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Composition and growth performance of *Tilapia zillii* and *Clarias gariepinus* in Rivers Niger and Benue, Kogi State, Nigeria

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species composition, length-weight relationship, condition factor, River Benue, River Niger, growth performance

Abstract

The study assessed composition and growth performance of *Tilapia zillii* and *Clarias gariepinus* between July, 2009 and December, 2010 in River Niger (RN) and River Benue (RB), Nigeria. Specifically, catch and percentage composition of these fish species in the two rivers were assessed, the morphometric parameters were evaluated and their length weight relationships (LWRs) were estimated. Three stage sampling procedures was adopted to collect data that lasted for 18 months. Both descriptive and inferential statistics were used for the analyses. A total of 3997 individuals representing 14 species were collected from the commercial landings during the study. Among the fish species examined, two species: *T. zillii* and *C. gariepinus* were of primary interest, being among the relatively dominant species in the study area. Parameters of LWR, a and b and condition factor were estimated. Niger River had a higher catch (2,932 samples) compared to Benue River (1,065 samples). *Clarias gariepinus* was 2nd position and *Tilapia zillii* in 4th position in relative composition in both rivers. Length relationships were close for *Tilapia zillii* (26.2±11.4, /25.6±10 cm) and for *Clarias gariepinus* (34.4±5.2 cm, /34.02±4.7 cm) in Rivers Niger and Benue respectively. Bigger fish sizes were recorded along River Benue for *Clarias gariepinus* (424.2±181.5 g) compared to (402.7±212.9 g) as sizes found along River Niger, which showed a better healthy environment for growth. Coefficients of determination (r^2) at $\alpha_{0.05}$ of LWR was; *T. zillii* (0.33; 0.33) and *C. gariepinus* (0.40; 0.35). Mean condition factor (K) ranged between 0.98 and 1.08 (*Clarias gariepinus*) and 0.20 and 0.41 (*Tilapia zillii*) in RN and RB, respectively. This study, therefore, called for close monitoring of LWR and condition factor of all the commercial fish species for effective stock management of the fishery.

Introduction

The course of Rivers Niger and Benue with the confluence at Lokoja, is found within a massive basin covering a distance of about 386.4 km (FMARD, 2014). This freshwater basin possesses a large floodplain mostly characterized by extensive perennial swamps and lagoons within which important fishery resources can be identified (Akpan - Idio *et al.*, 2013). Populations of different fish types, from the pelagic species to the benthos (Christensen *et al.*, 2011; Alum-Udensi *et al.*, 2016) are among those identified in this region. Indeed, about 200 fish species, including endemic ones and belonging to different fish families have been reported to live in this region (Laë, 1995). The availability of such variety of fish species attracts their exploitation to meet human demands.

The tributaries of Niger River have been good sources of fisheries and very vital for navigational purposes to those living in the riverine and coastal areas; yet the fish population within this environment has been affected by an ever-increasing natural and artificial factors that tamper with their abundance and prevalence (Nevalainen *et al.*, 2017). These factors include increased human population, deforestation, infrastructural development, desertification, increased invasive aquatic species, sedimentation in river basin, decreased river flow, dredging activities and oil spillage (Elum *et al.*, 2016). These factors alter aquatic system ecology and induce various responses by the species, from inabilities to survive the stress conditions to subsequent migration of fish species to tolerable locations (Alum-Udensi *et al.*, 2016).

Several reports by researchers have established the prevalence, distribution and abundance of fish species in different freshwater bodies in Nigeria (Oguntade *et al.*, 2014; Josef *et al.*, 2015; Ayamre and Ekelemu, 2016 and Uruku and Adikwu, 2017). These reports with differing views, statistics and composition may be influenced by natural locations of investigations, sampling gears used, season or occurrences (natural or man-made) preceding such research activity. As such, several reports show that Nigeria inland water fish yields are generally regarded to be on the decline and catch composition, frequency of size and increase or decrease in total catch seem not to be reliable for most inland waters of Nigeria for more than two decades (Fabre *et al.*, 2013). This seems to portray inadequate information on and management of the fisheries resources.

Growth is the change in absolute weight (energy content) or the length of fish over time (Diego *et al.*, 2018). It can also be seen as a function of fish size (Katja *et al.*, 2012). Growth performance of an organism depends on the health status of the environment or habitat in which it lives. The length or weight of fish species becomes indicator of level of environmental viability. As the environment or habitat is influenced by various factors (internal or external) such as stress, sex, season, availability of feeds, as well as other water quality parameters (Zahangir *et al.*, 2015), the degree of fish wellbeing points at conditions that support its growth. The pattern of fish growth is a change in magnitude, which

could be in size (weight and length) and is a morphometric feature that deals with body proportion. Thus, morphometric analyses have become increasingly common in biological studies to quantify and investigate biological shapes (Fabre *et al.*, 2013). The study of growth patterns in fish has been based principally on LWRs or relationships between sizes of scales or other calcified tissues and body length, because of their importance in age and growth analyses (Chowdhary and Srivastava, 2013). LWRs of fishes which are also referred to as growth index (Paiboon and Kriangsak, 2015), is an important management tool used in estimating the average weight at a given length growth; though they are known to vary seasonally and spatially (Alex *et al.*, 2012). The most widely used form of the LWR is the standard allometric model (Vu *et al.*, 2016), also referred to as differential scaling.

The condition factor of fish, also called 'length-weight factor' is expressed as 'coefficient of condition' (Abdul *et al.*, 2016). Several investigations by different research teams to establish the correlation between the LWRs and condition factor of fish species, tend to support the inevitability of healthy environment to optimum growth performances of fish species.

The aquatic environments are a composite of natural features and occurrence supporting a diverse but largely enshrouded ecosystem. More so, they are unique and complex combinations of natural features and phenomena, supporting a diverse but largely concealed ecosystem. These natural locations accommodate amazing populations of aquatic fauna. Rivers Niger and Benue are such environments which has thirty-six (36) families of freshwater fish with nearly 250 species, 20 of which are found nowhere else on Earth but River Niger and this massive supply attracts a large human population, thriving for basic survival (Ayuba, 2016). This freshwater basin possesses a large floodplain mostly characterized by extensive perennial swamps and lagoons within which important fishery resources can be identified (Akpan - Idio *et al.*, 2013). In consonance with research information, the lower Niger-Benue River has been reported to contain a rich fish fauna with many species adapted to seasonal flooding (Laë, 1995). The prevalence and survival of the fish population depends, to a significant extent, on the physico-chemical parameters of the immediate environment (Supratim and Kaushik, 2014). The aquatic environment, like any other natural habitat, is vulnerable to intermittent disruptions which may be natural or man-made. Natural fluctuations, unlike man-made disruptions, occur overtime and they become gradually regulated until the stress factors are removed (Alum-Udensi *et al.*, 2016). The physical endowment (water and sediment quality) support the survival of aquatic lives, by supplying vital substances to boost optimum growth; but human dependence on fisheryproducts impact significantly on the prevalence and abundance of these resources. *Tilapia* sp and *Clarias* sp are abundance because they are highly prolific species (Josef *et al.*, 2015), however, any activity that alters the physical environment, drives to extinction these aquatic species or interfere with their growth patterns (Alex *et al.*, 2012). The aim of this study was to obtain information on the composition and growth performance of *Tilapia zillii* and *Clarias gariepinus* in Rivers Niger and Benue, Kogi State, Nigeria. This needed information would be based on the following objectives: to assess catch and composition of *T. zillii* and *C. gariepinus* in Rivers Niger and Benue, to assess the morphometric parameters and percentage composition of *T. zillii* and *C. gariepinus* in Rivers Niger and Benue and to estimate the LWR of *T. zillii* and *C. gariepinus*.

Materials and methods

The study was focused on two major fresh water: Rivers Niger and Benue in Kogi State, Nigeria. It is situated in the savannah region between longitude 05°20" and 08°00" East and latitude 05°30"and 08°50" North The range in mean monthly minimum and maximum temperatures during the wet and dry seasons in the region are 21.9-26.5 and 30.7-36.7 °C, respectively. The potential for fish production is very high, with over 2000 fishing households and 200 major fishing villages sustained by Rivers Niger and Benue (KADP, 2011). The major landing sites in Kogi State are riverside and major fish markets. The study population consists of all the fisher folks along Rivers Niger and Benue in Kogi State, Nigeria. A three-stage sampling technique was used for the study. At first stage, the purposive sampling technique was adopted to select eight (36 %) Local Government Areas (LGAs) along River Niger (Kogi, Ajaokuta, Ufo and Lokoja) and River Benue (Omala, Idah, Ibaji, and Igalamela) in Kogi State, according to the intensity of fishing operation. At the second stage, three fishing villages were selected by the simple random technique from each of these LGAs. At the third stage, the fish samples for length-weight relationship and condition factor were randomly collected from purposely chosen fishing grounds of River Niger and River Benue between July 2009 and December 2010. The number of individual species and total number of all fishes caught by number of gears were counted and recorded against it. Identifications were made with the aid of relevant texts (Idodo-Umeh, 2003; Olasebikan and Raji, 2013). The length and weight were taken using the method described by Adebayo and Kusemiyu (1994). Total length (cm) from the tip of the snout (mouth closed) to the extended tip of the caudal fin was done using a 1-50 cm wooden measuring board. Body weight was measured to the nearest gram using a digital sensitive scale (Falcon, Bl 3002).

Length-weight relationships

Length-weight relationship was estimated by using the equation:

$$W = aL^b$$

Where:

W= weight (g), L= total length (cm), a = constant and b= growth exponent.

A logarithmic transformation was used to make the relationship linear as follows:

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

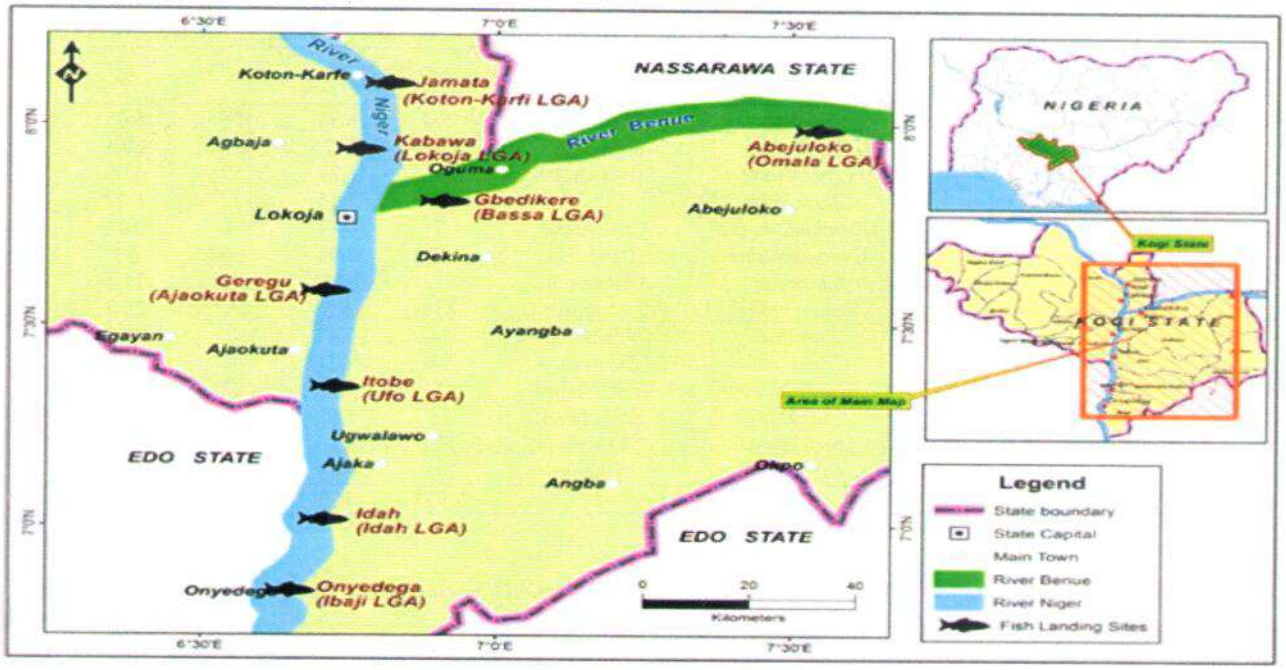


Fig. 1: Fish Landing Sites along Rivers Niger and Benue in Kogi State, Nigeria

Condition factor

Condition factor for each sample was determined according to Arunlertaree and Moolthongnoi (2008), using the Fulton's coefficient formula:

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

Where:

K = condition factor, W = weight in grams, L = total length in centimeter.

Fish with condition factor values greater than one (≥ 1) were considered as high while those < 1 were low.

Results

The catch composition identified had 3997 individuals, 13 families, 14 fish species such as *Alestes sp*, *Clarias gariepinus*, *Chrysichthys sp*, *Clarotes sp*, *Gymnarchus*, *Heterobranchus bidorsalis*, *Heterotis niloticus*, *Lates sp*, *Labeo sp*, *Momyrops sp*, *Ophiocepalus sp*, *Synodontis sp* and *Tilapia zillii* as depicted in Table 1. The relative abundance of fish fauna by number and percentage in River Niger (RN) and River Benue (RB) throughout the sampling period is shown in Table 1. The most abundant fish species was *Heterotis niloticus* (28.51 %, 836 samples (RN); 25.20 %, 268 samples (RB)) followed by *Clarias gariepinus* (22.75 %, 667 samples (RN); 20.4 %, 217 samples (RB)), then *Heterobranchus bidorsalis* (12.01 %, 352 samples (RN); 11.1 %, 118 samples (RB)) and then *Tilapia zillii* (7.44 %, 218 samples (RN); 6.48 %, 69 samples (RB)). *Lates niloticus* (0.48 %, 14 samples (RN); 0.28 %, 3 samples (RB)) and *Distichodus laticeps* (0.42 %, 7 samples (RN); 0.38 %, 4 samples (RB)) were the least species in Rivers Niger and Benue, respectively.

In the order of abundance of individual fish species, the composition differed in Rivers Niger and Benue. The Niger River had higher catch figures, when compared to Benue River. The relative composition of *Clarias gariepinus* and *Tilapia zillii* in both rivers were at 2nd and 4th positions, respectively. The morphometric and LWR parameters of *T. zillii* and *C. gariepinus* in Rivers Niger and Benue were documented in Table 2 and Figs. 2-5. The average total length and mean body weight along River Niger for the sampling period were 24.0 to 46.5 cm, 21.5 to 802.3 g for *C. gariepinus* and 3.0 to 40.2 cm, 18.8 to 172.0 g *for T. zillii*; while the average total length and mean body weight along the fishing grounds of River Benue for the sampling period ranged from 25.2 – 45.5 cm, 150.4 – 805.8 g for *C. gariepinus* and 4.5 – 39.6 cm, 12.6 – 22.2 g for *T. zillii*.

The intercept, a values were 1.22 (R. Benue) and 1.27 (R. Niger) for *T. zillii* and 0.55 (R. Benue) and 3.13 (R. Niger) for *C. gariepinus*. The corresponding exponent, b values were 0.43 (R. Benue) and 0.41 (R. Niger) for *T. zillii* and 2.05 (R. Benue) and 3.67 (R. Niger) for *C. gariepinus*. The exponent, b values of all the fishes in the two rivers were each less than 3 and indicated negative allometric growth pattern in all the fish species, except *C. gariepinus* in R. Niger, which showed a positive allometric growth pattern, where b>3. The correlation coefficients (r^2) which values ranged from 0.0.33 to 0.40 in all the fish species in both rivers showed a low degree of positive correlation ($P<0.05$) between their TL and TW. Figs. 2 – 5 and b showed the regression graphs of the species of fish. The regression graphs gave straight line relationships which implied that as the length increased, the weight also increased.

Table 1. Fish Composition along Rivers Niger and Benue in Kogi State, Nigeria

Species	Family Name	English	Niger		Benue	
			N	%	N	%
Alestes sp	*Alestidae*	Silversides	204	6.96	58	5.45
Clarias gariepinus	*Clariidae*	Mudfish	667	22.75	217	20.4
Chrysichthys sp	*Claroteidae*	Silver catfish	96	3.27	53	4.98
Clarotes sp	*Claroteidae*		63	2.15	21	1.97
Distichodontis sp	*Distichodontidae*	Grass-eater	7	0.24	4	0.38
Gymnarchus	*Gymnarchidae*	Trunkfish	89	3.04	65	6.1
Heterobranchus bidorsalis	*Clariidae*	African pike	352	12.01	118	11.1
Heterotis niloticus	*Arapaimidae*	Africa arowana	836	28.51	268	25.2
Lates sp	*Lattidae*	Nile perch	14	0.48	3	0.28
Labeo sp	*Cyprinidae*	African carps	98	3.34	41	3.85
Momyrops sp	*Mormyridae*	Trunk fishes	110	3.75	43	4.04
Ophiocepalus sp	*Channidae*	Snakehead	56	1.91	49	4.6
Synodontis sp	*Mochokidae*	Catfish	122	4.16	56	5.26
Tilapia zillii	*Cichlidae*	Tilapia	218	7.44	69	6.48
Total			2,932	100	1,065	100

Table 2: Morphometric parameters, composition and LWR of *T. zillii* and *C. gariepinus* from Rivers Niger and Benue in Kogi State, Nigeria

Species	*T. zillii*		*C. gariepinus*	
Rivers	Benue	Niger	Benue	Niger
Number (N)	69	218	217	667
Percentage (%N)	10.27	10.52	32.29	32.18
TL (cm) Min-Max	4.5-39.6	3.0-40.2	25.2-45.5	24.0-46.5
Mean length (cm)	25.6±10	26.2±11.4	34.02±4.7	34.4±5.2
WR (g) Min-Max	12.6-22.2	18.8-172	150.4-805.8	21.5-802.3
Mean weight (g)	67.4	95.4	424.2	402.7
a	1.22	1.27	-0.55	3.13
b	0.43	0.41	2.05	3.67
r^2	0.33	0.33	0.35	0.40
K	0.41	0.20	1.08	0.98
G	NA	NA	NA	PA

N/B: N = sample size; TL =Total lengths in cm; WR =Weight in g; a = Constant, b= growth exponent; r^2 = the coefficient of determination; K= Condition factor; G= growth pattern; NA = Negative allometric; PA = positive allometric

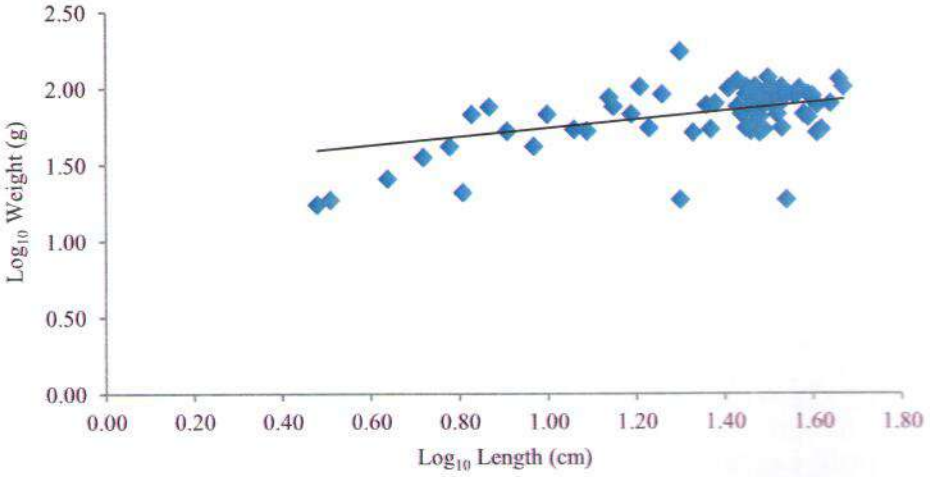


Fig. 2: Length-weight relationship of *Tilapia zillii* along River Niger, Nigeria

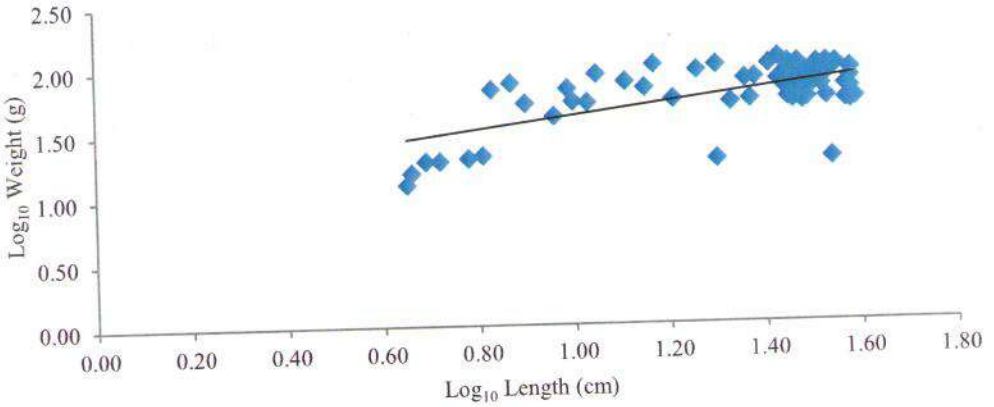


Fig. 3: Length-weight relationship of *Tilapia zillii* along River Benue, Nigeria

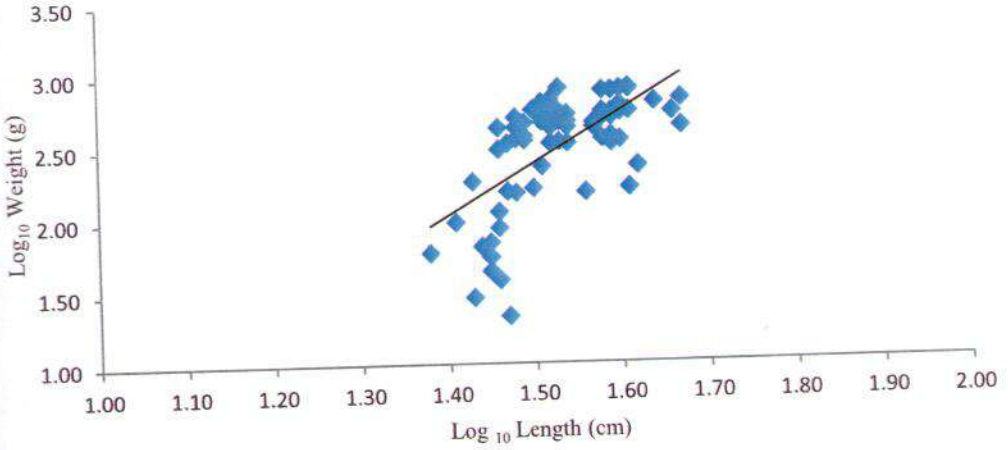


Fig. 4: Length-weight relationship of *Clarias gariepinus* along River Niger, Nigeria

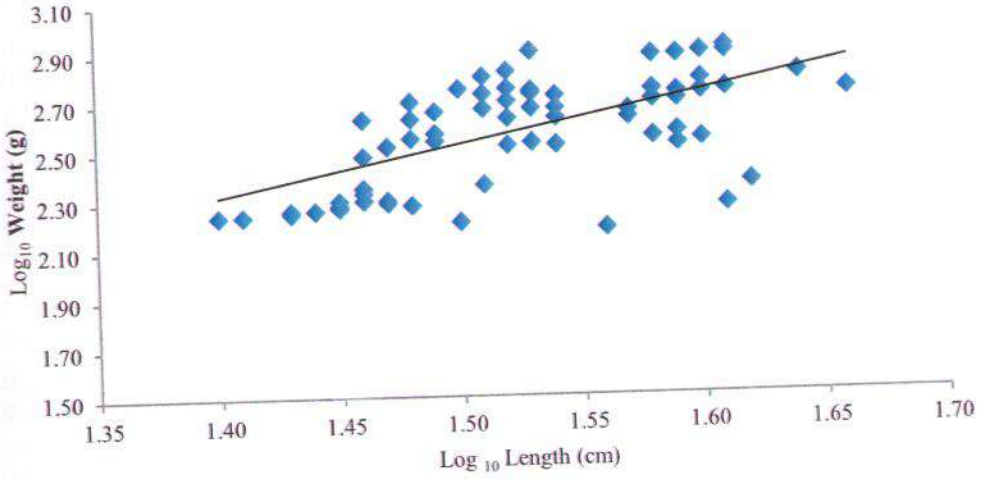


Fig. 5: Length-weight relationship of *Clarias gariepinus* along River Benue, Nigeria

The condition factor of the two species of fish in the two rivers were shown in Tables 2 and 3. Condition factor values were generally higher in River Benue (0.41; 1.08) than River Niger (0.20; 0.98) for *T. zillii* and *C. gariepinus* respectively. However, they were significantly different at $p<0.5$. The body condition of the fishes in the rivers were generally low except for *C. gariepinus* (1.08) in R. Benue.

Table 3: Mean condition factors (k) of *Tilapia zillii* and *Clarias gariepinus* in Rivers Niger and Benue, Nigeria

Species	Rivers		Sig.-value
	Niger	Benue	
Tilapia zillii	1.70±6.73[a] (0.05-64.44)	2.62±4.93[a] (0.05-21.40)	0.278
Clarias gariepinus	0.95±0.48[b] (0.08-2.07)	1.08±0.40[b] (0.29-2.07)	0.000

Note: Mean values with the same alphabet superscript on the same column are not significantly different ($\alpha_{0.05}$). Values in parenthesis are the minimum and maximum values

Discussion

The availability of members of the families: Cichlidae and Clariidae in Rivers Niger and Benue are well known (Ayanwale *et al.*, 2013; Idodo-Umeh, 2003; Abowei and Davies, 2009). The high proportions of *Tilapia* and *Clarias* species could be attributed to their adaptation to lentic aquatic environmental qualities, productivity of the river, changes in the hydrological regime of the river (Toyisi and Effiong, 2005) and their high prolific breeding nature (Dan-Kishiya, 2012) coupled with their good parental care which gives a considerable advantage in the colonization of their habitat (Toyisi and Effiong, 2005). The results of this study compares favorably with the findings of Komolafe and Arowomo (2009).

Generally, length and weight are fundamental parameters of growth (Paiboon and Kriangsak, 2015). Treating these parameters statistically helps to establish their relationship and to arrive at the formulae for length-related body measurements. Length relationships were close for both *Tilapia zillii* (and *Clarias* in Rivers Niger and Benue. Bigger fishes were observed in River Benue for *Clarias gariepinus* as compared to those observed for it in River Niger. This implies that River Benue was a healthier environment for fish growth than R. Niger, That is, River Benue may be richer in available food and suitable habitat for species growth than River Niger. The exponent value showed negative allometric value for *Tilapia zillii* and *Clarias gariepinus* showed positive allometric growth along River Niger. *Tilapia zillii and C. gariepinus* along River Benue showed negative allometric growth coefficient of the regression at 95 % confidence limits. Froese (2006) and Froese and Pauly (2007) suggested that exponent b should fall with $3 < b < 3.67$ values of allometric growth pattern. According to Frosta *et al.*, (2004), the slope, b indicates the rate of weight gain relative to growth in length and varies among different populations of the same species or within the same species. In this study, b-value was less than and more 3, this implies allometric growth pattern. Victor *et al.*, (2014) asserts that most inland water fish in Nigeria had negative allometric growth pattern. However, Taiwo (2011) reported a positive allometry for *Chrysichthys nigrodigitatus* and *Schilbe intermedius* from Owalla and Ekoende Reservoirs. In agreement with this study, Arimoro and Idoro (2007) made similar observations on *Callinectes amnicola* in Badagry, Lagos State and Warri River, Niger Delta, respectively.

Correlation coefficient for *T. zillii* and *C. gariepinus* along River Niger and *T. zillii* and *C. gariepinus* along River Benue indicates an average degree of correlation between length and weight in the sampled population. This agrees with Ayandiran and Fawole (2014) who noted that *Clarias gariepinus* showed low correlation coefficient value of 0.26 in Oluwa River, Nigeria.

Condition factor is the morphometric index used to evaluate physiological status of fish based on the principle that those individual lengths which have a higher mass are in better condition. The condition factors were generally higher in River Benue than River Niger for *T. zillii* and *C. gariepinus*, respectively. It could be influenced by size or age (Anwa-Udondiah and Pepple, 2011).

In fishery science body wellbeing ≥ 1.0 is considered as good. The highest value of mean condition factor recorded for *C. gariepinus* among others implies that it could survive better even when biotic and abiotic factors are less favourable. Explanation for this k-value could be due to activities and population changes in the ecosystem. The different values of mean K obtained in this study could therefore be as a result of differences in increase or decrease in feeding activities and population alteration, possibly due to modification of food resources.

Conclusion

The mean condition factor along River Benue were higher compared to their respective species for River Niger. River Niger produce fish of lower *b* value, which may be attributed to pollution status or anthropogenic activities that occur in it. It is essential to embark on research to monitor and study the physico-chemical conditions and a well-conceived environmental impact assessment of Rivers Niger and

Benue in order to provide a basis for an informed decision on sustainable management of the rivers.

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