IJABR Vol. 6(1): 31 - 44 (2014)

Original Article

GROWTH PATTERN, CONDITION FACTOR AND PROXIMATE COMPOSITION OF *Synodontis membernaceus* FROM RIVER KADUNA FLOOD PLAINS, NIGERIA.

*Bake,G. G[1].,Kpotun, A[1]., Egwin, E. C[2]. and Sadiku,S.O.E[1].

1 Department of Water Resources, Aquaculture and Fisheries Technology, Federal University of Technology, Minna, Niger state, Nigeria.
2 Department of Biochemistry, Federal University of Technology, Minna, Niger state, Nigeria .

Submitted: March 05, 2014; Accepted: June 06, 2014; Published: June 30, 2014.

ABSTRACT

Growth pattern involving evaluation of length-weight relationship (LWR), condition factor (K) and seasonal proximate composition of *Synodontismembernaceus* from River Kaduna flooded plains were investigated. A total of 123 fish (58 males and 65 females) were collected bi-weekly from fishermen from April - October 20011 using cast net and gill nets of 50 - 55mm mesh sizes. The specimens had mean standard length of 17.6 $\pm$1.71cm, total length of 20.0 – 27.5 cm, body weight of 90.0-199.7g.
The growth pattern analysis depict a strong significant correlation between the Length and weight of the *Synodontismembernaceus*and the growth exponent “b” indicates a negative allometric growth with a (K) value index above 1. Proximate analysis result showed that the lipid and moisture contents were inversely

proportional in the body of the fish while other nutrients in the body of the fish do not fluctuate significantly over time.

Key words: Growth pattern, K value,length- weight relationship,*Synodontismembernaceus*,

***Corresponding author:** gabbygana@futminna.edu.ng +234-81-62850992

INTRODUCTION

Fish has become important component in the diet of humans especially in developing countries of the world hence it provides 22% of the protein intake in sub-Saharan Africa (FAO, 2003).However in some countries where other animal proteins are scare or expensive can exceed 50%. In sub-Saharan African per capital fish consumption is the lowest compared regions of the world and it is still on the decline (FAO, 2003). This is largely due to decline in capture fisheries and the ever increasing human population.

In fisheries science, morphological characteristics are very important for identifying fish species and their habitat as well as their ecological niche (Bagenal and Tesch, 1978; Akombo*et al.,* 2011). The morphometric relationships between length and weight can be used to assess the well-being of individuals and to determine possible differences between separate unit stocks of the same species (King, 2007). In addition, length weight relationships are also important in fisheries management for comparative growth studies (Moutopoulos and Stergiou, 2002). Pauly (1993) stated that length-weight relationship (LWR) provides valuable information on the habitat where the fish lives while Kulbicki*et al*. (2005) stressed the importance of Length Weight Relationship (LWR) in modelling aquatic ecosystems. There is dearth of information on the LWR of fresh water and brackish water fish resources of Nigerian waters (Fafioye and Oluajo, 2005).

Growth in fish is in length as well as bulk (King, 1996). Adedeji and Araoye (2005) stated that growth is a function of fish size; the relationship between lengths and body weights are essential for establishing the taxonomic characters of the species (Pervin and Mortuza, 2008).

The length-weight relationship (LWR) is an important factor in the biological study of fishes and their stock assessments. It describes the functional regime in weight distribution per unit size of sub-population (Anon, 20011). Length and weight data are useful standard results of fish sampling programs (Morato*et al*., 2001). In fish, size is generally more biologically relevant than age, mainly because several ecological and physiological factors are more size-dependent than age-dependent.

Consequently, variability in size has important implications for diverse aspects of fisheries science and population dynamics (Erzini, 1994). Length-weight regressions have been used frequently to estimate weight from length because direct weight measurements can be time-consuming in the field (Sinovcic*et al.*, 2004).

The importance of fish in developing countries has increased greatly. Foran*et al.* (2005) reported that fish is a highly proteinous food. Therefore, considering the nutritional benefits associated with fish consumption, it has become important that fish's mineral and proximate composition be assessed in order to establish the safety level of the table-sized species before consumption.The principal constituents most affected by the seasonal cycle changes are fat and moisture. The knowledge of proximate composition of fish species is important in the application of different technological processes (Huss, 1988) and as an aspect of quality of raw material, sensory attributes and storage stability (Sikorski*et al.*, 1990).

Furthermore, the measurement of the percentages of some of these proximate profiles such as protein, carbohydrates, lipids, moisture and ash contents is often necessary to ensure that they meet the requirements of food regulations and commercial specifications (Waterman, 2000). Determination of some proximate profiles such as protein content, lipid, ash and other nutrients is often necessary to ensure that they are within the range of dietary requirement and commercial specifications (Waterman,2000)

Synodontis is one of the important commercial fresh water fishes of Nigeria in West Africa, belonging to the catfish Family Mochokidae. *Synodontismembranaceus* belong to the genus *Synodontis* and they mostly occur only in Africa (Willoungby, 1974). Reed *et al*. (1967), Millarad and Lamoral (1967), Willoungby (1974), Araoye (1997: 2004) and Laleye 2006 reported that *Synodontis* species are characterized by short stumpy body, a shielded head. The dorsal and the pectorial fins are strong with serrated spines, which can be locked in an extended position. *S.membernaceus* is usually common during higher inundation, i.e. a period of rise in the water level from March – December (Willoungby 1974). It has a great demand in the market because of its high nutritive and delicious values. The genus Synodontis is among the most favoured edible fish in Northern Nigeria (Reed *et al.,* 1967), owing to their overwhelming abundance in the artisanal fisheries. It contributes a large proportion to the annual fish landings in the region. The genus consists of many species, some of which are commercially more important. *S. membernaceus* is generally preferred by fishermen and consumers because of their relatively medium size. They command a higher market value than other species of the

genus. In Jebba Lake, *S. membernaceus* is the dominant species, occupying unique and prominent position in the commercial fisheries of the lake (Owolabi 2005). It is highly relished either fresh or smoke-dried and despite its abundance and nutritional value, no routine work has been done on the morphometrics and the proximate composition of *S. membranaceus* of River Kaduna flood plains which is one of the major tributaries of River Niger which is located within middle belt of Nigeria. Therefore this present study was undertaken to investigate the length-weight relationship, condition factor and seasonal nutritional composition of *Synodontismembernaceus*from River Kaduna flood plains.

MATERIALS AND METHODS

Sampling Area

The Kaduna River is a major tributary of the Niger River, which took its source from Jos Plateau and flows in a northwesterly direction then southwards to join the Niger downstream of Wuya at Nupeko. It covers a distance of about 575km and drains on area of about 66.300 $km^2$of diverse topography. The river is dammed at Shiroro about 348km down its course to form a reservoir with a surface area of about 312 km^2. The river is divided into two topographical zones. The upper zone; from its source to Zungeru town. This area is undulating with many rocky hills and rapids. While the lower zone starts downstream of Zungeru town to the confluence a distance of about 150 km. This area is characterized by the presence of an extensive flood plain covering a total of about 150,000 ha down the Niger.

Kaduna River rises or over-flood its bank during the rainy season that is between May and September. The flood plains have shown considerable effect on the population of plankton communities, which is as a result of nutrient of both allochthonous and autochthonous organic matter concentration within the flood plains during the flooding and during the retreat of the floodwater.

Fish Sampling, Measurement and Sex Determination

Specimens of *S. membernaceus*were collected fortnightlyfrom fishermen at three sampling sites namely Nku, Nupeko and Fokpo along River Kaduna flood plains from April 2011 to October 2011. Gill nets of mesh sizes ranging from 20-35 mm were the fishing gear used. Specimens collected were kept chilled in an ice chest to reduce post humous digestion of the stomach contents while in transit to the laboratory of the Department of Water Resources Aquaculture and Fisheries Technology, Federal University of Technology Minna. In the laboratory, 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 individual fish was measured to the nearest 0.1 g with an electric balance

after removing the adhered water and other particles from the surface of body. Each of the specimens was cut open ventrally with the aid of dissecting scissors after which a semicircular cut was laterally made on the side of the specimens for better observation. The gonads which are two parallel tubules located closely to the dorsal wall of the abdominal cavity were examined with the naked eyes.

Growth Pattern and Condition Factor

Linear regression was employed to determine the type of relationship between any given pairs of variables and their linear equation. Regression table was used to ascertain the significance of this relationship derived from the length weight analysis, using the ponderal index denoted as

$W = aL^b$

Where, W =weight (g), L= standard length (cm)

The length-weight relationship (LWR) was expressed by the equation:

Log weight = Log a + b Log length

Where a and b are regression constants (Bagenal, 1978).

The condition factor was calculated using the Formula:

$K = [100\ W] / L^3$ (Ricker, 1975).

Where K = condition factor, L = standard length (cm) and W =weight (g).

Proximate Composition Analyses

Proximate composition analyses were performed according to AOAC procedures (AOAC, 2000). Water content was determined by drying samples at 105 ± 2°C until a constant weight was obtained. Dried samples were used for determination of crude fat, protein and Ash contents. Crude fat was measured by solvent extraction method in a soxhlet system where n-hexane was used as solvent. Crude protein content was calculated by using nitrogen content obtained by Kjeldahl method. A conversion factor of 6.25 was used for calculation of protein content (AOAC, 2000).

Data analyses

Proximate composition data were analyzed using one – way analysis of variance (ANOVA) using statistica 6.0 (Stat-Soft, Inc., USA). Differences between treatments were compared by Tukey's test. Level of significance was tested at $P<0.05$.

RESULTS

Morphometric Measurement of *Synodontismembernaceus*

A total of 123 *S. membernaceus* specimen was collected (58 males and 65 females) with their total length ranging between 20.0 to 27.4 cm and the standard length ranged from 16.40 to 21.50cm, with a corresponding body weight ranging from 90.02 to 199.48g (Table 1).

Length–Weight relationship and growth pattern of Synodontismembernaceus

The growth pattern of *S.membernaceus* was derived from the standard length and the body weight measurement of the specimens. Log weight was regressed against log length and graphically depicted as

shown in Fig. 1, 2 and 3 for the male, females and combined sexes respectively.

Length–weight relationship and growth pattern of male *Synodontismembernaceus*

When the regression of natural log of the weight was against the natural log of the length, it was observed that the allometric coefficient "b" for the male *S.membernaceus*sample collected was 2.34 and there was a very strong relationship between the standard length and the total body weight with a correlation co-efficient of 0.95.

Length–weight relationship and growth pattern of female *Synodontismembernaceus*

When the regression natural log of the weight was against the natural log of the length, it was observed that the allometric coefficient "b" for the female *S.membernaceus*sample collected have allometric coefficient "b" of 2.43 with a strong correlation co-efficient r = 0.94.

Length–weight relationship and growth pattern of combination of both sexes of*Synodontismembernaceus*

A combination of both sexes showed that coefficient "b" was 2.37 which is an indication of allometric growth and there was a strong correlation co-efficient r =0.94.

Condition factor (K) value index

Table 2 showed the condition factors (K) value index of the *S. membernaceus* male, female and combined sex. The K value of the male *S. membernaceus*ranged between 1.2-2.8 while that of the female ranged between 1.1- 2.7, however there was no significant difference in between them ($P>0.05$)

Proximate Composition

Table 3 showed the proximate composition of *Synodontismembernaceus*from River Kaduna flood plain collected over a period of seven months. Lipid from the samples collected ranged from 3.83±1.58 to 6.31±1.45% and was significantly highest in October and lowest in April ($P<0.05$). The Moisture and crude protein varied considerably over time in the samples, and ranged between 74.51±1.024 and 77.57±1.42 and 14.11±1.45 and 14.97±0.78% respectively and were significantly highest in May and lowest in October ($P<0.05$); however there was no significant different in the crude protein between April and September in the samples ($P>0.05$) and the Ash content ranged between 3.44±0.37 and 3.75±0.22 but there was no significant difference in the ash content of the samples throughout the period of the study ($P>0.05$).

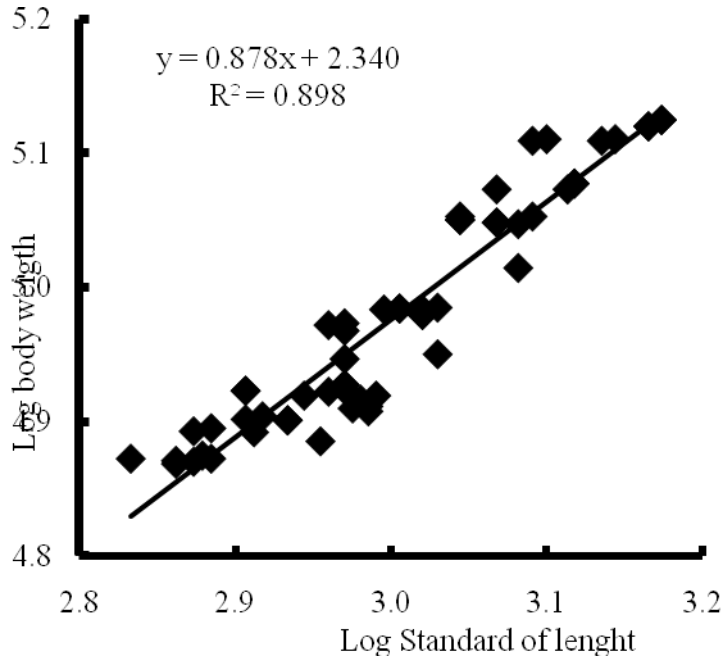

Fig1.Length–weight relationship of male *Synodontismembernaceus*from River Kaduna flood plains.

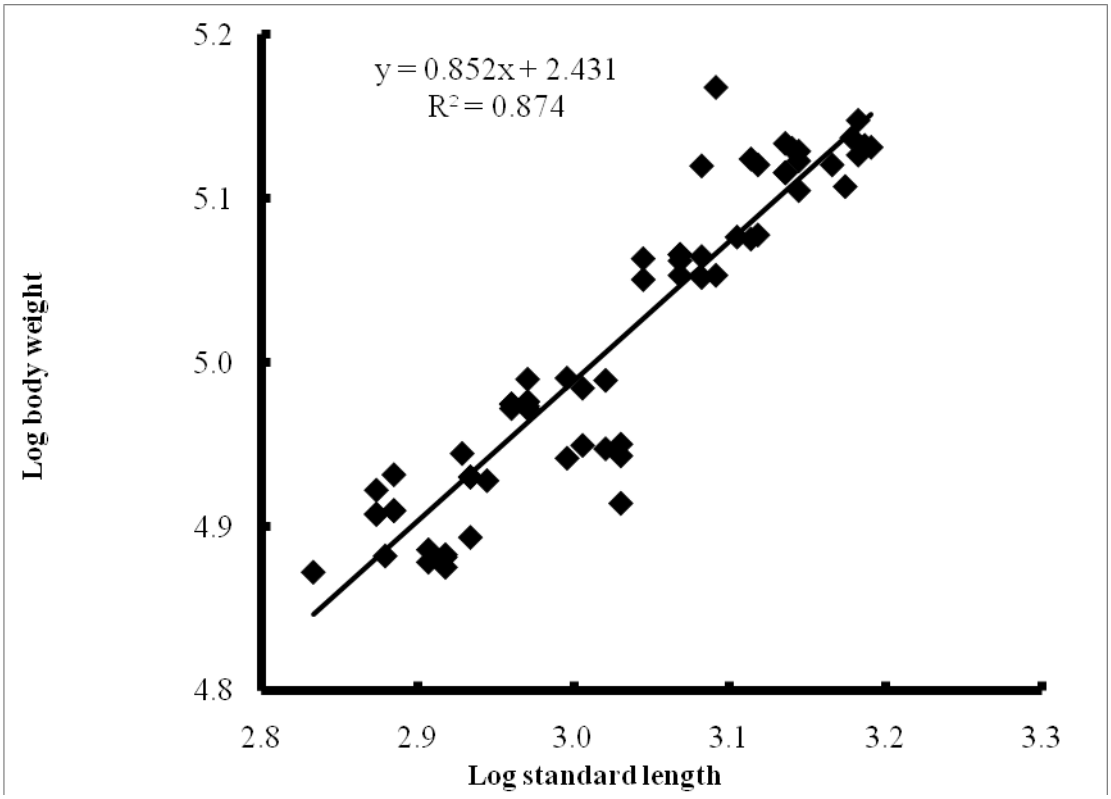

Fig2.Length–weight relationship of female *Synodontismembernaceus*from River Kaduna flood plains.

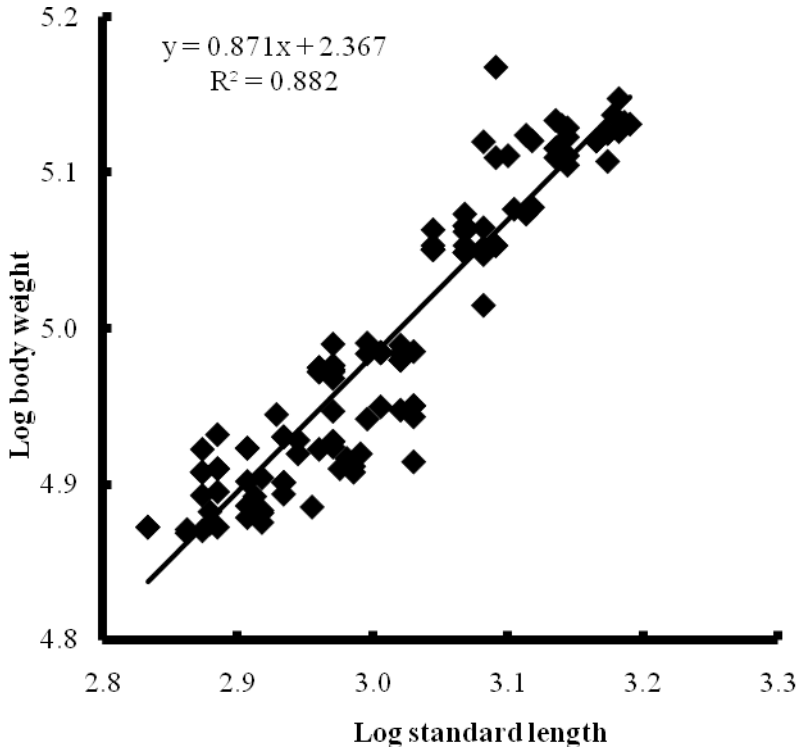

Fig3. Length–weight relationship of Combined sexes of*Synodontis membernaceus* from River Kaduna flood plains.

Table 1: Summary of biometrics measurement of *S. membernaceus*samples from River

		Total length (cm)	Standard length (cm)	Body weight (g)
Male	Range	20.0 - 27.4	17.0 - 24.9	132.1 - 168.2
	mean value	22.9±2.04	20.4±2.06	147.5±11.25
Female	Range	20.0 -27.4	17.0 - 24.3	130.6 - 175.5
	mean value	23.6±2.2	20.7±2.1	150.7±13.82
Combined	Range	20.0 - 27.4	17.0 - 24.9	130.6 - 175.5
	mean value	23.3±2.1	20.6±2.1	148.3±13.2

Table 2. Summary of condition factors of *S. membernaceus* samples from River Kaduna flood plain

Sex	Range	Mean value
Male	1.2 - 2.8	1.8±0.4
Female	1.1 - 2.7	1.8±0.4
Combine	1.1 - 2.8	1.8±0.4

Table 3: Summary of Proximate composition of *S. membernaceus*samples from River Kaduna flood plain

Months	Moisture (%)	Lipid (%)	Protein (%)	Ash (%)
April	77.57±1.42^{a}	3.83±1.58^{c}	14.11±1.45	3.44±0.37
May	76.82±1.26^{a}	3.87±1.48^{c}	14.65±1.57	3.64±0.19
Jun	75.55±2.42^{b}	4.49±0.33^{c}	14.77±0.56	3.75±0.22
Jul	75.64±2.16^{b}	4.76±0.41^{bc}	14.82±1.32	3.55±0.55
Aug	74.23±1.07^{c}	5.82±0.34^{b}	14.97±0.78	3.67±0.43
Sept	74.62±1.13^{c}	6.23±0.76^{a}	14.54±1.12	3.56±0.56
Oct	74.51±2.05^{c}	6.31±0.46^{a}	14.35±1.05	3.71±0.25

*Values in the same column with different superscript letters are significantly different (P<0.05) from each other.

DISCUSSION

The result of the basic biometrics, of *S. membernaceus* specimens of River Kaduna and data analysis of length-weight relationship gave useful information concerning growth and body physiology of the fish. The biometrics results of the *S.membernaceus*examined showed that the female fish were slightly heavier than the males. This slight difference observed in their weight might be attributed to the fact that some of the female were already gravid especially in the months of June and July. This agrees with the findings of Kunda (2008) that fluctuation in the weight of fishes in a given sample size might be due to their gonad condition.

Sadiku (1991); Bake and Sadiku (2012) summarized growth as a function of fish size. Wooten(1992) reported that fish growth in length as well as in bulkgrowth were due to

changes in the absolute weight (energy content) or length of fish over time (Wooten, 1992).Linear regression of standard length and weight give very useful co-efficient of regression "b" in determining growth pattern. In fisheries science, "b" value of 3.0 indicates isometric growth pattern. The values below this represent negatively allometric growth while values greater than 3.0 show positively allometric. In this present study, both sexes of *S. membernaceus*of River Kaduna flood plain were negatively allometric with "b" value of 2.36. This implies that the length growth is faster than body weight growth rate.The "b" values recorded in this study were similar and comparable to the findings of Abowei and Hart (2009) and Akombo*etal.* (2011). However, Sadiku and Oladimeji (1991) observed isometric growth pattern of *SynodontisSchall* obtained from Zaria Dam Nigeria and that of another *Synodontis* species from lake kanji (Willoughby, 1974). This also corroborates the findings of Olurin and Aderibigbe (2006) that regression coefficients obtained from length – weight relationships, which are indicative of isometric or allometric growths differs not only between species but at times also between stocks of the same species.

Condition factor otherwise called ponderal index denoted, as "K" value is a measure of fish condition, which reflects physiological condition of the fish. Although it is not a constant for individuals, species and population (Sadiku and Oladimeji 1991), it is still a useful measure of relative robustness. In this study, *S. membernaceus*from River Kaduna flood plains were identified as thriving well and robust with the mean K value of combined sexes 1.18 ± 0.4, as this value was higher than one. This value was slightly higher than that reported by Abowei and Hart (2009), this may likely be due to a number of factors namely sex, season, stress, availability of food and environmental condition aspointed out by various authors (Stewart, 1988; Bakhoum, 1994 and Khallaf*et al.,* 2003).

The proximate composition of *S. membernaceus*varies considerably between April- October. Stansby (1985) and Azim*et al.*(2012) independently reported that variation in proximate composition of fish flesh may vary with species variation, season, age and feeding habit of fish. The result of the present study showed that the crude protein of *S. membernaceus*was moderately high and slightly fluctuated from April to October. The relatively moderate percentage crude protein in *S. membernaceus*could be attributed to the fact that fishes are good source of pure protein, but the differences observed, in the obtained values may also be attributed to fish's consumption or absorption capability and conversion potentials of essential nutrients from their diet and availability of feed during the experimental period or their local environment into such biochemical

attributes needed by the organisms body (Adewoye and Omotosho, 1997; Bake *et al.,*2012).In this study variation in water and lipid content of the samples showed that while there was a gradual decline in water content, fat content gradually increased, this is in line with the previous works reported on freshwater fishes by Sadiku and Oladimeji (1991) and Bake and Sadiku (2012). Huss (1995) and Love (1997) also reported that fat content has shown inverse proportionality to water content in some semi-fatty fish species muscle, this may be attributed to the seasonal differences in availability of food and changes in the reproductive cycle, having considerable effect on the tissue biochemistry of the fish particularly changes in the lipid and water content of their body system.

In conclusion, this study showed that there is a proportionate growth in *S.membernaceus* reflecting a good physiological status of the fish. The growth pattern of *S.membernaceus* of River Kaduna flood plain is negatively allometric. The proximate composition result of *S. membernaceus*provides valuable information on variations in proximate composition of fish species hence the information can be useful to take necessary precautions in processing to curb post-harvest losses.

REFERENCES

Abowei, F. N. and Hart, A. I. (2009). Some Morphometric Parameters of ten species from the Lower Niger Delta, Nigeria. *Res. J. Biol. Sci*., 4(3):282 – 288.

Adedeji, R. A. and Araoye, P. A. (2005). Study and characterization in the growth of body parts of Synodontisschall (Pisces: Mochokidae from Asa dam, Ilorin Nigeria. *Nig. J. Fisheries*, (2 and 3): 219-244.

Adewoye, S.O. and Omotosho, J.S. (1997).Nutrient Composition of some freshwater fishes in Nigeria.*Biosci. Res. Commun.,* 11 (4): 333-336.

Akombo, P.M., Atile, J.I., Adikwu, I.A. andAraoye, P.A. (2011).Morphometric Measurements and growth patterns of four species of the genus *Synodontis*(Cuvier,1816) from Lower Benue River, Makurdi, Nigeria.*International Journal of Fisheries and Aquaculture*, 3(15):263-270.

AOAC. (Association of Official Analytical Chemists) (2000).*Official methods of analysis*.13th Edition, Washington D.C.

Anon. (2011). Annual Report, 2010-11, Central Marine Fisheries Research Institute, Cochin, 133 pp.

Araoye, P. A. (1997). Bio-ecology of a Mochokid, *Synodontisschall* (Block and Schneider 1801) in Asa Dam Ilorin, Nigeria.Ph D Thesis, University of Ibadan, Nigeria, p. 201.

Araoye. P. A. (2004). The Head-Body weight and Head-body length

relationships of *Synodontisschall* (Bloch and Schneider, 1801) in Asa Dam Ilorin, Nigeria.In proceedings of the 19th Annual Conference. Fisheries Society of Nigeria (FISON), Ilorin, Nigeria, 29th November to 3rd December, 2004. Editor, Araoye P.A., pp. 288-291.

Azim, M. A., Islam, M. R., Hossain, M. B. and Minar, M. H. (2012). "Seasonal Variations inthe Proximate Composition of *GangeticSillago, Sillaginopsispanijus*(Perciformes:Sillaginidae)".*Middle-East Journal of Scientific Research*,11 (5):559-562.

Bagenal, T.B. and Tesch,F.W. (1978).*Age and Growth In: Method of Assessment ofFish Production in Fresh Waters,* (ed. T. Bagenal). Oxford Blackwell Scientific Publication.pp 101 – 136.

Bake, G.G. and Sadiku,S.O.E. (2012).Basic morphometric measurements and growth pattern of Heterotis niloticus from River Kaduna flood plains, Nigeria*Journal of Science, Technology and Mathematics Education*,8 (1): 113-118.

Bake, G.G., Yisa,P.Z. and Sadiku,S.O.E. (2012). Proximate composition, food and feeding habit of Heterotisniloticus from River Kaduna flood plains, *Nigeria. Journal of Science, Technology and Mathematics Education*,9(1): 34-39.

Bakhoum, S.A. (1994). Comparative study on length weight relationship and condition factors of the *Oreochromis*in polluted and non-polluted parts of Lake Mariut, Egypt.*Bull. Natl. Inst. Oceanogr*. Fish., Egypt, 20: 201-210.

Erzini, K.(1994). An empirical study of variability in length-at-age in marine fishes.*J. Appl. Ichthyol.*, 10(1):17-41.

Fafioye, O. O. andOluajo, O. A. (2005).Length-weight relationships of five fish species in Epe Lagoon, Nigeria.*Afr. J. Biotechnol.*, 4: 749-751.

Food and Agriculture organization of the United Nations FAO.(2003). Review of the State, the World Agriculture. FAO Fisheries Circular 886. FAO, Rome, Italy.

Huss, H.H. (1995). Quality and quality changes in fresh fish, FAO Fisheries Technical Paper No. 348. FAO, Rome, Italy, pp. 20-92.

Laleye, P.A., Chikou, P., Vandewalle, J. C., Philippart, C. and Tuugels, G. (2006). Studies on Biology of two species of catfish: *Synodontisschall*and.*Synodontisnigrita* (Ostarriophysii: Mochokidae) from Oueme River, Benin. *Belg. J. Zool.,* 136(2): 193 – 201.

Love, R.M. (1997).*Biochemical dynamics and the quality of fresh and frozen fish*. In: G.M. Hall (Editor). Fish Processing Technology, Blackie Academic & Professional, London, UK, pp. 1-26.

Mendes, B., Fonseca, P. and Campos, A. (2004). Weight-length relationships for 46 fish species of the Portuguese west coast.*J. Applied Icht.*, 20: 355-361.

Morato, T., Afonso, P., Loirinho, P., Barreiros, J.P., Sanstos, R.S. and Nash, R.D.M.(2001). Length-weight relationships for 21 costal fish species of the Azores, North-eastern Atlantic. *Fisheries Research*, 50: 297- 302.

Moutopoulos, D. K. and Stergious, K. I. (2002). Weight-length and length-length relationships for 40 fish species of the Aegean sea (Hellas). *J. Appl. Ichthyol.*,18: 200-203.

Khallaf, E. A., Galal,M. and Authman, M. (2003).The Biology of *Oreochromisniloticus*in a polluted canal.*Ecotoxicol.*,12: 405-416.

King, R.P. (1996). Length-Weight relationships of Nigerian fresh water fishes.Naga, ICLARM Q., 19: 49 – 52.

Kulbicki, M., Guillemot, N. andAmand, M. (2005).A general approach to length-weight relationships for New Caledonian Lagoon fishes.*Cybium*, 29: 235-252.

Olaosebikan, B.D. and Raji, A. (1998): Field guide to Nigerian freshwater fishes. Decency Printers and stationary Ltd, Ilorin, Nigeria. 105pp.

Olurin, K.B. and Aderibigbe, O.A. (2006). Length-weight relationship and condition factor of pond reared juvenile *Oreochromisniloticus*. *World Journal of Zoology*, (2):82-85.

Owolabi, O. D. (2005). Some Aspects of Biology of *Synodontismembranaceus* (Geoffrey Saint Hillaire 1809) in Jebba Lake, Nigeria.Ph. D. Thesis, University of Ilorin, Nigeria.(Unpublished).

Pauly, D. (1993).Fishbyte section editorial.Naga. ICLARM Q. 16: 26.

Pervin, M. R. andMortuza, M. G. (2008). Notes on length-weight relationship and condition factor of fresh water fish, *Labeoboga* (Hamilton) (Cypriniformes: Cypriniformes). *Univ. J. Zool. Rajshahi Univ.*, 27: 97-98.

Reed, W., Buchard, J., Hopsin, A. J., Jonathan, J. and Yaro, I. (1967). *Fish and fisheries of Northern Nigeria* Gaskiya publication Zaria to Nigeria pg 226p.

Ricker, W.E. (1975).Computation and interpretation of biological statistics of fish populations.*Bulletin of the Fisheries Research Board of Canada,* 191: 1-382.

Sadiku S. O. E and Oladimeji, A. A. (1991). Relationship of proximate composition of *latesniloticus* (L) *Synodontis shall* (Broch&Schneider) and *Sarotherodongalilaeus* (trewaues) from Zaria Dam Nigeria. *Bioscience Research Communications*, 3 (1): 29-40.

Sikorski, Z.E., Lolakowska, A. and Pan, B.S. (1990).*The Nutritive Composition*

of the Major Groups of Marine Food Organisms. In: Resources Nutritional Composition and Preservation, Sikorski, Z.E. (Ed.). CRC Press-Inc., Boca Raton, Florida, pp: 30-52.

Sinovcic, G., Franicevic, M., Zorica, B. and Ciles-Kec, V. (2004). Length-weight and length-length relationships for 10 pelagic fish species from the Adriatic Sea (Crotia). *Journal of Applied Ichthyology*, 20: 156-158.

Stansby, M. (1985). Fish or Fish oil in the diet and heart attack. *Mar. Fish. Review,* 46(2): 60-63.

Stewart, K.M. (1988). Changes in condition and maturation of the *Oreochromisniloticus*L. population of Ferguson's Gulf, Lake Turkana, Kenya.*J. Fish Biol.*, 33: 181-188.

Waterman, J. J. (2000).Composition and Quality of Fish.Torry Research Statation.Edinburgh. Window, H., Stein, D., Scheldon, R. and Smith, J. R. (1987). Comparison of trace metal concentrations in muscle of a benthopelagic fish *Coryphaenoidesarmatus* from the Atlantic and Pacific oceans. *Deep Sea Res.*, 34: 213-220.

Willoughby, N.G. (1974). The ecology of the genus *Synodontis*(Pisces: Siluroidei) in Lake Kainji, Nigeria. Ph.D. Thesis, University of Southampton, Nigeria .288p

Wooten, R. J. (1992).*Fish Ecology* Blackies and sons Ltd. New York.Pp 1344-8