributes to an adequate management of the species and to the maintenance of the ecosystem equilibrium [11].

2. MATERIALS AND METHODS

2.1 Study area

Calabar River has Nsidung as one of its beach and flows from the northern part of the city of Calabar joining the southern at about eight kilometers. This River forms a natural harbour deep enough for vessels with a draft of six (6) meters. The River drains from part of Oban hills in the Cross River National Park [12] with the longitude of 8º18'E and latitude of 4º58'3N [13]. The basin of the River is about 43 kilometers wide and 62 kilometers long, with an area of 1,514 square kilometers [14]. The basin of the River has about 223 streams with a total length of 516 kilometers, this is a small number given the size of the basin.

The climate of the study area has a long wet season characteristic from April to October and a dry season from November to March. The mean annual rainfall is about 2,000mm [15]. A short period of drought occurs in the wet season around August or September. This process is known as August drought. A cold dry dusty period usually occurs between December and January (i.e. harmattan season). The temperature ranges, generally, between 22ºC in the wet season and 35ºC in the dry season. Relative humidity is generally above 60% at all seasons with nearest or close to 90% during the wet season [15, 16].

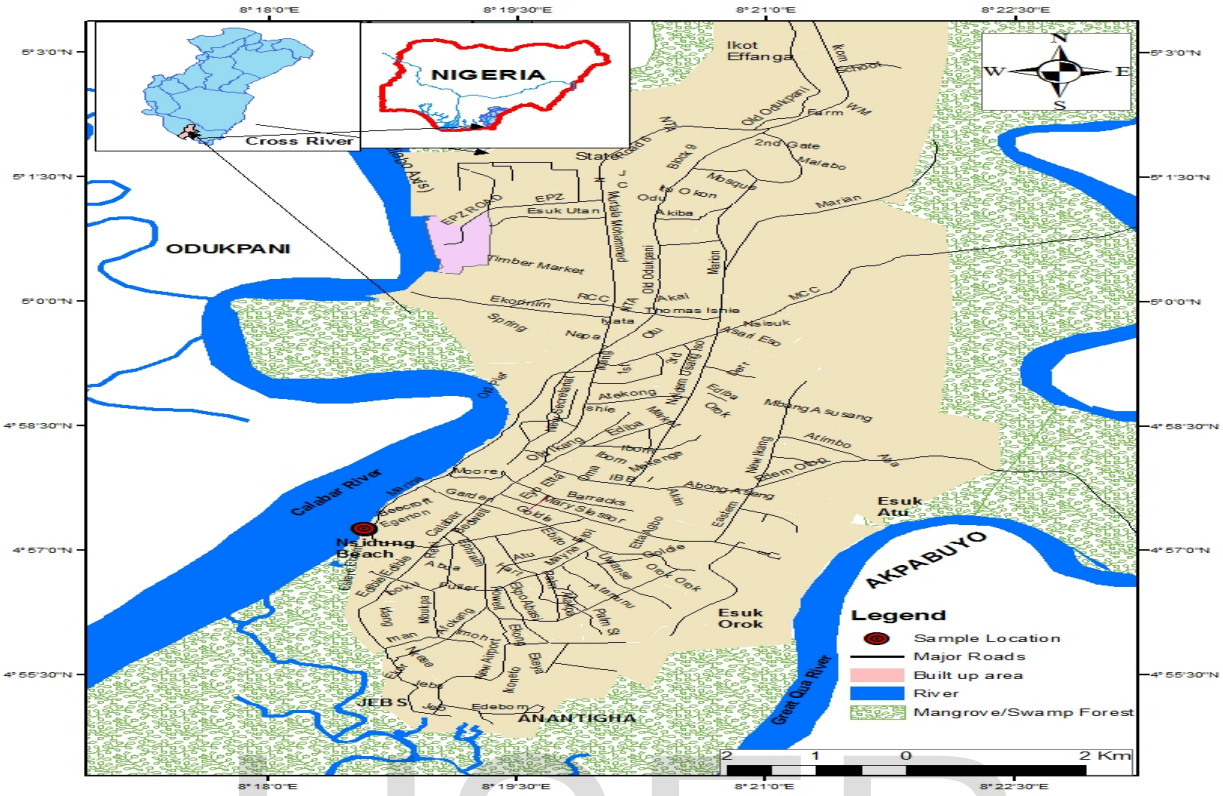

Fig 1: Map of Calabar River showing the study area at Nsidung Beach

2.2 Collection of samples

In this study, a total of 50 *Clarias gariepinus* and 50 *Oreochromis niloticus* samples were collected in total from Nsidung beach, Calabar River. The fish samples were collected at different period depending on when these species landed in the beach. Once the fish samples were collected, they were transported to Zoology and Environmental Biology laboratory, University of Calabar, Calabar, where they are sorted into sex and the length and weight taken accordingly.

2.3 Identification, counting and morphometric measurement of samples

Fish samples collected from the study site was identified using taxonomical key. The length (cm) and weight (g) parameters of the fish were measured and recorded. Length of fish sample collected was measured using a measuring board calibrated in centimetres (cm). Their total length (TL-cm) was measured from the tip of the mouth (snout) to the end of the caudal fin. This was done for each fish and was recorded for all individual species as their total length (cm). For weight measurement, each fish sample was blotted dry before being placed on METLAR 5000D-electronic weighing balance to measure the weight of the specimens in grams (g). This was done for each sample and was recorded for all individual species as their total weight (TW-g).

2.4 Estimation of length-weight relationship

The length-weight relationship was estimated using the function in equation 1 below:

$$W=aL^{b} \quad - - - - - - - - - - \quad 1$$

Where:

W = Weight (g), L = Length (cm), a = Intercept, b = slope (Growth exponent)

A logarithm transformation was used to make the relationship linear as shown in equation 2.

Log W = a + bLogL - - - - - - - - - 2

2.5 Condition Factor (K)

The condition factor (K) of the fish was calculated using Fulton's equation shown below:

$$K = \frac{W}{L^3} \times 100 \quad - - - - - - - - - 3$$

Where K = condition factor

W= fish weight in grams

L = fish length in centimetre

2.6 Statistical analysis

Correlation and regression analysis was carried out for the length-weight relationship of individual species using the regression formula according to Ogbeibu [17] below:

$$r^2 = \frac{b\sum xy}{y} \quad ----------4$$

$$a = \frac{n\sum x^2 - \sum y \sum x - \sum xy}{n\sum x^2 - \left(\sum x\right)^2} \quad ----------5$$

$$b = \frac{n\sum xy - \sum x \sum y}{n\sum x^2 - \left(\sum x\right)^2} \quad ----------6$$

The above formula helps in identifying the length-weight relationship in a straight line graph of Y = a+bx

Where:

r^2 = Correlation coefficient, a = Intercept, b = Slope, x = Length, y = Weight

3.RESULTS

3.1 Proportion of Sampled Fish Specimen

A total of 50 *C. geriepinus* specimens and 50 *O. niloticus* specimens were used through-out the study. Samples were collected from January to February, 2018. Out of the 50 *C. geriepinus* specimens collected, 26 were males and 24 were females, having a sex ratio of 1:1. The 50 *O. niloticus* specimens were made up of 28 males and 22 females, having a sex ratio of 1:2.

3.2Morphometric Parameters of *Oreochromis niloticus*

The summary of the morphometric parameters of *O. niloticus* for the male, female and combined sex is shown in Table 1. A total of 28 and 22 specimens of *O. niloticus* combining to give 50 specimens were used for the study. For the male, the total length ranged from 19.10 – 34.80 cm, having a mean and standard deviation of 25.49 ± 5.33cm. The weight ranged from 118.11 – 941.28g, having a mean and standard deviation of 299.89 ± 158.06g. The K-value (condition factor) ranged from 0.94 – 2.78, with a mean and standard deviation of 2.05 ± 2.03 (Table 1).

For the female, the total length ranged from 10.30 – 41.20 cm, having a mean and standard deviation of 24.06 ± 8.19cm. The weight ranged from 147.67 – 496.46 g, having a mean and standard deviation of 257.99 ± 114.40g. The K-value (condition factor) ranged from 0.62 -13.57, with a mean and standard deviation of 2.74 ± 3.09 (Table 1).

Table 1: Morphometric parameters of *O. niloticus* for different Sex

Morphometric Parameters(Tilapia)	Male	Female	Combined
No. of Specimens	28	22	50
Length range (cm)	19.10 – 34.80	10.30 – 41.20	10.30 – 41.20
Mean length ± SD	25.49 ± 5.33	24.06 ± 8.19	24.77 ± 6.76
Weight range (g)	118.11 – 941.28	147.67 – 496.46	35.06 – 941.28
Mean weight ± SD	299.89 ± 158.06	257.99 ± 114.40	278.94 ± 136.23
K range	0.94 – 2.78	0.62 -13.57	0.62 – 13.57
Mean K ± SD	2.05 ± 2.03	2.74 ± 3.09	2.35 ± 2.53

For combined sex, the total length ranged from 10.30 – 41.20 cm, having a mean and standard deviation of 24.77 ± 6.76cm. The weight ranged from 35.06 – 941.28 g, having a mean and standard deviation of 278.94 ± 136.23g. The K-value (condition factor) ranged from 0.62 – 13.57, with a mean and standard deviation of 2.35 ± 2.53 (Table 1).

3.3 Morphometric Parameters of *Clarias gariepinus*

The summary of the morphometric parameters of *Clarias gariepinus* for the male, female and combined sex is shown in Table 2. A total of 26 and 24 specimens of *Clarias gariepinus* combining to give 50 specimens were used for the study. For the male, the total length ranged from 18.10 – 28.00 cm, having a mean and standard deviation of 21.96 ± 2.59cm. The weight ranged from 37.96 – 169.37g, having a mean and standard deviation of 85.96 ± 34.49g. The K-value (condition factor) ranged from 0.62 – 1.20, with a mean and standard deviation of 0.77 ± 0.12 (Table 2).

For the female, the total length ranged from 16.20 – 28.20 cm, having a mean and standard deviation of 22.40 ± 3.51 cm. The weight ranged from 35.06 – 154.14 g, having a mean and

standard deviation of 88.10 ± 37.21 g. The K-value (condition factor) ranged from 0.64 -1.27, with a mean and standard deviation of 0.74 ± 0.12 (Table 2).

Table 2: Morphometric parameters of *Clarias gariepinus* for different Sex

Morphometric Parameters(Cat Fish)	Male	Female	Combined
No. of Specimens	26	24	50
Length range (cm)	18.10 – 28.00	16.20 – 28.20	16.20 – 28.20
Mean length ± SD	21.96 ± 2.59	22.40 ± 3.51	22.18 ± 3.05
Weight range (g)	37.96 – 169.37	35.06 – 154.14	35.06 – 169.37
Mean weight ± SD	85.96 ± 34.49	88.10 ± 37.21	87.03 ± 35.85
K range	0.62 – 1.20	0.64 -1.27	0.62 – 1.27
Mean K ± SD	0.77 ± 0.12	0.74 ± 0.12	0.76 ± 0.12

For combined sex, the total length ranged from 16.20 – 28.20 cm, having a mean and standard deviation of 22.18 ± 3.05cm. The weight ranged from 35.06 – 169.37 g, having a mean and standard deviation of 87.03 ± 35.85g. The K-value (condition factor) ranged from 0.62 – 1.27, with a mean and standard deviation of 0.76 ± 0.12 (Table 2).

3.4 Length-Weight Relationship of *O. niloticus*

The summary of the Length-Weight parameters of male, female and combined sex of *O. niloticus* are shown in Table 3. For the male *O. niloticus*, the a-value and b-value were: 1.767 and 1.994 respectively, having Log WT =1.994 Log LT + 1.767 as its Length-Weight equation (Fig 2). There was a strong relationship between the length and the weight of the male *O. niloticus* (0.90) at P<0.05 (Fig 2). The female *O. niloticus* had an a-value of 1.960 and a b-value of 2.573, and with an equation of Log WT =2.573 Log LT + 1.960 (Fig 3). There was a strong relationship between the length and the weight of the female *O. niloticus* (0.83) at P<0.05 (Fig 3).

Table 3: Length-Weight parameters and Equation of *Oreochromis niloticus*

Oreochromis niloticus Specimen	a-value	b-value	r-value	Equation
Male	1.767	1.994	0.90	Log WT =1.994 Log LT + 1.767
Female	1.960	2.573	0.83	Log WT =2.573 Log LT + 1.960
Combined	1.911	2.652	0.92	Log WT =2.652 Log LT + 1.911

The combined sex of *O. niloticus* had an a-value of 1.911 and a b-value of 2.652, and with an equation of Log WT =2.652 Log LT + 1.911 (Fig 4). There was a strong relationship between the length and the weight of the combined sex *O. niloticus* (0.92) at P<0.05 (Fig 4).

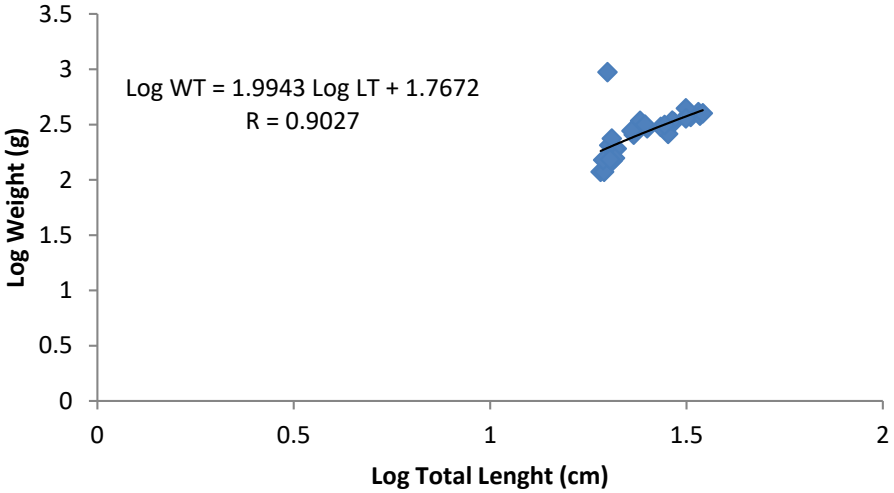

Fig 2: Log transformed graph for Length-weight relationship of male *Oreochromis niloticus*

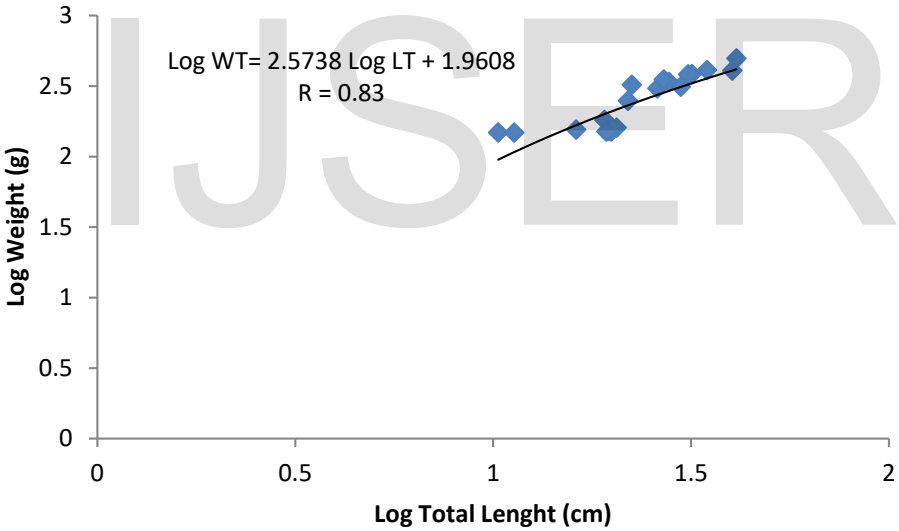

Fig 3: Log transformed graph for Length-weight relationship of female *O. niloticus*

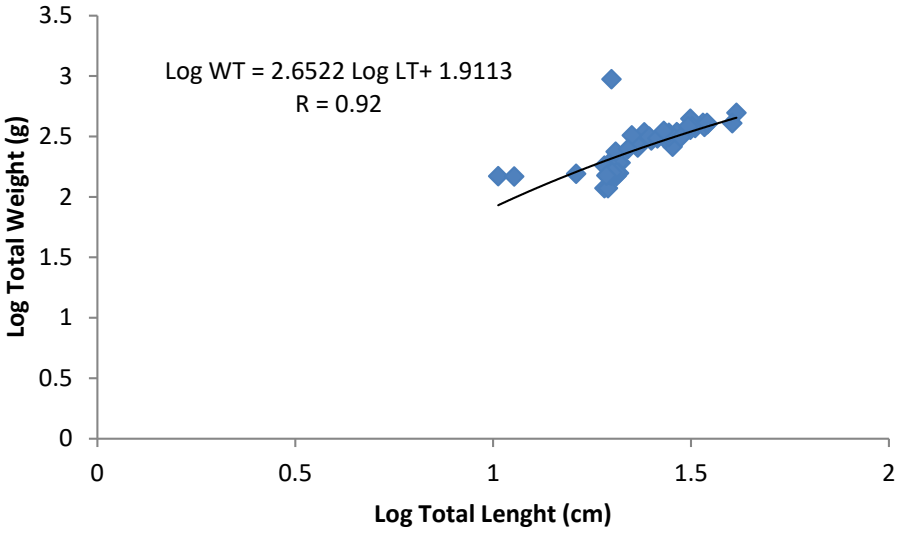

Fig 4: Log transformed graph for Length-weight relationship of combined sex of *O. niloticus*

3.5 Length-Weight Relationship of *C. gariepinus*

The summary of the Length-Weight parameters of male, female and combined sex of *C. gariepinus* are shown in Table 4. For the male *C. gariepinus*, the a-value and b-value were: -2.167 and 3.040 respectively, having Log WT =3.040 Log LT – 2.167 as its Length-Weight equation (Fig 5). There was a strong relationship between the length and the weight of the male *C. gariepinus* (0.92) at P<0.05 (Fig 5). The female *C. gariepinus* had an a-value of 0.840 and a b-value of 3.505, and with an equation of Log WT =3.505 Log LT + 0.840 (Fig 6). The length and weight of female *C. gariepinus* related strongly and significantly (0.94) at P<0.05 (Fig 6).

Table 4: Length-Weight parameters and Equation of *C. gariepinus*

***Clarias gariepinus* Specimen**	**a-value**	**b-value**	**r-value**	**Equation**
Male	-2.167	3.040	0.92	Log WT =3.040 Log LT – 2.167
Female	0.840	3.505	0.95	Log WT =3.505 Log LT + 0.840
Combined	0.797	3.474	0.94	Log WT =3.474 Log LT + 0.797

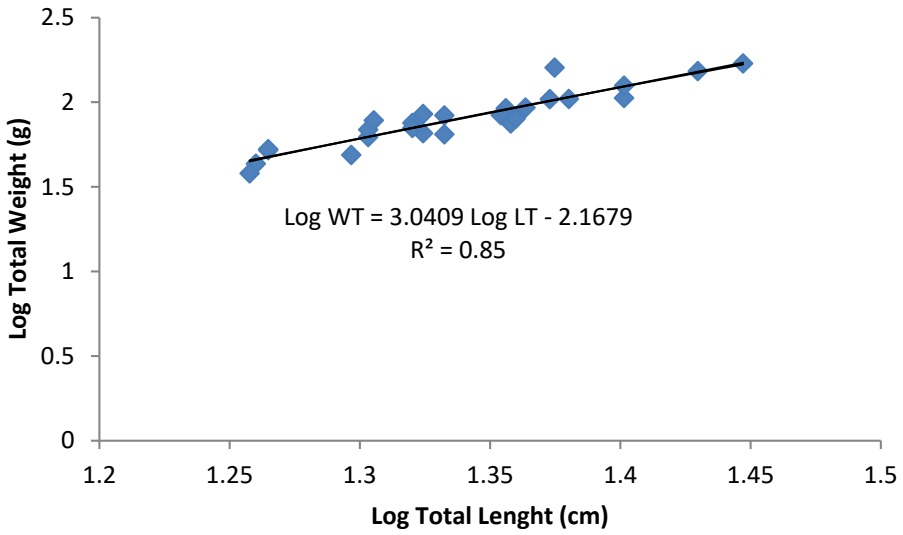

Fig 5: Log transformed graph for Length-weight relationship of male *C. gariepinus*

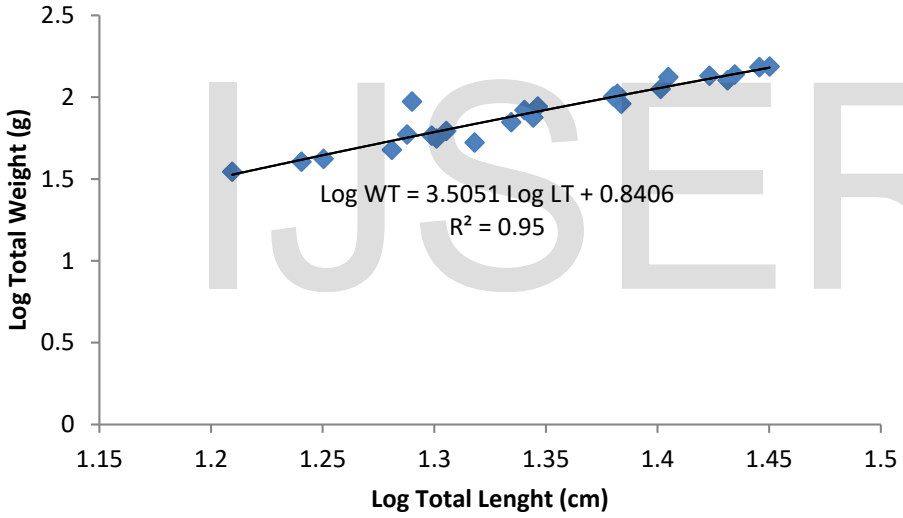

Fig 6: Log transformed graph for Length-weight relationship of female *C. gariepinus*

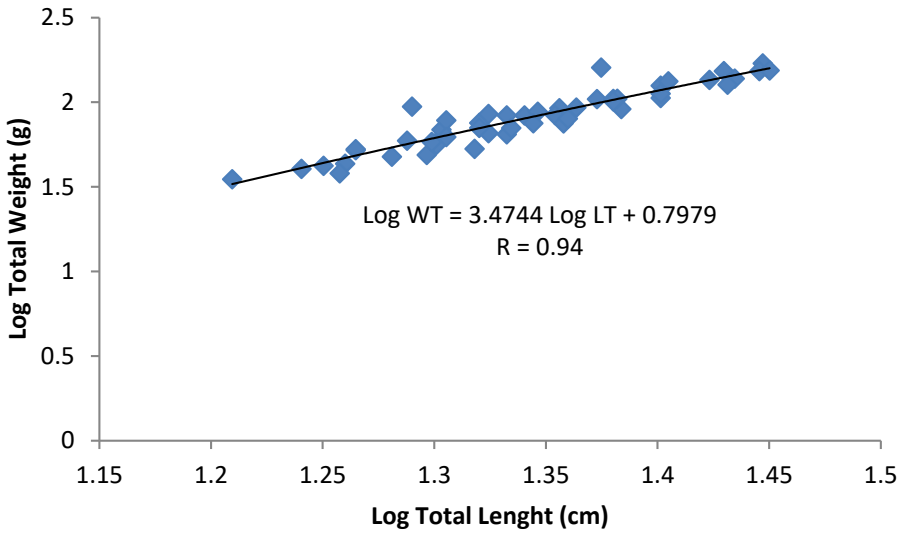

Fig 7: Log transformed graph for Length-weight relationship of combined sex *C. gariepinus*

The combined sex of *Clarias gariepinus* had an a-value of 0.797 and a b-value of 3.474, and with an equation of Log WT =3.474 Log LT + 0.797 (Fig 7). There was a strong relationship between the length and the weight of the combined sex *Clarias gariepinus* (0.94) at P<0.05 (Fig 7).

4.DISCUSSION

The Length-weight relationship of fish also known as growth index is an important fishery management tool [18]. According to Abowei and Davies [19], Abowei et al. [20], it is vital to estimate the average weight at a given length group. The total length and weight ranges of male, female and combined sex of *O. niloticus* of this study varied with that reported by Obasohan et al. [21]. Also, total length and weight ranges of male, female and combined sex *C. gariepinus* of this study varied with that reported by Ayo-Olalu [22]. The variations could be due to the fact that the maximum size attainable in fishes generally is location specific [23]. These variations could also be due to the fact that difference in sampling seasons influences fish size [24]. Akombo et al. [18] attributed such differences in fish size to fishing pressure and environmental pollution in the freshwater reaches of the lower River whereas, Sikoki et al. [25] attributed such variation in fish size to either genetic or environmental factors. Length-Weight relationships (LWRs) of fishes are important in fisheries biology and population dynamics where many stock assessment models require the use of LWR parameters [26].

Regression coefficients obtained from length-weight relationships (L-W) which are indicative of isometric or allometric growths differ not only between species but sometimes also between stocks of same species [27]. According to Akombo et al. [18], length weight relationship is cuvililinear with the exponent ranging from 2.5 to 4.0. Growth is isometric when the length exponent (b-value) is equal to 3 and allometric when length exponent (b-value) is less than or greater than 3. It is negative allometry when b-value is less than 3 and positive allometry when b-

value is greater than 3 [28]. In this study, the length exponent "b" = 1.994 (male), 2.573 (female) and 2.652 (combined sex) for *O. niloticus* showed that growth was negatively allometric. The b-value for male, female and combined sex *C. gariepinus* was 3.040, 3.505 and 3.474 respectively, indicating a positive allometric growth. This implication of the length exponent values "b" obtained for male, female and combined sex of *O. niloticus* in this study is that their weight increased faster than the cube of its total length, meaning that the male, female and combined sex of *O. niloticus* grew slimmer as they increase in size. In the other way round, the implication of the b-value reported for male, female and combined sex of *C. gariepinus* in this study is that the male and female *C. gariepinus* will grow rounder with increase in size. The negative allometric growth pattern observed in this study for male, female and combined sex *O. niloticus* did agree with findings of Obasohan et al. [21] for *O. niloticus*, but did not agree with that reported by Mortuza and Misnad [28] for male, female and combined sex of *O. niloticus* in different water bodies. In the case of *C. gariepinus*, the positive allometry reported for its male, female and combined sex corroborated with the report of Ayo-Olalu [22], who also reported a positive allometric growth, but differed with the report of Anyanwu et al. [29], who reported a negative allometric growth for different sexes. The reason for this discrepancies could be due to the fact that growths differ not only between species but sometimes also between stocks of same species [27]. Francis and Elewuo [30] attributed negative allometric growth pattern to climatic change and temporal effects.

In the present study, a strong positive correlation coefficient was obtained for *O. niloticus* and *C. gariepinus* indicating a strong association between length and weight of both species for male, female and combined sex. Similar findings have been reported by authors including Mortuza and Misnad [28], Obasohan at al. [21] (*O. niloticus*), Anyanwu et al. [29] and Ayo-Olalu [22] (*C. gariepinus*) for different water bodies in Nigeria. According to Ndome et al. [27], condition factor value greater than 1 (K >1) is an indication of good condition in fishes. In this study, the mean condition factor for male, female and combined sex of *O. niloticus* in this study were all greater than 1, indicating a good condition of the fish. Similar result was observed by Mortuza and Misnad [28], who also reported a mean K-value greater than 1. The mean condition factor of *C. gariepinus* for male, female and combined sex observed in this study were all lower than 1, indicating that the fish stock is under stress. The mean condition factor and b-value of the female *O. niloticus* were higher than that of their male counterparts. Similar result was reported by Srisuwantach et al. [31], who then explained this observation to be due to egg development in females, which could increase fish body weight. Factors reported to affect the condition of a fish species include environmental factors such as aquatic vegetation [32], food [33], stage of maturity, state of stomach fullness, season, and lack of grading into size classes [34] and genetic factors [18]. The sex ratio of *O. niloticus* was 1:2, indicating that for every 2 males, u will get 1 female, while that of *C. gariepinus* is 1:1, indicating that for every 1 male of *C. gariepinus*, 1 female of *C. gariepinus* will also be observed.

5. CONCLUSION

In conclusion, this study revealed that male, female and combined sex *Oreochromis niloticus* exhibited negative allometric growth pattern, while male, female and combined sex *Clarias gariepinus* exhibited positive allometric growth pattern. Also, the correlation coefficients of the length-weight relationships for the 2 fish species indicated high degree of positive

correlation. The condition factor revealed that *O. niloticus* were in good physiological state of wellbeing, whereas *C. gariepinus* were not.

AUTHOR'S CONTRIBUTION

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

ETHICAL CONSIDERATION

The authors ensured that all ethical and other basic principles underlying behavior and advancing welfare for the use of animals in research, including handling, relevant laws and regulations were considered before proceeding with the research. Permission was also received from the relevant bodies for the use of fish for this experiment.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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