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Comparative studies on length-weight relationship and Condition Factor of Nile tilapia, *Oreochromis niloticus* obtained from two reservoirs in Ekiti State, Nigeria

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Abstract

Comparative study was conducted to estimate the length-weight relationship and Condition Factor of *Oreochromis niloticus* populations obtained from two reservoirs in Ekiti State. A total number of 260 specimens, comprising 111 fish from Egbe Reservoir and 149 fish from Ureje Reservoir were measured using standard procedures. The results show that the mean total length and body weight of the fish from Egbe Reservoir were 17.68±1.79cm and 106.80±39.03g respectively, while those of the fish obtained from Ureje Reservoir were 21.41±1.95cm and 186.82±39.75g respectively. The length-weight relationship equations were Log W = 2.742 Log L- Log 1.423 and Log W = 1.660 Log L+ Log 0.055 for specimens obtained from Egbe and Ureje reservoirs respectively. The regression coefficient (b) indicated an allometric growth in all specimens. Also, positive linear relationship was observed between the length and weight of the studied fish and the condition factors (K) of fish species from both reservoirs indicated that the fish species were robust and in good condition as both male and female from both water bodies had "K" values above "1.0". Hence, the study concluded that the two reservoirs are suitable for *O. niloticus* growth and survival.
Keywords: Allometric growth, *Oreochromis niloticus*, Condition Factor, Length-weight relationship, Regression coefficient.

Introduction

Tilapia fish have their unique tastes as well as economic and health values, these have made the fish to be highly sourced for by the teeming human population. FAO (2010) reported that Tilapia is the third most farmed fish in the world after carps and salmonids, accounting for 4% of global aquaculture production. They are fresh water fish which live and feed near the bottom of the water. They can live in shallow streams, lakes and rivers. They have laterally compressed deep bodies, lateral lines and body covered in cycloid scales. They are mouth brooders because they carry the fertilized eggs and the young fish in their mouths for a couple of days. The Nile Tilapia, *Oreochromis niloticus*, is a native of Western Africa and the Nile basin (Froese and Pauly, 2015). It grows to a maximum length of 62cm, weighing 3.65kg (at an estimated age of 9 years) (FAO, 2012), however, its average total length is 20cm (Bwanika *et al.*, 2004).

Length and weight are important morphometric characters in fishery biology. A particular length and weight range can be peculiar to a certain species of fish at a specific developmental stage. It can be used to classify fish and also to monitor the growth rate of fish, particularly the cultured ones. Length-weight relationship of any fish is a prerequisite for the study of its population (Le Cren, 1951). It can also be used for the purpose of fish stock assessment and general wellbeing of the fish among others (Karal *et al.*, 2013).

The well-being of the fishes in a water body is considered as a good indicator of the health of the water body in relation to water pollution (Gupta and Tripathi, 2017; Kumar *et al.*, 2017). This is because length-weight, condition factor and size at first maturity investigations are the cheapest means of estimating the stress of water pollution on the body condition of fishes (Gupta and Tripathi, 2017). Condition Factor is influenced by stress, sex, season, availability of food and the water quality of the environment in which they live (Ighwela *et al.*, 2011).
This study is aimed at determining the length and weight relationship, growth pattern and the condition factors of two populations of *O. niloticus* obtained from Egbe and Ureje Reservoirs in Ekiti State, Nigeria.

Materials & Methods

Study Area
The first study site is a freshwater reservoir in Egbe Ekiti, Ekiti State, Nigeria. The dammed River was the Ose River that takes it source from Kwara State. The reservoir was constructed in 1975 and commissioned in 1989. It is a source of domestic water supply to the inhabitants of Gbonyin Local Government Area of Ekiti State and part of Akoko area of Ondo State. It lies between latitude 7^{o} 36 and 7^{o} 39N and longitude 5^{o} 32 and 5^{o} 36E of the equator. The dominant species of fish in the reservoir include *Tilapia zillii, Sarotherodon niloticus, Sarotherodon galilaeus, Clarias gariepinus, Clarias anguillaris, Parachana obscura, Hepsetus odoe and Mormyrus rume* (Adewumi *et al.*, 2014).

The second study site, Ureje Earth Dam, is also a freshwater reservoir located in Ado-Ekiti, Ado Local Government area of Ekiti State, Southwestern Nigeria. Ado- Ekiti is the capital of Ekiti State; the town is bounded in the north by Ifaki-Ekiti, in the south by Ikere-Ekiti, in the east by Ilu-Omoba and in the west by Ilawe Ekiti. The dam was constructed over 50 years ago and the geographic coordinates of the dam-site are between latitude 7^{o} 35.74′ and 7^{o} 36.26′ N of the equator and longitude 5^{o} 12.45′ and 5^{o} 13.01′ E of the Greenwich meridian. The areas around the dam-site are covered with thick vegetation, characterizing a tropical rain forest belt of Nigeria. Climatically, two seasons are witnessed in the study area namely wet season (April to October) and dry season (November to March) (Odekunle, 2004).

Collection of fish specimens
Fresh specimens of *O. niloticus* were collected directly from local fishermen who used cast net and gill nets (Figure 1). Specimens were collected simultaneously on a weekly basis from both locations making a total of 111 specimens from Egbe Reservoir and 149 from Ureje Reservoir between September 2019 and January 2020. The specimens were transported in a container to the laboratory of the Department of Zoology and Environmental Biology, Ekiti State University, Ado-Ekiti where the morphometric traits (length and weight) were measured for each specimen and recorded after separating them into males and females.

Figure 1. *Oreochromis niloticus* specimens obtained from Egbe (A) and Ureje (B) Reservoirs

Length - Weight Analysis

Excess water was drained from the body of the fish to ensure accuracy (Oso *et al*., 2017). The total length was measured to the nearest 0.01cm and weight to the nearest 0.01g. A calibrated meter rule was used to measure the fish length while an electronic weighing balance (Model – TH-1000) was used to determine the weight. Length-weight relationship was calculated using the allometric growth formula as used by Richer (1973) in the form of $W = aL^b$; Where

W – stands for body weight (g).

L – stands for total length (cm).

a = Intercept on the length axis, Y – intercept (when X = 0.0)

b = Regression coefficient (or an exponential expressing the relationship between length and weight).

The LWR equation was then transformed into a linear form:

Log W=Log (a) + b (Log L).

The log-transformed length-weight relationship was determined by linear regression analysis and the scatter diagrams of length and weight were plotted (Datta *et al.*, 2013).

Condition Factor

The condition factor was evaluated from the mean weight and length using the equation or formula:

$K = 100 (W/L^3)$ (Pauly, 1984).

Where W = the observed weight of fish in gram.

L = the observed total length for each fish in centimeter.

K is used to denote the Condition Factor.

Data Analyses

Statistical analyses such as descriptive statistics, regression analysis and Student's T-test were done using Microsoft Office Excel (2007) software. Duncan's Multiple Range Test from IBM SPSS Statistics (Version 22, 2013), was used to separate the different means observed.

Results

Length, weight and condition factor of O. niloticus from the two populations

A total of 260 fish specimens comprising of 52 males, 59 females and 68 males, 81 females respectively, obtained from Egbe and Ureje Reservoirs were analyzed during the study period. Hence, the male to female sex ratio of the fish was recorded to be 1:1.13 and 1:1.19 for specimens obtained from Egbe and Ureje Reservoirs respectively. The mean total length and

body weight of male fish obtained from Egbe Reservoir were significantly lower at $p<0.05$ than those from Ureje Reservoir. These were also observed in the female fish obtained from the two reservoirs (Table 1). However, the mean total length of male and female *O. niloticus* analysed from each reservoir was not significantly different from each other at $p<0.05$. While the mean body weight of male fish from Egbe Reservoir was significantly lower than that of the female at $p<0.05$, there was no significant difference between the male and female *O. niloticus* from Ureje Reservoir. The mean condition factor recorded for the male and female fish from Egbe Reservoir was not significantly different from each other while there was significant difference ($p<0.05$) in the Condition Factor of male and female *O. niloticus* from Ureje Reservoir (Table 1). Table 2 also showed the mean total length, body weight and condition factor of 17.86±1.79cm, 106.80±39.03g and 1.57 ±0.43 respectively for specimens obtained from Egbe Reservoir which were significantly lower than 21.41±1.95 cm, 186.82±39.75 g and 2.43±0.73 of those obtained from Ureje Reservoir. Figures 2 and 3 showed the number of specimens having an interval of Condition Factor values for both sexes in Egbe and Ureje Reservoirs respectively. The highest number of specimens was recorded for fish whose condition factor (K) ranged from 1.50 - 1.99 in both reservoirs.

Table 1: Length, weight and condition factor of male and female *O. niloticus* from each population

Population	Sex	Mean total length (cm)	Mean body weight (g)	Condition factor
Egbe Reservoir	Male	17.68 ± 1.70^{a}	96.29 ± 25.15^{a}	1.61 ± 0.39^{a}
	Female	18.01 ± 1.87^{a}	116.07 ± 6.32^{b}	1.51 ± 0.45^{a}
Ureje Reservoir	Male	21.52 ± 1.89^{b}	191.87 ± 7.85^{c}	2.39 ± 0.72^{c}
	Female	21.32 ± 2.01^{b}	182.59 ± 1.04^{c}	2.09 ± 0.63^{b}

*Rows means with different superscripts are significant at $p<0.05$

Table 2: Length, weight and condition factor of *O. niloticus* from both populations

	Mean total length (cm)	Mean total weight (g)	Condition factor
Egbe Reservoir	17.86 ± 1.79^{a}	106.80 ± 39.03^{b}	1.57 ± 0.43^{a}
Ureje Reservoir	21.41 ± 1.95^{a}	186.82 ± 39.75^{b}	2.43 ± 0.73^{b}

*Rows means with different superscripts are significant at $p<0.05$

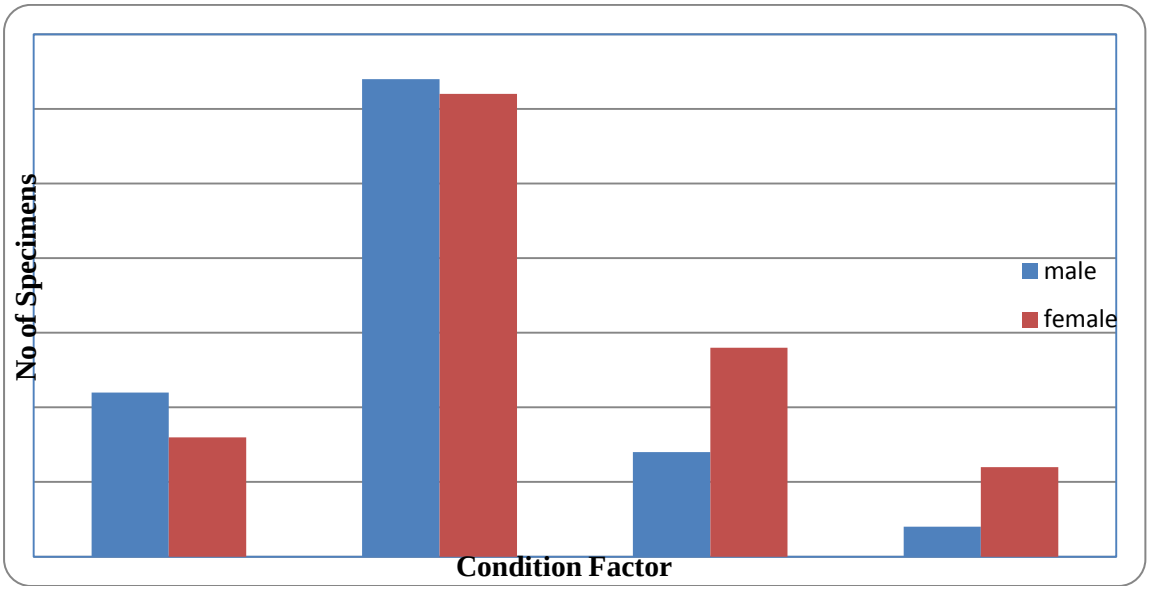

Figure 2. Number of specimens within an interval of Condition Factor values for both sexes in Egbe Reservoir.

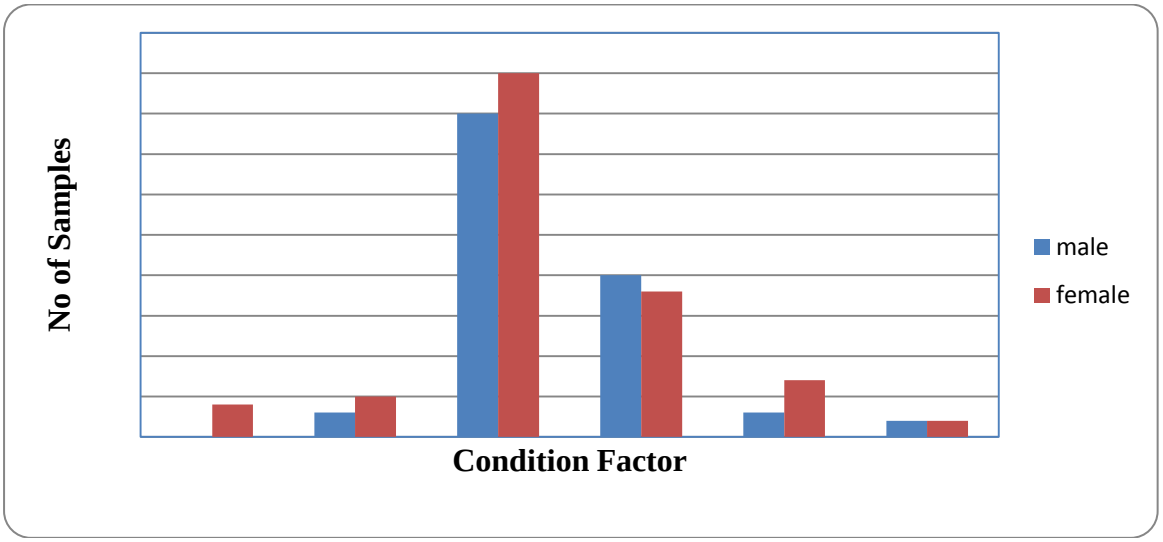

Figure 3. Number of specimens within an interval of condition factor values for both sexes in Ureje Reservoir

Length-Weight Relationship of O. niloticus from the two Populations.

The diagrams illustrated in Figure 4 below showed the relationship between the length and weight of the specimens. There was a positive relationship because an increase in the length showed a corresponding increase in weight. The coefficients of regression (b) of both populations were not exactly equal to 3. The 'b' values of males and females from Egbe reservoir were 2.130 and 3.083 respectively while those of males and females from Ureje reservoir were 1.765 and 1.556 respectively. For the combined sexes in each population, the 'b' values were 2.742 and 1.660 respectively.

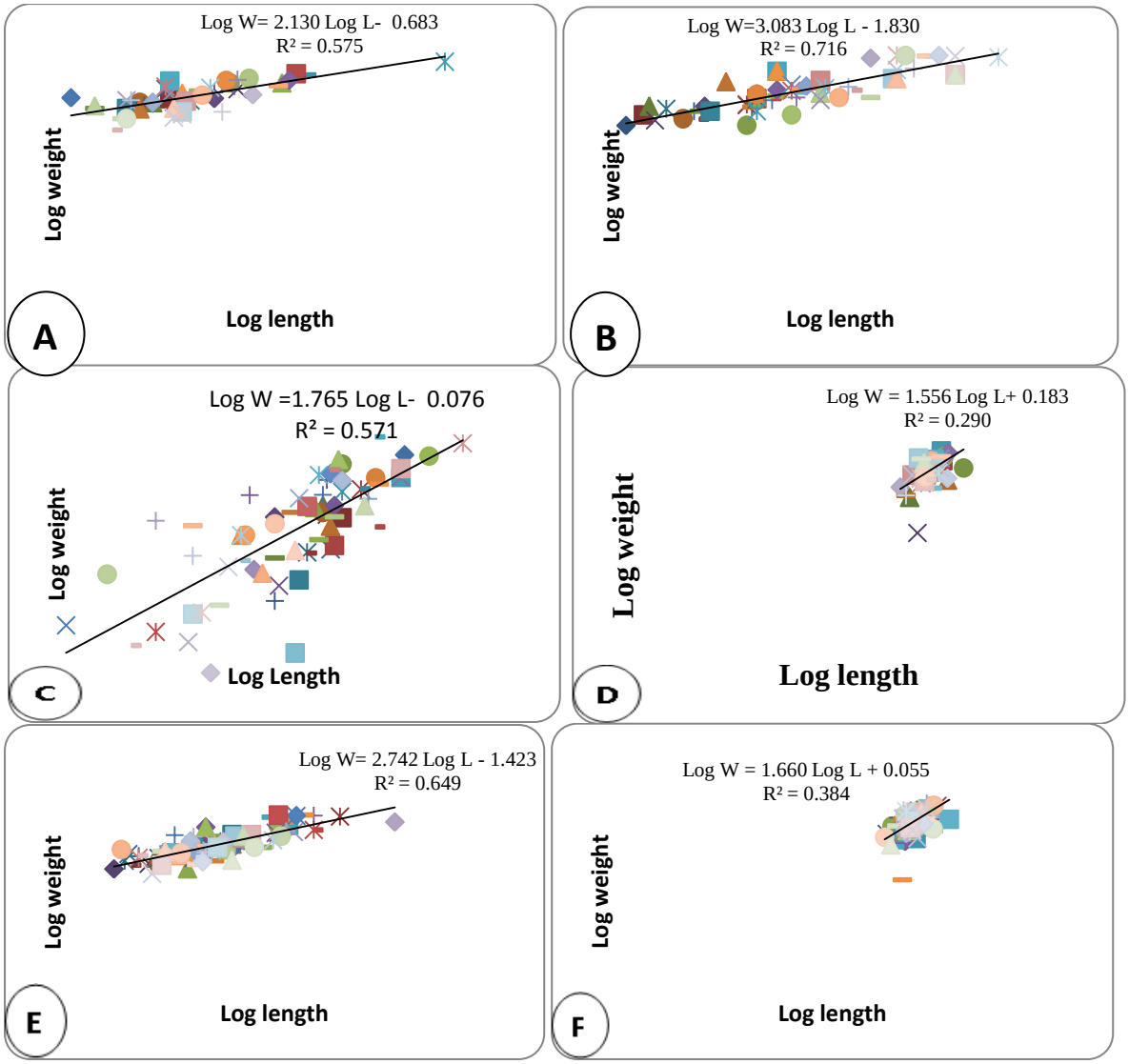

Figure 4. Length -Weight Relationships of male and female *Oreochromis niloticus* from the study sites.

A - Male from Egbe Reservoir; **B** - Female from Egbe Reservoir; **C** - Male from Ureje Reservoir; **D** - Female from Ureje Dam; **E** - Bothe male and female from Egbe Reservoir; **F** - Both male and female from Ureje Dam

Discussion

Length-weight relationship is an approach that is widely applied in fisheries management and provides information on stock condition. (Ola-Oladimeji *et al*., 2020). It is also of importance in fish biology as it can be used as a characteristic for distinguishing taxonomic units and the relationship changes with the various developmental events in life such as metamorphosis and onset of maturity (Thomas *et al*., 2003). Also, it is widely used for the purpose of conversion of equation of growth-in-length to growth-in-weight for use in stock assessment models and estimations of biomass from length observations (Wootton, 1990; Moutopoulos and Stergiou, 2002). The mean total length for both male and female from Ureje reservoir was higher than those of the specimens obtained from Egbe reservoir. Also, the average body weights of specimens from Ureje reservoir were higher than those obtained from Egbe reservoir, although the female specimens from Egbe reservoir had a higher mean value than the males. This variation can arise as a result of the differences in the type of food available, season of reproduction, site of collection and other factors. When the value of 'b' is less than 3.0, the fish

experiences a negative allometric growth (Mazumder *et al*., 2016). However, when the value of 'b' is more than 3.0, it is referred to as a positive allometric growth. Ibrahim (1984) reported that, the value of 'b' then becomes greater than 3.0 as the fish becomes fatter, and if the value is lower however, the fish is slimmer (Getso *et al*., 2017). The results obtained from this study has shown that the regression coefficient or growth coefficient (denoted as b) of all specimens from both populations exhibited negative allometric growth pattern except for the female *O. niloticus* specimens from Egbe reservoir. This result corresponds with the work of Fagbuaro *et al*., (2019) on length-weight relationship and condition factor of two species of Tilapia and one species of mormyrops from Itapaji dam in Ekiti State, Nigeria which had the 'b' value less than 3 indicating allometric growth within the sampled specimens. Also negative allometric growth patterns were recorded for some Tilapia species in Ogun State, Nigeria by Famoofo and Abdul (2020). The lower b value for female specimens from Ureje Reservoir agrees with Asmamaw *et al*. (2019) that the rate of weight gain calculated to be less than the increase in length, could be due to the timing of the batch where females empty their gonad, loosing energy after the production of egg, hence less weight in relation to their length. Furthermore, the result of the length-weight relationship of *Oreochromis niloticus* in this study can be said to agree with the report of Sangu *et al*. (2007) on some fish species in the Mediterranean Coast of Turkey and Offem *et al*. (2009) on fish of some Nigerian inland water bodies. It is also similar to the findings of Oso and Iwalaye (2016) who reported that three (3) out of their four (4) collections obtained from Ero Dam in Ekiti state, Nigeria had negative allometric growths. The Condition Factor provides information on the quality and suitability of the environment to the health and sustenance of aquatic organisms (Ogunola *et al*., 2018). The relationship of length-weight relationship can be used in the estimation of Condition Factor (K) of fish. The Condition Factor is the measure of the wellbeing of a fish. From the results obtained in this study, all specimens were in good condition and it gives a clue that the environmental factors favoured the fish growth. The Condition Factor values of specimens from both populations were greater than 1; although fishes from Ureje reservoir had higher K values. This suggest that the fishes in both populations had a good general well-being and those from Ureje reservoir could be said to relatively better. Ujjania *et al*. (2012) stated that condition factor greater or equal to one is good, indicating a good level of feeding, and favourable environmental conditions. Length-weight relationship parameters and the K value of fish have been reported to be affected by factors such as feeding intensity, availability of food, fish size, age, sex, season, stage of maturation and so on. (Bagenal and Tesch, 1978; Ujjania *et al*., 2012; Gupta and Banerjee, 2015).

Conclusion

It is hereby concluded from this study that both reservoirs are suitable for the growth and survival of the studied fish because a positive linear relationship was observed between the length and weight of the male and female fish from both populations and the condition factors also indicated that the fish were in good condition as both male and female had K values greater than 1. Consequently, it is recommended that specimens from Ureje Reservoir can be used in breeding studies for the improvement of the strains because of the higher condition factor obtained thereof.

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