International Scholars Journals

African Journal of Fisheries Science ISSN 2375-0715 Vol. 6 (7), pp. 001-008, July, 2018. Available online at www.internationalscholarsjournals.org © International Scholars Journals

Full Length Research Paper

Morphometric measurements and growth patterns of four species of the genus *Synodontis* (cuvier,1816) from Lower Benue River, Makurdi, Nigeria

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Accepted 3 of March, 2018

Relationship between basic morphometric measurements and growth pattern of four species of *Synodontis* from Lower Benue River was investigated bi-monthly from February to October, 2009 to determine variations and differences in the growth pattern of the different populations. Morphometric parameters of a total number of 195 specimens of *Synodontis clarias*, *Synodontis membranaceus*, *Synodontis resupinatus* and *Synodontis schall* were measured and evaluated by linear regression and correlation. There was a strong positive correlation between body weight and body girth, standard length and body weight, standard length and head length, standard length and body depth, standard length and snout length, standard length and eye diameter and body weight and eye diameter in *S. clarias*, *S. membranaceus*, *S. resupinatus*, and *S. schall* but the correlation between standard length and eye diameter and body weight and eye diameter in *S. resupinatus* were low. The growth pattern analysis depicts allometric growth in these species with their 'b' values less than 3.

Key words: *Synodontis*, morphometric, Lower Benue River.

INTRODUCTION

The genus *Synodontis* (Cuvier, 1816), commonly known as the catfish is the most favoured edible fish in Northern Nigeria (Reed et al., 1967). *Synodontis* are highly relished in Ilorin, Kwara state, Nigeria and its environs because of its bony head and fleshly body which usually attracts lovers of common pepper soup (Araoye, 1997; 2004). Laleye et al. (2006) described it as a highly valued food-fish in Benin contributing an unquatified but significant proportion to the fishery of the rivers. The genus consists of many species, some of which are commercially more important than others. *Synodontis membranaceus* is generally preferred by fishermen and consumers because of their relatively large sizes. They command a higher market value than other species of the genus, because they grow bigger.

Synodontis are very common throughout the year and probably more important in the commercial catches than any other genera. Very few species such as *Synodontis schall* occur universally (Lowe- McConnell, 1975; Reed et al., 1967). Wooten (1972) reported that fish grow in length as well as in bulk while Sadiku and Oladimeji (1991) summarized growth as a function of the fish size. Many studies on growth patterns in fishes have largely been based on weight and length relationships, or relationship between size of scales (or other calcified tissues) and body length because of their importance for age and growth analysis (Le-cren, 1951).

Morphometric characters are important for identifying fish species and their habitat as well as ecological criteria in any stream, lake or sea. It is common to use morphometric measurements to identify and classify fishes (Bagenal and Tesch, 1978). The length-weight relationship of fish also known as growth index is an important fishery management tool, vital in estimating the average weight at a given length group (Abowei and Davies, 2009). It has been used widely in fish biology with several purposes such as estimating the mean weight of fish based on known length (Beyer, 1987). The length-weight relationship is used in evaluating the growth in morphometric parameters relative to total length (King, 1996). It is also used in morphometric interspecific and intraspecific population comparison to

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assess the index of well being of the fish populace (Bolger and Connolly, 1989).

No work has been done on the morphometrics of fish and characterization of growth of its external body parts into allometry and isometry on River Benue which is located within middle belt of Nigeria, except for the ones carried out by Araoye, 2004; Adedeji and Araoye, 2005 on Asa lake in Kwara State, Nigeria also in the middle belt of Nigeria. Therefore the need for this study on lower Benue River to generate a base line scientific data on this genus for subsequent studies is paramount.

MATERIALS AND METHODS

Description of the study area

The study was carried out in the Lower Benue River, Makurdi. The Lower Benue River as described by Reid and Sydenhan (1979) is the portion of the Benue River contained within the Benue State of Nigeria. River Benue originates mainly in the Adamawa Mountains of Cameroun, some 500 km beyond the Nigerian frontier, and flows west across East-Central Nigeria (Nedeco, 1959). It is the largest tributary of the Niger which it joins at Lokoja. The River has extensive alluvial plain (uncommon in African Rivers) stretching for many kilometers, covering a distance of approximately 187 km. This extensive flood plain forms breeding grounds for many fish species (Beadle, 1974). The highest water levels are in August to September and the lowest are in March to April. In the Benue valley at Makurdi (1 to 200 m altitude), the water temperatures ranged between 22 to 26°C for most of the year (Okayi, 2002).

Sampling method

Synodontis clarias, *S. membranaceus*, *Synodontis resupinatus*, and *S. schall* were purchased from fish mongers at Wadata market, Makurdi. Wadata market is one of the landing sites on the bank of River Benue. Bi-monthly purcahsing of the specimens from the market was taken for nine months (February to October, 2009). The fish samples purchased were transported to the laboratory in plastic containers containing ice blocks to keep the fish fresh.

Morphometric measurements

The morphometric characters measured included head length (HL), body girth (BG), standard length (SL), body weight (BWT), eye diameter (ED) and snout length (SNL). Standard length was measured by using a measuring board. The anterior tip of the fish was placed against a stop at the beginning of the measuring scale with the fish's mouth closed. Standard length was taken as the length from the tip of the fish's mouth to the hidden base of the median tail fin rays. Body girth was taken at the deepest point of the trunk using a rule. The body weight was taken using a digital electronic weighing balance and eye diameter was measured as length of orbit using a rule. HL, BG, ED and SNL, were all measured in milimeters while BWT was measured in grams.

Determination of sex

The gonads were inspected after the fish were dissected to determine the sex of the fish using a key prepared by Nikolsky (1963). In adult females, eggs were readily seen swollen in the paired ovaries of some samples, while in adult males, the testes were typically flattened and elongated, whitish and non-granular in appearance. In immature specimens, the shape of the gonad was a guide to the sex of the fish (for example, testes have finger like processes in many catfish), (Bagenal and Tesch,1978). For each species sex ratio was calculated using the formula:

$$\text{Sex ratio} = \frac{\text{number of males}}{\text{number of females}}$$

Fulton's condition factor (k)

The condition factor (k) was computed from

$$K=100W/L^3 \text{ ----------- } (1)$$

Where, W is the observed total weight for each specimen, L is the observed standard length for each specimen and k is the condition factor.

The length-weight relationship

Length-weight relationship in fishes was represented by:

$$W = aL^b \text{ ----------- } (2)$$

Where b is an exponent usually between 2 and 4, W is the observed total weight, a is the intercept on the length axis and L is the observed standard length. The logarithmic transformation of equation 2 gives a straight line relationship

$$\text{Log } W = \log a + b \log L \text{ ---------- } (3)$$

Log weight is plotted against log length, the regression coefficient is b, and log a is the intercept of the line on the Y-axis.

RESULTS

Morphometric measurements

S. membranaceus had the highest values of the measured parameters followed by *S. clarias*, *S. schall* and *S. resupinatus* respectively (Table 1).

There was a high positive correlation between BWT and BG, SL and BWT, SL and HL, SL and SNL, SL and ED,BWT and ED in *S. clarias*, *S. membranaceus* and *S. schall* (Table 2), while in *S. resupinatus*, the association between SL and ED and BWT and ED was a weak positive correlation.

S. resupinatus had only one female and eight males throughout the sampling period with the highest male to female ratio of 8:1 (Table 3). *S. clarias* had male to female ratio of approximately 1:1, *S. membranaceus* had male to female ratio of 1:2 and *S. schall* had male to female ratio of 1:1. The condition factors 'k' of the four species is shown on (Figure 5). *S. schall* had the highest (0.5488) mean condition factor. The mean condition factor (0.0024) for *S.clarias* was the least.

Table 1. Some Morphometric Parameters of *S. clarias*, *S. membranaceus*, *S. resupinatus* and *S. schall* from River Benue.

Species	Morphometric parameters/weight	Range	Mean
	SL	9 to 200 (mm)	138.09 (mm)
	ED	6 to 11 (mm)	9.55 (mm)
S. clarias	HL	42 to 84 (mm)	61.91 (mm)
(N=22)	SNL	7 to16 (mm)	11.36 (mm)
	BG	29 to 60 (mm)	42.27 (mm)
	BWT	18.90 to 198.43 (g)	75.28 (g)
	SL	125 to 262 (mm)	207.52 (mm)
	ED	11 to 18 (mm)	13.87 (mm)
S. membranaceus	HL	55 to 1412 (mm)	104.17 (mm)
(N==23)	SNL	9 to 20 (mm)	18.87 (mm)
	BG	46 to 94 (mm)	75.26 (mm)
	BWT	48.90 to 485.85 (g)	259.52 (g)
	SL	101 to144 (mm)	111.00 (mm)
	ED	7 to 10 (mm)	8.22 (mm)
S. resupinatus	HL	45 to 68 (mm)	56.78 (mm)
(N=9)	SNL	9 to 11 (mm)	9.89 (mm)
	BG	36 to 51 (mm)	44.56 (mm)
	BWT	28.25 to 85.96 (g)	57.13 (g)
	SL	75 to 245 (mm)	141.309 (mm)
	ED	7 to 13 (mm)	9.19 (mm)
S. schall	HL	29 to 105 (mm)	60.48 (mm)
(N=141)	SNL	4 to20 (mm)	10.55 (mm)
	BG	22 to 94 (mm)	46.50 (mm)
	BWT	11.01 to 434.31 (g)	91.07 (g)

Table 2. Relationship between morphometric parameters of four species of *Synodontis* from River Benue.

Species	Y-axis	X-axis	Coefficient
	BWT	BG	0.9398
	SL	BWT	0.9704
	SL	HL	0.8566
S. clarias (N=22)	SL	BG	0.9710
	SL	SNL	0.6318
	SL	ED	0.6934
	BWT	ED	0.5823
	BWT	BG	0.8822
	SL	BWT	0.9562
	SL	HL	0.9637
S. membranaceus (N=23)	SL	BG	0.8499
	SL	SNL	0.9050
	SL	ED	0.7220
	BWT	ED	0.7600

Table 2 Cont.

	BWT	BG	0.9222
	SL	BWT	0.9588
	SL	HL	0.9037
S. resupinatus (N=9)	SL	BG	0.8429
	SL	SNL	0.6222
	SL	ED	0.2735*
	BWT	ED	0.3152*
	BWT	BG	0.8837
	SL	BWT	0.9027
	SL	HL	0.9410
S. schall (N=141)	SL	BG	0.8805
	SL	SNL	0.8357
	SL	ED	0.7311
	BWT	ED	0.6237

* Weak associations.

Table 3. Male to female sex ratio of *S. clarias*, *S. membranaceus*, *S. resupinatus* and *S. schall* from River Benue.

Species	Number of males	Number of females	Total number	Sex ratio
S.clarias	12	10	22	1.2 : 1
S. membranaceus	9	14	23	1 : 1.6
S. resupinatus	8	1	9	8 : 1
S. schall	68	73	141	1.1 : 1.1

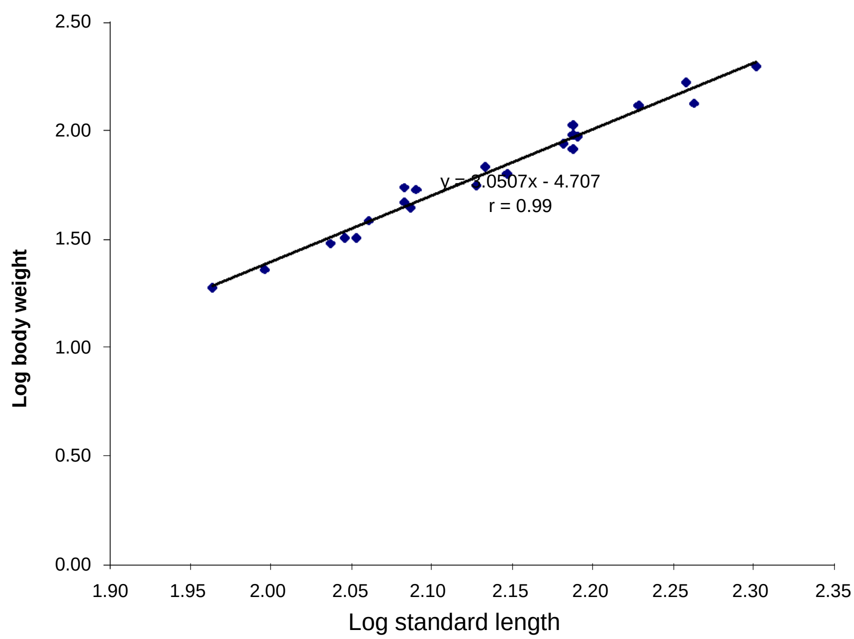

Figure 1. Log standard length-log body weight relationship in *S. clarias* from River Benue.

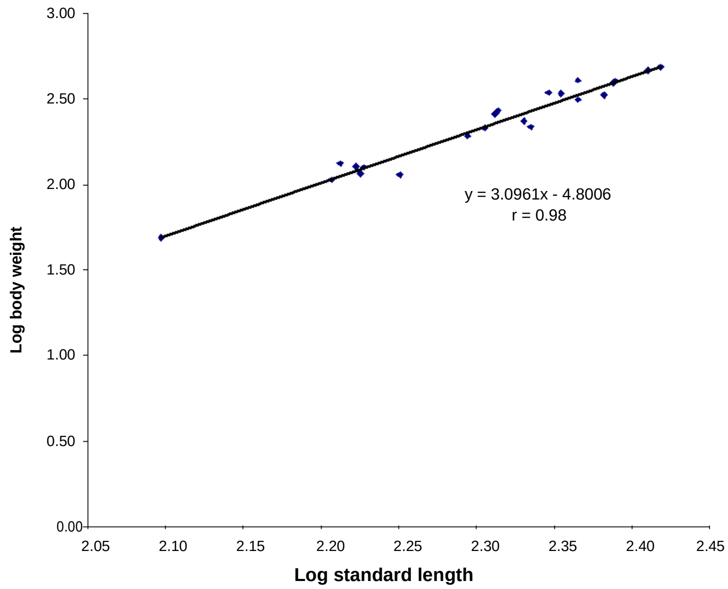

Figure 2. Log standard length-log body weight relationship in *S. membranaceus* from River Benue.

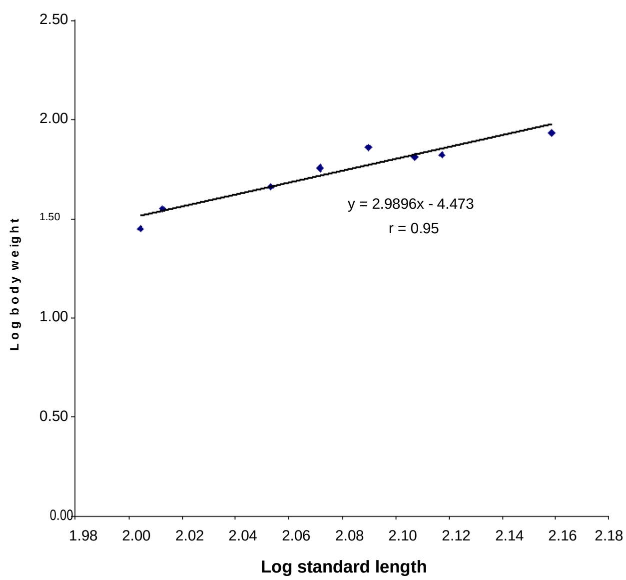

Figure 3. Log standard length-log body weight relationship in *S. resupinatus* from River Benue.

The logarithmic transformations of the length-weight relationship equations are shown in Figures 1 to 4 for *S.clarias*, *S. membranaceus*, *S. resupinatus* and *S. schall* respectively. All showed a straight line relationship. *S. schall* was the most common throughout the sampling period as could be seen in Figure 6. While *S. resupinatus* were not found in March, April, May, June and August; *S. membranaceus* were not found in March, April and October. *S. clarias* were also not found in March, May, August and October (Figure 6).

DISCUSSION

S. membranaceus had the highest range of values in all the measured morphometric parameters amongst the four species of *Synodontis* investigated. This could be as a result of its faster growth rate and defensive mechanism

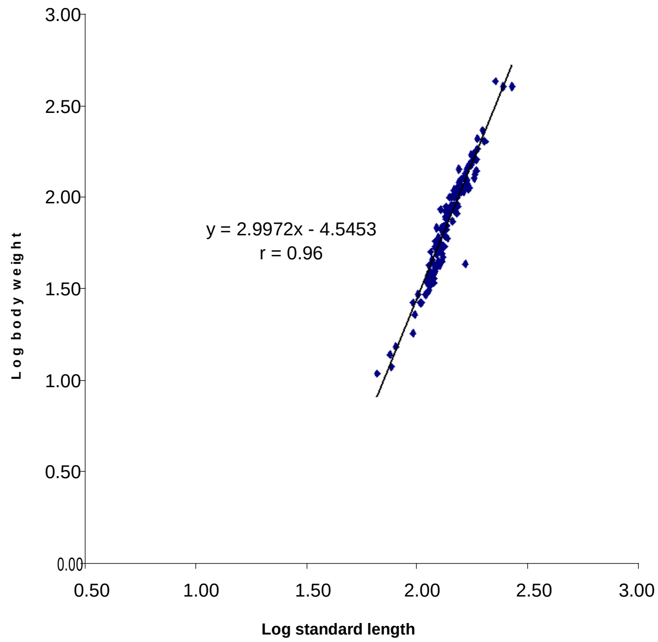

Figure 4. Log standard length-log body weight relationship in *S. schall* from River Benue.

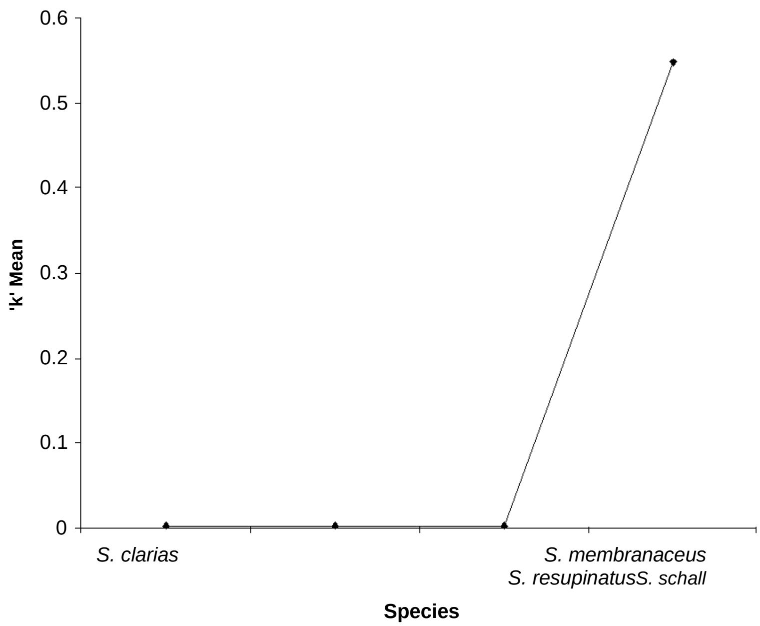

Figure 5. Condition factor ‘k’ of four species of *Synodontis* from River Benue.

against predation (Abowei and Hart, 2009). Owolabi and Omotosho (1999) and Owolabi (2005) observed that the overwhelming presence of *S. membranaceus* as the biggest *Synodontis* could be as a result of its adaptiveness to whatever natural diets that were present in the river with rapid growth impetus and high fecundity.

Idodo (2005) reported that the size of *S. membranaceus* could be attributed to its higher and fairly feeding intensity both diurnal and nocturnal than other species of *Synodontis*. Feeding and reproductive phenomena were the main factors responsible for the size of fish Oni et al. (1983).

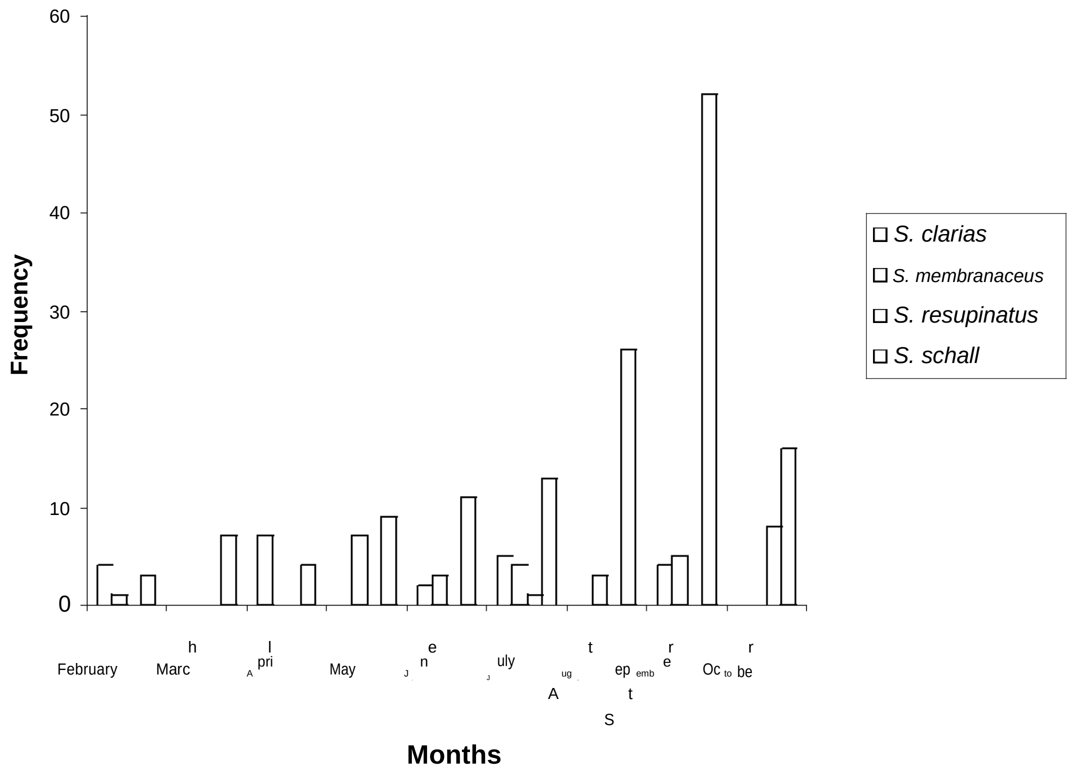

Figure 6. Frequency distribution of *S. clarias*, *S. membranaceus*, *S. resupinatus* and *S. schall* from River Benue (February to October, 2009).

This study demonstrated that correlation coefficient was highly positive in *S. schall*, *S. membranaceus* and *S. clarias* as SL was regressed against other body parts. In *S. resupinatus* the correlation between SL and ED, BWT and ED was weak (Table 2). This implies that as the length of the fishes increased, the body weights also increased together with the lengths of the other body parts except the eye diameter.

The research also revealed that all the species of *Synodontis* investigated exhibited negative allometric growth patterns with b values less than 3 (Figures 1, 2, 3 and 4). Adedeji and Araoye (2005), reported allometric growth in *S. schall*. Abowei and Davies (2009) also reported allometric growth for *Gnathonemus tamandua*. The values of 'b' in the log standard length-log body weight relationship of The linear growth relationships obtained from the transformed lengths fitted over weights indicated the three dimensional growth structures of most fish species (Lagler et al., 1977).

S. clarias, S. membranaceus, S. resupinatus and S. schall being allometric implied that the body weights of these species increased faster than the cube of their total length (Adeyemi et al., 2009; Abowei and Davies, 2009).

There was great variation in the distribution of all the species with *S. schall* being fairly distributed throughout the sampling months while *S. resupinatus* was not common and poorly distributed (Figure 6). This could be attributed to distinct habitat preferences. *S. resupinatus* prefers habitat with close proximity to the shoreline and fairly deeper waters while *S. membranaceus* prefers unclear areas (2005). The abundant and fair distribution of *S. schall* throughout the sampling period could be attributed to its successful adaptation within its environment due to low predation and its diverse feeding habits as was reported by Araoye (1997). The highest value of mean condition factor 'k' recorded for *S. schall* among others also implies that it could survive better even when biotic and abiotic factors are less favourable. Elsewhere in the world, Laleye et al. (2006) reported that *S. nigrita* was less abundant than *S. schall* in the Oueme River, Benin. Bishai and Gideiri (1967) reported that *S. schall* was among the commonest species of *Synodontis* in the Nile River. Nwadiaro and Okorie (1985) obtained mean k range of 0.49 to 1.48 for *Chrysicthys filamentous* in Andoni river. Abowei (2010) obtained a mean 'k' value of 0.4 to 1.0 for *Elops senegalensis* from Nkoro river in the Niger Delta of Nigeria. According to Abowei (2010) the condition factor k reflects through its variations the information on the physiological state of the fish in relation to its welfare. From a nutritional point of view, there is the accumulation of fat and gonad development (Le-Cren, 1951). From a reproductive point of view, the highest k values are reached in some species. Condition factor (k) also gives information when comparing two populations living in certain feeding, density, climate, and other conditions; when determining the period of gonad maturation; and when following up the degree of feeding activity of a species to verify whether it is making good use of its feeding source (Abowei, 2010). Data pulling and sorting into classes, sex stages of maturity and state of stomach were some of the factors that could affect the well being (condition factor) of a fish (King, 1991, 1996; Gayanilo and Pauly, 1997). The different values of mean k obtained in this study could therefore be as a result of differences in gonadal maturation, increase or decrease in feeding activities and population changes possibly due to modifications in food resources.

ACKNOWLEDGEMENTS

Authors wish to express their profound apperciation to Dr. Adeyemi, S. O. for his invaluable support throughout the research. We also thank Mr. Waya, J. I. for always been ready to assist us with the laboratory materials and chemicals. Similarly we express our gratitude to Mr. Atoo Iyough for always been available to drive us to the markets and Mr. Kenneth Sule who voluntarily typed this work for us. May God bless you all.

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