LENGTH-WEIGHT RELATIONSHIP, CONDITION FACTOR (k) AND SEX RATIO OF FOUR FISH SPECIES FROM RIVER SILUKO, EDO STATE, NIGERIA

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ABSTRACT

The length-weight relationship (LWR), condition factor (K) and sex ratio of Ctenopoma kingsleyae, Gnathonemus niger, Gnathonemus petersii and Synodontis schall belonging to three families Anabantidae, Mormyridae, and Mochokidae were studied between March and August, 2015 in River Siluko. The correlation coefficients (r) for Length-weight relationship were highly significant (P < 0.01) and the growth exponent 'b' = 2.979, 2.097, 2.793 and 2.813 for C. kingsleyae, G. niger, G. petersii and S. schall respectively, indicate a negative allometric growth pattern. Mean condition factor (K) of 3.594 (C. kingsleyae), 1.652 (G. niger), 1.314 (G. petersii) and 2.723 (S. schall), revealed that all fish species were in good health condition. Except in G. niger (1: 0.59) with significantly higher number of males, a balanced population was observed for the other fish species. Findings from this study will serve as baseline information in River Siluko, and will contribute valuably to the existing data to enhance the management and conservation of these fish species.

Keywords: Freshwater, growth pattern, male-biased sex ratio, utilization

INTRODUCTION

Fish remains among the most traded food commodities worldwide. It is an important renewable resource, often exploited for both subsistence and commercial purposes from lakes, rivers, wetlands, seas and oceans. According to the Food and Aquaculture Organization of the United Nations (FAO, 2000), one billion people world-wide rely on fish as their primary source of animal protein. The harvest, handling, processing and distribution provide a source of livelihood for millions of people all over the world. The percentage dietary protein obtained from fishes is very high in some African countries, such as Senegal (47%), Gambia (62%), Sierra Leone (63%) and Ghana (63%), and this protein can be directly assessed without spending much money (FAO, 2000).

Nigeria is blessed with abundant inland water resource with over 200 species of fish (Ita, 1994; FAO, 2000). Ugwu (1997) states that about 40% of the animal protein derived from fish; especially by rural dwellers; while Zelibe and Ekelemu (2006) reported that fish accounts for at least 55% of the protein intake of Nigerians. In spite of the rich fish diversity potential of Nigerian waters, a decline in fish production has been observed over the years. Meeting the demand for fish can only be achieved by improved and efficient fisheries management, and development of aquaculture and improvement in the handling, processing, storage and distribution of fish.

The length-weight relationship of fish species, in conjunction with age data, can provide information on the natural history, stock composition, age at maturity, life span, mortality, growth and reproduction of valuable fish species, thus making management and utilization possible (Diaz *et al*., 2000). It has many uses particularly in estimating the mean weight of a given length class, in comparing species and populations in different geographic areas and in estimating the condition or "wellbeing" of the fish (Petrakis and Stergiou, 1995; Garcia *et al*., 1998). According to Abowei and Davies (2009), LWR also known as a growth index, is an important fishery management tool, used in estimating the average weight at a given length group. Condition factor reflects the well-being of the fish and it gives information when comparing two populations living in different feeding, density, climatic and other conditions (Abowei, 2010). It is useful in determining the gonadal development, and the degree of feeding activity to ascertain if the species are making good use of their food source (Ighwela *et al.,* 2011).

Knowledge of the monthly and seasonal variation in sex ratio of a fish population is important for obtaining information on seasonal segregation of the sexes and their differential growth. According to Vicentini and Araujo (2003) studies on sex ratio provide information on the proportion of male to female fish, indicates the dominant sex in a given population and the basic information necessary for fish reproduction and stock size assessment.

To enhance the management, utilization and conservation of fishes, information on their biology is important; but this is scanty or scarce for most freshwater fish species in Nigerian waters. This study therefore aims to provide data on the LWR, condition factor and sex ratio of *C. kingsleyae*, *G. niger*, *G. petersii* and *S. schall* in River Siluko.

MATERIALS AND METHODS

Study Area

The study was carried out along a stretch of River Siluko (6° 17' 20° N, 5° 00' 25° E) in Siluko town (Fig. 1), located in Ovia South West Local Government Area of Edo State, Nigeria. Siluko town is about 64km North-West of Benin-City and has an elevation of 51 meters above sea level. River Siluko drains water from the Owena River which has its source in the hills of the North-East catchment area around Effon-Alaayein Ekiti State and flows southwards joining Ofosu and Aden Rivers, north of Siluko town and then as River Siluko (Akinro and Olawale 2007). It drains into the Atlantic via Benin River, after being joined by the Okomu and Osse Rivers (Arimoro *et al.,* 2006).

River Siluko, lies within the rain-forest zone which is governed by two distinct climatic seasons, the rainy (wet) and dry seasons. The vegetation along the river is that of forest swamp and consists of trees (*Khaya senegalensis, Pycnanthus angolensi, Alsonia congoensis* and *Khaya ivorensis*), grasses (*Pennisetum purpureum, Megathyrsus maximus* and *Leersia hexandra*), and weeds (*Pista stratiotes, Nymphea lotus* and *Salvina nymphellula*). During the rainy season large number of water hyacinth (*Eichhornia crassipes*) float on the water surface covering a large area of the water surface, thereby reducing and obstructing navigation. Human activities in the river include washing, bathing, fishing, saw milling and spiritual cleansing. The inhabitants of Siluko town are predominantly farmers, and traders; and a few engage in fishing (Obasogie and Ogunjemite, 2014).

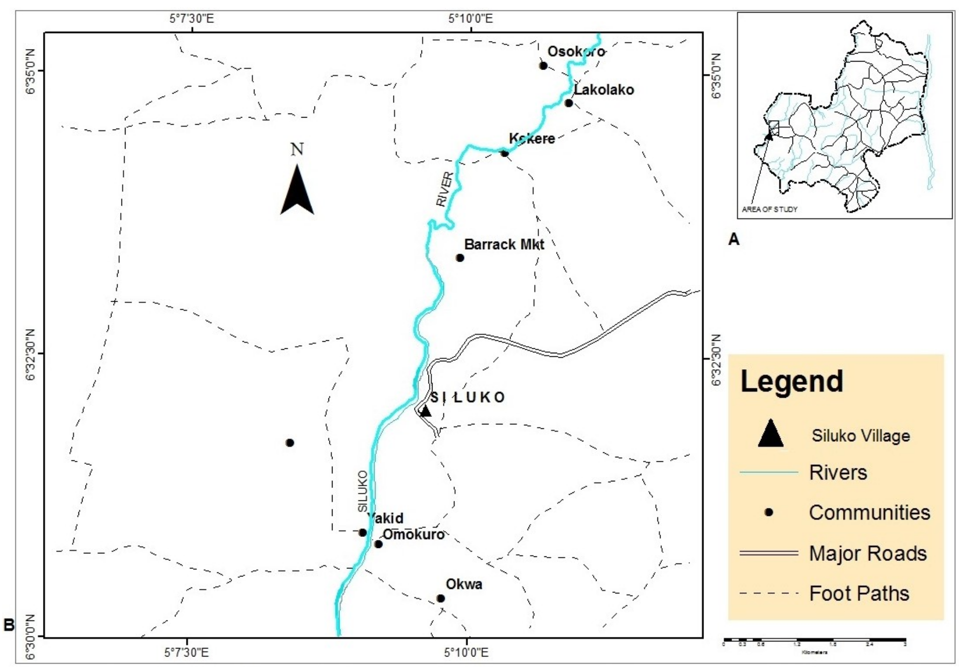

Fig. 1: Map of Edo State showing study area (A), River Siluko (B)

Fish sampling

Fish specimens were purchased from artisanal fishers and middlemen at Siluko market, which is one of the landing sites along the bank of the River. Sampling of landed catches was done forth-nightly for a period of six months, March to August, 2015. The fish specimens were immediately stored and placed in an ice chest and transported to the laboratory in the University of Benin. All fish specimens collected were identified to species level using the keys by Babatunde and Raji (1998) and Idodo-Umeh (2003).

Length-weight measurements

Total length and Standard length were measured to the nearest centimeter (0.1cm) using a meter rule and measuring board. The Total length (TL) was measured from the tip of the snout (mouth closed) to the extended tip of the caudal fin. Standard length (SL) was measured from the tip of the snout to the caudal peduncle. Body weight of each fish specimen was measured to the nearest 0.1g using a digital electronic weighing balance (Mettler Toledo JL6001-G/LA01).

Length-Weight Relationship (LWR)

The LWR of the fishes were calculated using the equation:

$$W = aL^b$$

Where W = the observed total weights of the fishes in grams.

L = the observed standard lengths in centimeters.

a and **b** = are constants.

b is the slope usually between 2 and 4, and **a** is the intercept on the length axis (Bagenal., 1978).

The logarithmic transformation of the equation gives a straight line relationship

$$\textbf{Log W = Log a + b Log L.}$$

When $\mathbf{Log_{10}W}$ is against plotted $\mathbf{Log_{10}L}$, the regression coefficient is **b**, and **Log a** is the intercept on the Y axis.

Condition Factor (K)

This was computed for individual fish according to Le Cren (1951) using the equation:

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

Where K = Condition factor.

L= Standard length in centimeters.

W= Body weight of fish in grams.

Sex Determination

The sexed specimens were categorized into males and females for each species, after they were dissected to reveal the fresh gonads. The total number of each sex for the various species was pooled monthly and the ratio of males to females was determined for all species. Monthly and overall sex ratios of the population were subjected to chi-square analysis test, using the equation:

$$X^2 = \frac{(Fi - fi)^2}{Fi}$$

Where,

fi = Observed frequency

Fi = Expected frequency

RESULTS

A total of 506 fish specimens (149 *C. kingsleyae*, 100 *G. niger*, 127 *G. petersii* and 130 *S. schall*) were examined.

Length-weight relationship (LWR)

The length-weight relationships of the four fish species are shown in Table 1 and illustrated in Figs 2-5. All length-weight relationships were highly significant ($P < 0.01$) with r values of 0.953 (*C. kingsleyae*), 0.853 (*G. niger*), 0.905 (*G. petersii*) and 0.872 (*S. schall*). The 'b' values of 2.979, 2.097, 2.793 and 2.813 obtained for *C. kingsleyae*, *G. niger*, *G. petersii* and *S. schall* respectively, indicate a negative allometric growth pattern.

Table 1: Length-weight relationship of four fish species collected from River Siluko

Fish species	N	Length			Weight			a	b	r	k
		Min	**Max**	**Mean ± SD**	**Min**	**Max**	**Mean ± SD**				
Ctenopoma kingsleyae	149	7.40	13.50	9.61 ± 1.05	11.50	80.85	32.28 ± 12.20	1.437	2.979	0.953	3.504
Gnathonemus Niger	100	9.50	13.50	11.39 ± 0.93	14.81	36.81	23.91 ± 4.74	0.842	2.097	0.853	1.616
Gnathonemus Petersii	127	9.30	21.70	16.14 ± 1.99	8.11	110.70	52.51 ±19.88	1.675	2.793	0.905	1.207
Synodontis Schall	130	6.70	15.00	9.50 ± 1.61	7.13	83.20	23.97 ±13.74	1.417	2.813	0.872	2.612

a = Intercept on χ-axis, b = Slope, r = Coefficient of Regression, k = Condition Factor

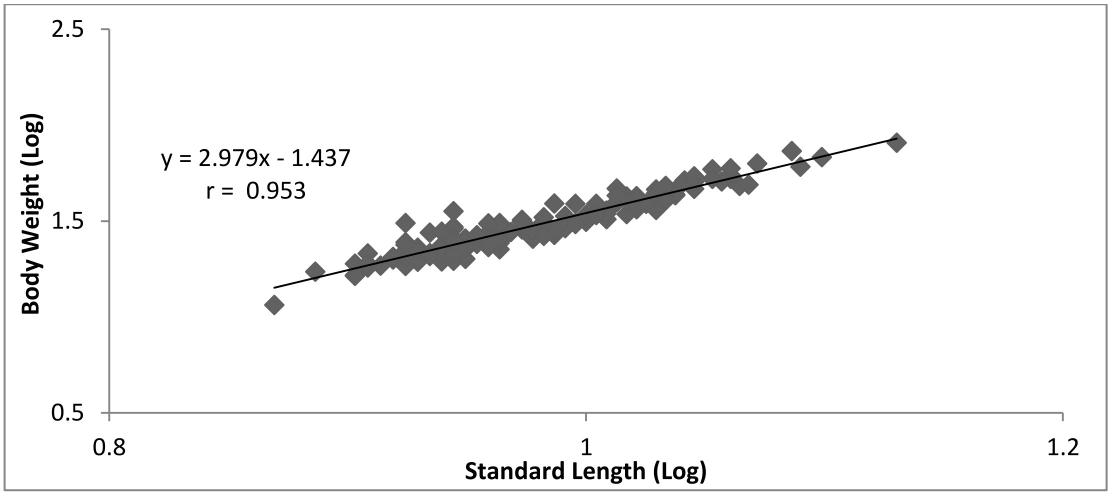

Fig. 2: Length-weight relationship of *Ctenopoma kingsleyae*

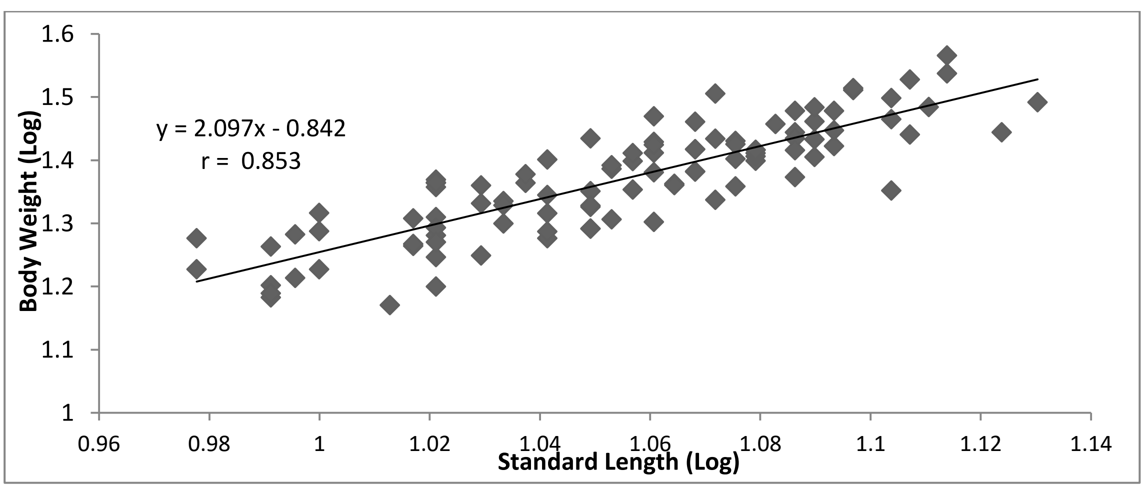

Fig. 3: Length-weight relationship of *Gnathonemus niger*

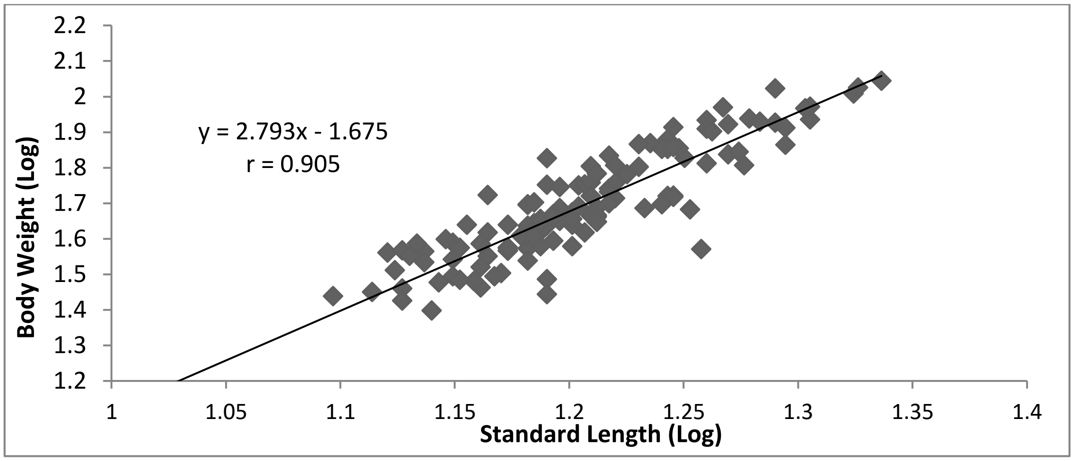

Fig. 4: Length-weight relationship of *Gnathonemus petersii*

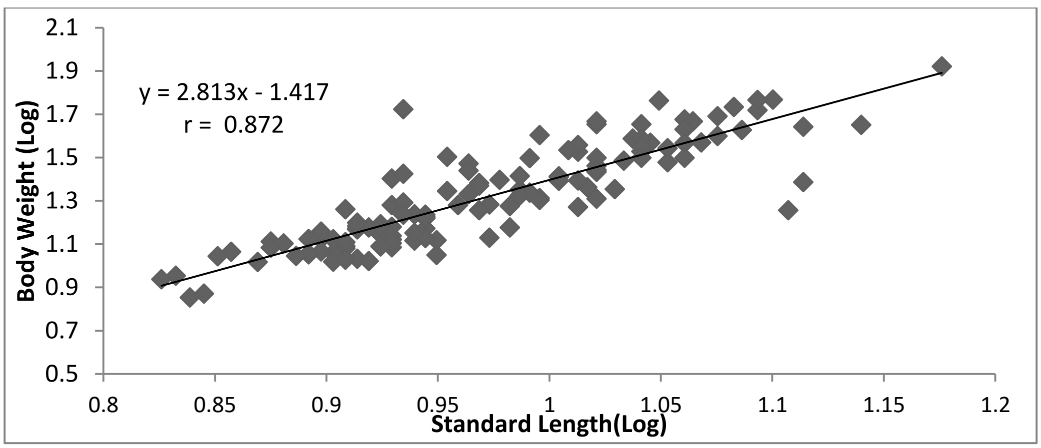

Fig. 5: Length-weight relationship of *Synodontis schall*

Condition Factor (K)

The mean condition factor (K) values of 3.504, 1.616, 1.207 and 2.612 for *C. kingsleyae*, *G. niger*, *G. petersii* and *S. schall* respectively for the period of study indicated that the fishes were in good condition (Table 1). The mean monthly condition factor ranged from 3.408 to 3.576, 1.597 to 1.646, 1.097 to 1.492 and 2.343 to 3.505 for *C. kingsleyae*, *G. niger*, *G. petersii* and *S. schall* respectively (Fig. 6). No clear seasonal pattern in condition factor was observed among the fish population.

Sex Ratio

All 506 fish specimens examined had observable gonads. The sex ratios of the four fish species are presented in Tables 2-5. Analysis of overall sex ratio showed that, males and females occurred in almost equal proportions for *C. kingsleyae* (1:0.69), *G. petersii* (1:0.69) and *S. schall* (1:1.41), except in *G. niger* (1:0.59) were males outnumbered females significantly ($P < 0.05$).

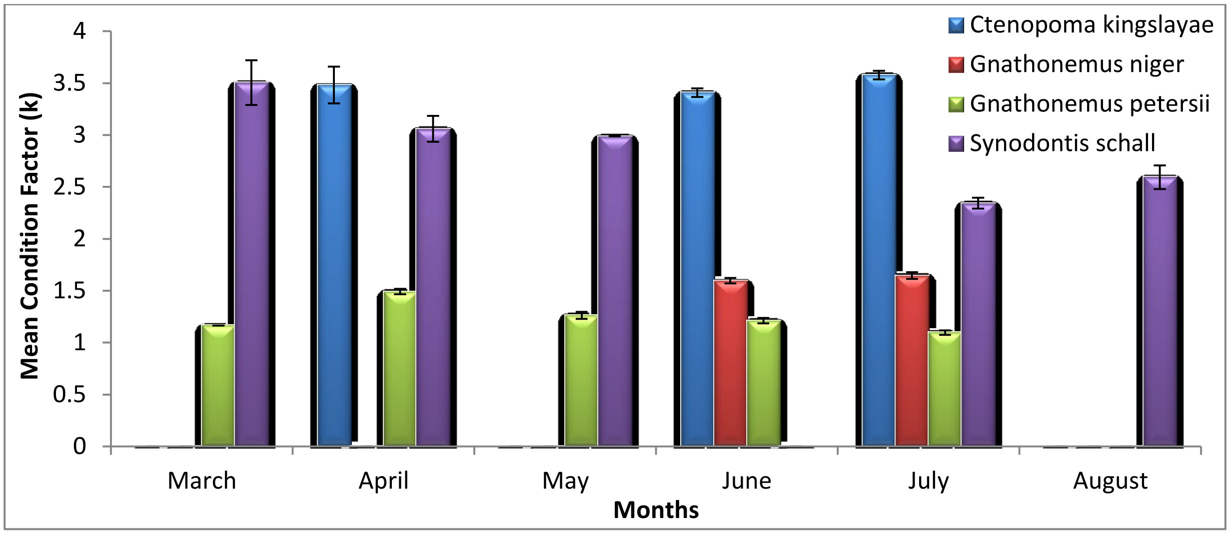

Fig. 6: Mean monthly condition factor of four fish species collected from River Siluko

Table 2: Monthly Sex ratio of *Ctenopoma kingsleyae* in River Siluko

Month	Number of fish sexed	Number of males	Number of females	Sex ratio (M:F)	Chi-square (χ^2)
MARCH (2015)	0	0	0	0:0	0
APRIL	13	6	7	1:1.17	0.077
MAY	0	0	0	0:0	0
JUNE	57	31	26	1:0.84	0.439
JULY	79	51	28	1:0.55 *	3.073
AUGUST (2015)	0	0	0	0:0	0
TOTAL	149	88	61	1:0.69	4.595

$\chi^2 = 4.595$ * Significant at $P < 0.05$

Table 3: Monthly Sex ratio of *Gnathonemus niger* in River Siluko

Month	Number of fish sexed	Number of males	Number of females	Sex ratio (M:F)	Chi-Square (χ^2)
MARCH (2015)	0	0	0	0:0	0
APRIL	0	0	0	0:0	0
MAY	0	0	0	0:0	0
JUNE	60	33	27	1:0.82	0.060
JULY	40	30	10	1:0.33 *	10.000 *
AUGUST (2015)	0	0	0	0:0	0
TOTAL	100	63	37	1:0.59	6.760

$\chi^2 = 6.760$ * Significant at $P < 0.05$

Table 4: Monthly Sex ratio of *Gnathonemus petersii* in River Siluko

Month	Number of fish sexed	Number of males	Number of females	Sex ratio (M:F)	Chi-square (χ^2)
MARCH (2015)	1	0	1	0:1	0
APRIL	11	9	2	1:0.22 *	4.455
MAY	20	9	11	1:1.22	0.200
JUNE	54	25	29	1:1.16	0.296
JULY	41	32	9	1:0.28 *	12.902
AUGUST (2015)	0	0	0	0:0	0
TOTAL	127	75	52	1:0.69	3.226

$\chi^2 = 3.226$ * Significant at $P < 0.05$

Table 5: Monthly Sex ratio of *Synodontis schall* in River Siluko

Month	Number of fish sexed	Number of males	Number of females	Sex ratio (M:F)	Chi-square (χ^2)
MARCH (2015)	5	0	5	0:5	1.667
APRIL	15	11	4	1:0.36 *	3.267
MAY	1	0	1	0:1	0.091
JUNE	0	0	0	0:0	0
JULY	41	21	20	1:0.95	0.024
AUGUST (2015)	68	22	46	1:2.09 *	8.471
TOTAL	130	54	76	1:1.41	3.723

$\chi^2 = 3.723$ * Significant at $P > 0.05$

DISCUSSION

The correlation coefficients (r) for length-weight relationships of the four fish species examined were high and highly significant, indicating an increase in length with increase in weight. Similar findings have been reported for fish species from different water bodies (Fawole (2002), Laleye, 2006, Oboh and Ogbeibu, (2007), Odedeyi *et al.,* (2007), Abowei and Hart, (2009), Akombo *et al.,* (2011), Alhassan *et al.* (2014) and Oboh and Omoigberale, (2014). The observed length-weight relationship values showed that *C. kingsleyae G. niger, G. petersii* and *S. schall* were negatively allometric in their growth; which implies that the fishes became thinner as they grew longer (Akombo *et al.,* 2104). The observed b values for *G. niger* (2.097) and *G. petersii* (2.793) in this study are similar to b values of 2.870 (Fawole, 2002), 1.990 (Odedeyi *et al.,* 2007) and 2.880 (Alhassan *et al.,* 2014) reported for a related species, *Mormyrus rume*. *Synodontis schall* with a b value of 2.813 compared favourably with the ‘b’ values of 2.286 and 2.675 reported for same species by Midhat *et al.,* (2012) and Akombo *et al.,* (2014) respectively. According to Fagberon *et al.,* (1991), obedience to the cube law (Isometric growth b = 3) is rare in a majority of fishes. If fish is to maintain their shape as they grow their “b” values must be equal to 3, but there is no existing theory that says so (Pauly, 1993). When “b” value is less than 3, the fish has a negative allometric growth and when “b” value is greater than 3 growth is said to be positively allometric (Khaironizam and Norma-Rashid, 2002). Abdallah (2002) stated that in most fishes of tropical and temperate region “b” values range from 2.7-3.3, while Bagenal and Tesch (1978), Fagade (1979) and Baijot *et al.* (1997) reported values of 2-4, 2.9-3.4 and 2.5-3.5 respectively. Also, King (1996) reported that as an assemblage most Nigerian freshwater fishes exhibit negative allometric growth pattern. This suggest that the results of this study are valid and are comparable to results from earlier studies on freshwater fishes. As observed in this study, changes in length-weight relationships, even in a single species may be as a result of gear selectivity, sex and difference in season, and time of the year as well as the sample size (Frota *et al.,* 2004)

The mean condition factor (K) for *C. kingsleyae* (3.504), *G. niger* (1.616), *G. petersii* (1.207) and *S. schall* (2.612) in this study are greater than one (1) and were within the range of 2 – 4 recommended by Bagenal and Tesch (1978) as suitable for freshwater fishes. This revealed that the four fish species from River Siluko were in good condition. Mean "K" (2.612) obtained for *S. schall* was comparable to that (2.855) for same species from Benue River (Akombo *et al.,* 2014), but differed from that (0.0000712 to 0.00894) from River Osun (Olojo *et al.,* 2012).Condition factor has been used as an index of growth and feeding intensity for different populations of the same species, which is indicative of food supply and timing duration of breeding (Bagenal and Tesch, 1978). Condition factor is strongly influenced by both biotic and abiotic environmental conditions and can be used as an index to access the status of the aquatic ecosystem. The result of the condition factor obtained in the present study is a reflection of abundant food sources and good water quality of the river, thus it provides a suitable habitat for these fish species. According to Edah *et al.* (2010), condition factor can also be affected by factors such as sex, season, age and maturity stages. It decreases as the fish increases in size. A condition factor of less than one (1) means the fish is elongated, starving and generally not in good condition. An index of 1- 1.2 means the fish is doing well and an index of 1.4 shows that, the fish is near spawning (Alhassan *et al.,* 2014).

The observed overall sex ratios for *C. kingsleyae* (1:0.69), *G. niger* (1:0.59), *G. petersii* (1:0.69) and *S. schall* (1:1.41), in this study revealed that except for *G. niger* in which males significantly outnumbered females , all other three fish species had a balanced population. *Ctenopoma kingsleyae* with a sex ratio of 1:0.69, compares reasonably with that (1:1) reported for a related species *Trichogaster labiosu* under captive breeding (Motilan and Nishikanta, 2015). The preponderance of males over females obtained for *G. niger* (1:0.59) in this study, has been similarly reported for some related species, *M. rume* (1:0.55) by Fawole (2002) and *M. rume* (2.5:1), *G. cyprinoides* (5:1), *G. senegalensis* (2.5:1) and *Petrocephalus bane ansorgii* (2.5:1) by Nzeh and Lawal (2012). *Gnathonemus petersii* (1:0.69) with almost equal proportions of males and females, compared with sex ratios reported for related mormyrid species (Omotosho, 1997; Odedeyi *et al.,* 2007 and Alhassan *et al.,* 2014). An overall sex ratio of 1:1.41 observed for *S. schall*, is similar to sex ratios of 1:1.1, 1:1.04, 1:1, 1:0.9 and 1:1.35 reported for same species by Laleye *et al.* (2006), Mekkawy and Hassan (2011), Akombo *et al.,* (2011), Oboh *et al.* (2013), Akombo *et al.* (2015). A baised sex ratio often result from sex – differential mortalities of young and adults, sex – differential maturation times, and sex – differential dispersal and migration patterns (Bessa-Gomes *et al.,* 2004; Veran and Beissenger, 2009). Differences in sex ratios among same and related fish may be due to the types of fishing gear used during sampling, mortality and survival rate among species, migration of different sexes during feeding and spawning, age difference and sex present during sampling (Oboh *et al.,* 2014). Male- baised sex ratio observed for *G. niger* may be as a result of either physiological difference or mechanisms which renders females more prone to natural mortality than males (i.e. male aggressive behaviour) (Boussou *et al.,* 2010). Male – baise sex ratio may lead to high male aggression and reduced female survival (Hailey and Willemsen, 2000; Le Galliard *et al.,* 2005), or they may move away from male-biased patches (Coft *et al.,* 2003; Steifetten and Dale, 2012) or if they stay, they intensify courtship and competition (Kvarnemo *et al.,* 1995; Forsgren *et al.,* 2004; Silva *et al.,* 2010).

CONCLUSION

The findings from this study revealed that the regression of length relative to weight was positive, with b values indicating negative allometric growth pattern for all four fish species. The observed populations were in good condition during the period of study. It is hoped that the findings from this study will serve as baseline for further studies in River Siluko, and will contribute valuably to the existing data on the management, utilization and conservation of these important freshwater fish species.

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