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Aspects of the Biology of Some Selected Fish Species from Lake Alau, Arid Zone Nigeria

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ABSTRACT
Some biological aspects of *Clarias gariepinus, Oreochromis niloticus* and *Heterotis niloticus* from Lake Alau were investigated for Ten (10) months (July 2012 – April 2013). Out of the 518 Fish samples collected randomly, *Clarias gariepinus* was the dominant species with a size distribution ranging from 10-37cm standard length (total length: 12-40cm); weight (61.70-1440.20g). The size of *O. niloticus* ranged from 23.28-27.28cm as the mean, standard length, 25.62-30.16cm mean total length and 26.68-115.60g (mean weight), while 131-3504g with corresponding 40.00-68.30cm and 43.30-70.20cm standard and total length of *H. niloticus.* All the species studied indicated negative allometric growth (b<3). The GSI revealed a significant difference (P>0.05) among all the three species. However, there is no significant difference (P<0.05) in *O. niloticus* among the entire study months. The information obtained on length-weight relationship and GSI are important parameters for stock assessment and understanding of the population dynamics, which could be used to promote the species in the wild. Thus, condition factor, K, is a useful index in monitoring food supply, breeding season, growth, physiological state, relative robustness and the general wellbeing of intra and inters populations of the studied species.

Key Words: Fish species, Morphmetric, Gonadosomatic index, Lake Alau, Arid zone, Nigeria

INTRODUCTION

Lake Alau is the second largest lake in Borno State after Lake Chad. Its importance is not only for fish production but also because of its other uses to the people of Maiduguri for domestic purposes. In addition, it has the potentials to serve industrial establishments and irrigation according to Nwoko (1991).

The fish diversity which is currently recognized worldwide shows 25,000 species, of which 10,000 species are found in freshwater ecosystems. Specialists have estimated that at least 5,000 await discovery. Thus freshwater fish discovery can serve as a platform of livelihood and biodiversity of conservation values (www.fishbase.org, 2009). Nigeria is endowed with a vast network of rivers, streams, seasonally flooded plains, natural and man-made reservoirs, as well as brackish water in lagoons and coastal creeks, which form habitat for fish (Bolorunduro, 2003). Roughly 40% of the fish consumed in Africa South of Sahara are freshwater fish as compared to a global average of 25%, while West Africa is relatively a large consumer of finfish (Bonga, 1999). The fish yield of most Inland waters in Nigeria is generally on the decline for causes that may range from inadequate management of fisheries to degradation of water bodies (Odo *et al.* 2009). Detailed knowledge of the form and function of the river system and responses of fish species is needed for effective fisheries management planning. Welcomme and Halls (2001) reported that such detailed knowledge of individual systems is generally lacking.

Teugels and Guegan (1994) reviewed fishes in the Congo Basin, the region known for very high richness, second to the Amazon basin in species richness, 25 families and 686 species were reliably reported. 40 groups of fish species in Madagascar from brackish and freshwaters were reported by Stiassny and Raminosoa (1994). Teugels and Powell (1993) reviewed group of fishes in Niger basin, a

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region of high richness, 36 families and 243 species primarily of freshwater were reported. Boulenger (1916) listed 976 species of African freshwater fishes comprising 185 genera and 43 families. Ita (1993) reported 268 different fish species in 34 well known Nigeria freshwater rivers, lakes and reservoirs, which constitute about 12% of Nigeria's total surface area of about 98, 185, 000 hectares. However, according to Jamu and Ayinla (2003) the yields of most of these inland waters are generally in decline due to environmental degradation (such as water pollution) and improper or poor management of fisheries resources. Environmental protection agency (EPA) recommended species richness and relative abundance as ecological risk assessment in aquatic ecosystems. Welma (1948) produced a list of 181 species of fish that could be found in Nigeria Inland waters. Ita (1993) reported an estimated 230 species of fish in Nigeria rivers. Odo *et al.* (2009) reported estimated 52 fish species belonging to 17 families from Anambra River, Nigeria. Soyinka *et al.* (2010) gave a report on seasonal distribution and richness of fish species in the Badagry Lagoon, South West Nigeria, 37 species distributed among 21 families of fish were reportedly caught from the lagoon.

Ayoade and Ikulala (2007) reported that length-weight relationships (LWRs) of fishes are important in fisheries biology because they allow the estimation of the average by establishing a mathematical relationship between the relative wellbeing of the fish population. They further asserted that length-weight relationships has a number of important applications in fish stock assessment. Among these applications are: estimating the standing stock biomass and comparing ontogeny of fish population from different regions. This information will enhance management, conservation and culture of these species.

Length-weight relationships (LWR) is represented by the power curve, W= alb where the W= weight (g), L= total length (cm), a= constant and b= growth exponentially (Ayoade and Ikulala, 2007). When b is equal to 3, growth in fish is said to be isometric that is fish become more robust with increasing length (Bagenal, 1978). Similarly, when b is less or greater than 3, growth in the fish is allometric that is fish become thinner with increasing length. King 1996a noted that only a few estimates of species-specific length-weight relationship parameters are available for Nigerian fishes.

Abowei and Hart (2009) in an investigation of some morphometric parameters of 10 finfish species of lower Nun River, Niger Delta, Nigeria; observed that all species exhibited positive allometric growth. They concluded that these populations stand the risk of over-exploitation in the lower Nun River if urgent measures are not taken to protect their fisheries.

Similarly, Hannifar *et al.,* (2006) investigated LWRs of *Channa punctata* from Western River in which the study showed no significant difference ($p > 0.05$) in the LWR as a function of sex. Miranda *et al*. (2006) also reported 'b' value ranging from 3.47 to 7.28 in an investigation of the LWR of cyprinid fishes of Liberian peninsula. Laleye (2006) in an investigation of length-weight and LWR of Quame River Benin (West Africa), recorded b values which range from 2.3307 to 3.5185 and revealed that 38.5% of the species had b values significantly different from 3.

In the study of the LWR of 33 cryptic reef fish from South Western Gulf of California, Balart *et al*. (2006) observed 'b' values which varied between 2.63 and 3.61 while in a related study, Britton Harper (2006) observed 'b' values which ranged between 2.90 and 3.22 in a study of fish species in the freshwater rift valley lake of Kenya.

MATERIALS AND METHODS

Study area

The study was carried out in Lake Alau which is located between latitude 12^0N and 13^0N and longitude 11^0E and 13^0E with the total surface area of 56 Km^2 CBDA (1986). The climate is Sahelian with two distinct seasons. The rainy season starts from June and end in September, with a mean annual rainfall of about 600mm (Bankole *et al.,* 1994). The dry Harmattan season (October to February) is preceded with the rainy season and starts from (June to September). During the dry Harmattan very low temperatures between 16-19^0C occur during the night and the cold, dry Harmattan wind with temperature values of between 26 and 29^0C in the day. The dry, hot season starts from March to May, marking the driest period with intense heat. During these period atmospheric temperature values of 46 to 48 has been recorded (Fasesan, 2000; Idowu, 2004).

Sampling area

Three landing sites were chosen randomly for fish sample using catch statistics. The fish identified systematically and measurements such as length-weight relationship, condition factor and gonads was identified and calculated.

Fish sample collection

Fish samples were collected from fish mongers at the landing site. In the laboratory, identification of the fish species was carried out following Fish Base (2006) software was also used as a guide. Further descriptions of the species were carried out on Wikipedia (2009), the free encyclopaedia.

Occurrence and biometric data (such as total length, TL; and body weight, BW) of individuals in each taxon for each tributary were recorded. Total length was measured to the nearest 1 mm and BW to the nearest 0.01 g. The sex of each specimen was identified by visual examination and later confirmed after dissection and examination of the gonads. The gonads were detached from the other visceral organs and weighed. The weighted gonads, which were in pairs, were then separated and the length and width of each gonad measured to the nearest centimetre. The GIS was determined by weight of the gonads over body weight of the fish in percentage.

Data analysis

Statistical analysis

All data on the physico-chemical and biological studies was analyzed using analysis of variance (ANOVA). The significant effect in the ANOVA was tested using fisher's protected LSD to distinguish difference between means ($P<0.05$). The estimation of species abundance and diversity of Zooplanktons was done using Margalef's Diversity Index (D), Shannon-Wiener Diversity Index (H^{l}) and Simpson's Index(D) methods.

RESULTS

Fish species composition

In this study Fish species composition comprised five hundred and eighteen (518) individuals from three (3) families, namely; *Clariidae, Cichlidae* and *Osteoglossidae* (Table 1). Family *Clariidae* was represented by *C. gariepinus*, *Chichlidae* by *O. niloticus* and *H. niloticus* represent *Osteoglossidae* respectively. *Claris gariepinus* was the most abundant species comprising 418 individuals. The second most abundant species was *O. niloticus* which comprised of 50 individuals of the fish population, while the least abundant fish was *H. niloticus* comprising 50 individual's base to catch at the sight. *H. niloticus* was scarce at the three (3) landing sites compared with *O. niloticus* species.

Table1: Length-Weight parameters of three fish species encountered on Lake Alau, Nigeria

Species	N	a±SD	b±SD	CI of b	r^2
C. gariepinus	418	0.6275±0.1093	1.7210±0.0798	1.5646 – 1.8774	0.5279
H. niloticus	50	-0.2092±0.1714	1.9058±0.1060	1.6980 – 2.1136	0.8707
O. niloticus	50	0.2313±0.2513	1.2056±0.1863	0.8403 – 1.5708	0.4658

The size distribution of *C. gariepinus* was 1440.20 g and 40 and 37cm total and standard length, respectively in the month of August (Table 2). The smallest specie weighed 61.7 g with 12 cm and total length and standard lengths, respectively, while the condition factor in the month of December was 0.707.

The morphometric measurement of *O. niloticus* is presented in Table 3. The highest mean weight of 115.6 grams was obtained in the month of January with a corresponding total mean length and a mean standard length of 25.62 cm and 23.28cm respectively. 26.68 g was the lowest mean weight obtained in the month of October with 30.16cm mean Total length and 27.28cm mean Standard length.

Table 2: Morphometric Measurements of *Clarias gariepinus* from Lake Alau Nigeria

Month	N	Weight (g)			TL (cm)			SL (cm)			K		
		Mean	Min.	Max	Mean.	Min.	Max	Mean	Min.	Max	Mean	Min.	Max
Jul.	40	1004.1±34.0	103.0	1315.0	27.028±0.526	20.000	34.000	24.875±0.588	18.000	39.500	5.173±0.234	1.288	8.438
Aug	41	1028.6±29.3	563.0	1440.2	26.539±0.666	19.000	40.000	24.088±0.643	16.100	37.000	5.837±0.245	2.250	8.975
Sept	43	1162.5±20.5	752.0	1434.1	28.991±0.648	22.000	39.000	26.400±0.579	20.000	36.000	5.132±0.238	2.252	8.161
Oct.	42	1155.8±30.4	291.0	1365.4	29.160±0.652	20.000	38.000	24.000±0.897	15.000	36.000	4.942±0.248	2.212	9.765
Nov	42	964.9±51.6	138.0	1357.3	25.750±0.701	17.000	37.400	22.495±0.785	15.000	36.000	5.581±0.273	2.452	9.189
Dec	42	841.8±65.5	61.7	1331.5	24.607±0.908	12.000	34.000	22.238±0.884	10.000	31.000	5.324±0.297	0.707	9.100
Jan.	41	1067.9±34.9	92.3	1275.1	26.039±0.504	17.000	33.000	23.634±0.481	15.000	30.000	6.165±0.273	1.879	9.254
Feb.	42	1002.2±45.6	57.0	1242.1	24.952±0.547	11.000	33.000	23.343±0.493	18.000	35.000	6.266±0.236	1.946	9.101
Mar	42	1033.3±27.0	542.0	1275.1	25.029±0.441	19.000	32.000	22.883±0.409	17.000	30.000	6.714±0.177	3.793	8.037
Apr.	43	1045.0±26.3	551.0	1286.8	25.677±0.531	19.000	37.000	23.472±0.514	17.000	34.000	6.420±0.218	2.540	8.424

Table 3: Mean (±SEM) Morphometric measurements of *O. niloticus* from Lake Alau Nigeria

Months	Weight (g)			TL (cm)			SL (cm)			K		
	Mean	Min.	Max	Mean	Min.	Max	Mean	Min.	Max	Mean	Min.	Max
Jul.	98.88±9.97	77.40	123.00	24.78±0.69	23.40	26.50	21.375±0.66	20.10	23.20	1.02±0.12	0.81	1.33
Aug.	85.0±19.00	58.90	160.00	27.58±4.19	21.60	44.10	24.46±3.51	19.40	38.20	0.77±0.19	0.11	1.23
Sept.	83.90±8.23	58.00	101.00	29.30±3.44	23.30	42.30	26.54±3.43	20.10	39.00	0.62±0.17	0.10	1.11
Oct.	26.68±3.38	17.80	35.90	30.16±1.21	27.20	33.00	27.28±1.31	23.20	30.20	0.13±0.00	0.12	0.14
Nov.	37.36±5.47	19.80	49.80	23.46±1.52	20.00	28.60	20.98±1.24	18.40	25.20	0.45±0.01	0.12	0.73
Dec.	114.1±27.80	46.00	185.60	26.30±2.23	20.50	30.30	23.66±2.02	18.20	27.30	0.78±0.05	0.64	0.93
Jan.	115.6±13.6	91.30	168.70	25.62±1.08	23.30	29.70	23.280±0.80	21.40	26.10	0.90±0.02	0.85	0.95
Feb.	106.0±19.9	50.00	174.90	23.72±1.69	19.20	29.10	21.42±1.51	17.20	26.00	1.04±0.08	0.81	1.22
Mar.	97.7±10.40	63.60	123.20	24.82±0.71	22.50	27.00	21.84±1.04	19.00	25.40	0.93±0.06	0.75	1.05
Apr.	99.07±7.87	77.70	128.20	24.20±0.70	22.40	27.00	21.367±0.95	19.30	25.20	1.03±0.07	0.80	1.30

∑N= 50

The highest K value of 1.328 was obtained in July while the lowest (0.0978) in the month of September.

The features of *H. niloticus* as presented in Table 4 indicates 3504 g as the highest weight obtained in the month of September with corresponding 70.20cm and 68.30cm total and standard length, respectively. 131 g was the minimum weight obtained in the month of December with 43.30cm total length and 40.00cm standard length. The mean condition factor of 1.16 was the highest obtained in the month of July.

Table 4: Morphometric Measurements of *Heterotis niloticus* from Lake Alau, Nigeria

Months	N	Weight(g)			TL(cm)			SL(cm)			K		
		Mean.	Min.	Max	Mean	Min.	Max	Mean	Min.	Max	Mean	Min.	Max
Jul.	4	1535±634	303	3310	48.30±7.20	30.30	65.40	44.20±7.54	28.30	63.20	1.554±0.288	1.158	2.409
Aug.	5	1218±371	200	2110	45.00±5.67	27.00	60.20	42.38±5.85	24.00	58.50	1.407±0.252	0.987	2.364
Sept	5	1186±602	300	3504	44.42±7.57	30.00	70.20	42.06±7.62	28.50	68.30	1.2414±.0921	0.9644	1.4668
Oct.	5	1257±251	585	2000	54.40±5.04	40.50	71.00	52.02±5.08	38.40	69.20	0.8792±.0754	0.6035	1.0331
Nov.	5	799±213	300	1580	46.68±4.31	33.20	60.00	44.18±4.49	30.00	58.20	0.8690±.0620	0.7802	1.1111
Dec	5	900±322	131	2012	52.68±4.86	43.30	70.10	50.06±5.19	40.00	68.40	0.710±0.167	0.0905	0.982
Jan.	5	1114±244	620	1710	51.74±2.93	45.00	59.10	49.76±3.22	43.30	57.60	0.8440±.0.0297	0.7637	0.8948
Feb.	5	673±153	320	1230	40.00±3.51	33.50	53.30	37.50±3.39	30.20	50.00	1.228±0.105	0.984	1.578
Mar	5	653±367	177	2100	35.76±5.48	26.20	55.40	33.68±5.44	23.40	53.20	1.2140±.0.0878	0.9671	1.3970
Apr.	6	892±198	320	1510	43.25±5.01	27.80	58.30	42.35±4.23	25.30	55.00	1.159±0.182	0.712	1.976

∑N= 50

Gonadosomatic Index

Monthly mean variation of Gonadosomatic index (Table 5) revealed that there was a significant difference (P>0.05) among all the three (3) species. However, there is no significant difference (P>0.05) in *O. niloticus* among the entire study months, while there was a significant difference (P<0.05) in the month of September, October and December for *H. niloticus*. Similarly, for *C. gariepinus* there was a significant difference in almost all the months of the study with the exception of August, September, and December (14.68±1.23).

Table 5: Monthly variation in Gonadosomatic index of three fish species encountered in Lake Alau, Nigeria

Months	GSI		
	C. gariepinus	*H. niloticus*	*O. niloticus*
July	20.47 ± 1.29^{a}	0.52 ± 0.20^{ab}	2.66±0.51
August	14.65 ± 1.51^{cde}	0.63 ± 0.22^{ab}	1.71±0.18
September	15.42 ± 1.27^{cde}	0.64±0.14	2.09±0.25
October	16.83 ± 0.80^{abcd}	0.48 ± 0.07^{b}	2.01±0.15
November	12.80 ± 1.20^{e}	0.70 ± 0.12^{ab}	1.93±0.31
December	14.67 ± 1.23^{cde}	1.31 ± 0.75^{a}	2.22±0.19
January	19.39 ± 1.19^{ab}	0.53 ± 0.08^{ab}	1.76±0.42
February	17.82 ± 1.46^{abc}	0.67 ± 0.10^{ab}	1.52±0.26
March	13.44 ± 1.66^{de}	0.91 ± 0.22^{ab}	2.04±0.03
April	16.47 ± 1.65^{bcde}	0.62 ± 0.10^{ab}	1.65±0.04

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Means in the same column followed by different superscripts differ significantly (P<0.05)

The length-weight relationship of *C. gariepinus* is presented in figure 1. The value of 'b' for this specie is less than 3, therefore the growth was negative allometric (b<3) for the overall samples of *C. gariepinus*. The correlation coefficient (r^2) is 0.05279, with a length-weight relationship equation log W=0. 6275+1.721 Log*SL.

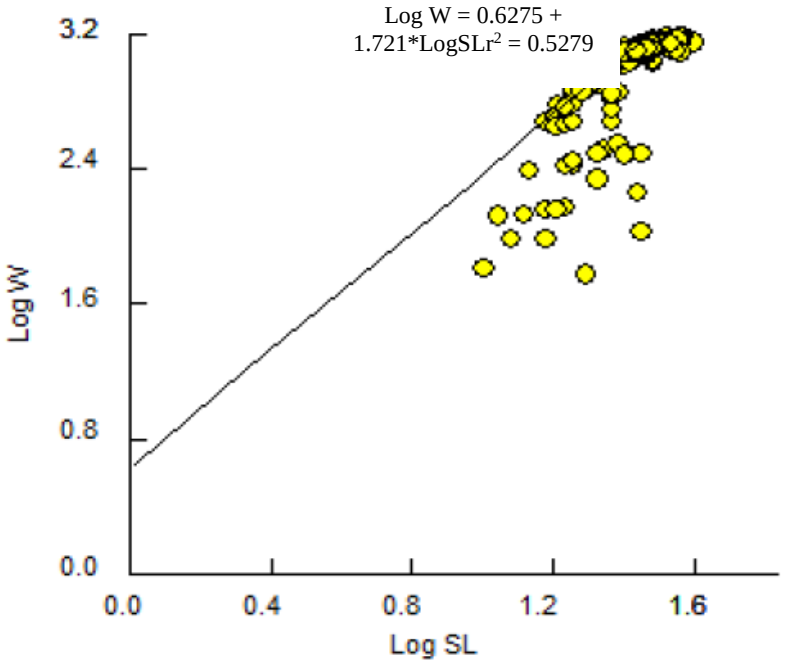

Figure 1: Length-weight relationship of *Clarias gariepinus*

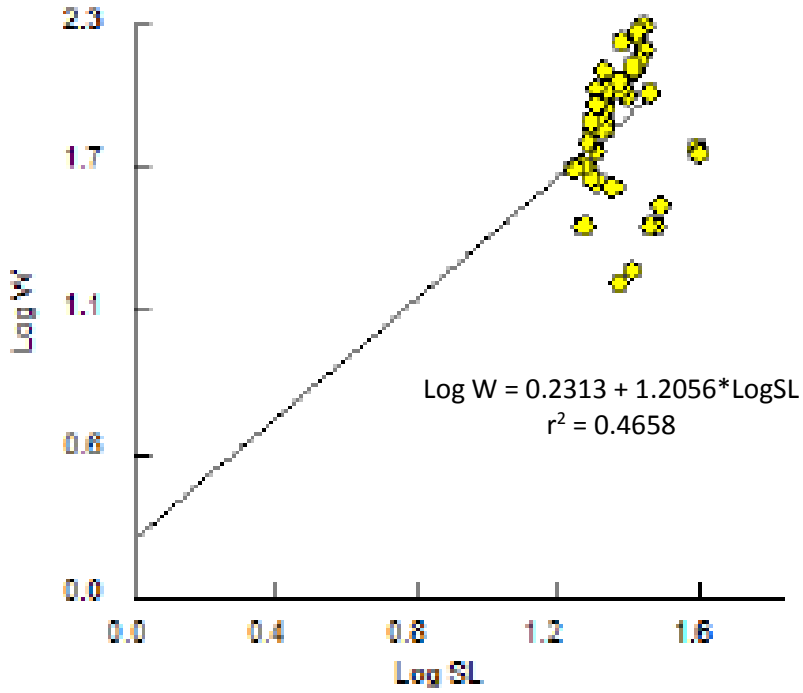

Figure 2: Length-weigh Relationship of *Oreochromis niloticus*

It's 'b' value is less than 3 which indicates negative allometric growth (b<3) for the whole species. The length-weight relationship equation is Log W= 0.2313+1.2056* Log SL with a correlation coefficient (r^2) of 0.4658. However, the length-weight relationship for *H. niloticus* (Figure 3) shows the negative equation of Log W= -0.2092+1.9058* Log SL with corresponding correlation coefficient (r^2) of =0. 8707. It is also revealed that 'b' value is less than 3 (b<3) and hence indicate negative allometric growth.

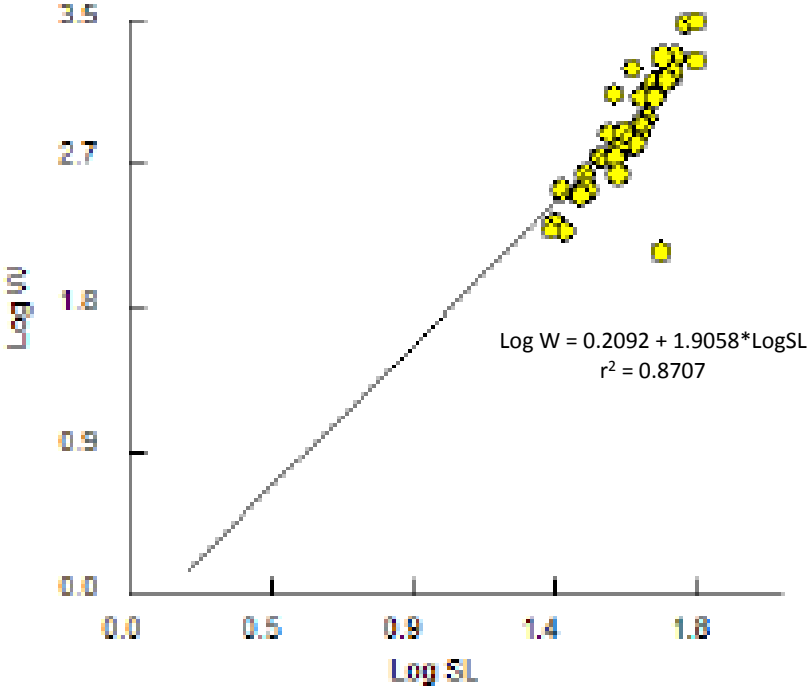

Figure 3: Length-weight Relationship of *Heterotis niloticus*

DISCUSSION

Morphometric characteristics of fish fauna

A Comparison of the result of this study revealed that, the morphometric measurements of *C. gariepinus* agree with Tauran *et al.*, (2004) who promulgated that the morphometric character varies with differences in size and habitat of a fish. It is well known that morphometric characters can show high plasticity in response to differences in environmental conditions, such as food abundance and temperature.

The exponent 'b' value of *C. gariepinus* exhibit negative allometric growth, this is that increased in length is faster than the body weight and depth of the fish. This is in line with King (1996a) who got 2.61 as the value of 'b' in Abadaba Lake in Imo state. Laleye (2006) in Quema River also got 2.95, but contrary to the findings of Entusa-Mensah *et al.*, (1995) who got 'b' value of 3.22 in Volta River. Pauly (1983) reported that a slope less than 3 denotes negatives allometric growth.

The 'r' value of *C. gariepinus* indicates a strong correlation between the length and weight. The condition factor indicates that they are living in good to excellent condition, even though the smaller one is more in better condition than the older once during the period of this study.

The condition factor (K) of the 3 fish species ranged between 1.2 and 6.7. A closer examination of the condition factors revealed that one of the fish species, *C. gariepinus* had K values outside the range (2.9 – 4.8), recommended as suitable for matured fish by Bagenal and Tesch (1978). This could have been caused by adverse environmental factors (Anene, 2005).

The 'b' value of *O. nilotions* ranging between 0.8403 to 1.5708 indicate that the species exhibits negative allometric growth being less than 3.0 as reported by Pauly (1983). This growth implies that *O. niloticus* increase weight faster than in length. These also correspond to the finding of Kumolu-Johnson and Ndimele (2010) who all suggested allometric growth with such corresponding 'b' value is very prominent with most of fish species in Lake Alau.

The condition factor (K) was lower than those reported by Saliu (2001). This could be as a result of differences in *niloticus* in Lake Alau was inversely related and this is a similar phenomenon with the work of Dale and Kraljevi (1996) who recorded a condition factor ranging between 1.19 - 1.64 habitat

condition and the environment where the fish were obtained. Some of the k value of *O.* Therefore, some of *O. niloticus* found in Lake Alau live in relatively good condition.

The highly significant relationships between the body weight and standard lengths of *H. niloticus* indicated that the body weight of the specie could be estimated with a fairly high degree of accuracy ($P<0.001$) from known standard lengths. The exponents, 1.7980 – 2.1136 for *H. niloticus* indicated that the growth is allometric among the majority of the fishes in which, according to the Le Cren (1951) obedience to the cube law (isometric growth) was rare. In spite of the importance of length-weight relationship in growth studies, Oni *et al*. (1983) pointed out that the condition factor is a better indicator of growth and physiological 'wellbeing' of a fish species, was better in *H. niloticus* than in *O. niloticus*, indicating that the former was more robust than the latter. Another study of robust fish with high K values is *T. zilli* (Oni *et al.*, 1983), *O. niloticus, T. zilli* and *H. niloticus* (Thomas, 1966).

Gonadosomatic Index

The ganadosomatic index (GSI) values obtained in this study showed that *C. gariepinus* had higher values than *O. niloticus* and *H. niloticus*. This was associated with the heavy weight of ovaries which contained the eggs. The GIS was also observed to be higher in the rainy season than in the dry season, thus, a further confirmation that breeding and spawning in these species take place during the rainy season, and that the reproductive circle is annually as reported by (Laleye *et al*., 2006; Araoye, 2001; Offem *et al.*, 2008). Gonadosomatic index was found to be independent of the size of fish, as the smaller samples of all the species in this study had developed gonads and were thus, already engaged in reproductive activity. However, Ikomi (1996) and Saliu and Fagade (2003) reported higher GSI values in larger samples of *Brienomyrus longianalis* in upper Warri River and *Brycinnus longipinnus* in Asa reservoir, respectively. They attributed the higher GSI in the larger samples to the heavier weight of their gonads. GSI was found to have significant correlations with total length, total weight and gonad maturation stage in females, but not in males, this may be due to the heavier weight of the female gonads.

Conclusion

In order to uphold the United Nation Charter (1992) that all species and habitats should be safeguarded to the extent that is technically, economically and politically feasible, The information obtained on length-weight relationship and GSI are important parameters for conservation of the population dynamics, which could be used to promote the species in the wild. Thus, condition factor, K, is a useful index in monitoring food supply, breeding season, growth, physiological state, relative robustness and the general wellbeing of intra and inters populations.

Settlement around Lake Alau should be encouraged to adopt environmentally friendly initiative by embracing low and management at all stages of product life.

A more intensive study of these fish species in Nigerian lakes will lead to the documentation of other species and wider distribution of many others than those that were recorded in the current study. This will lead to greater understanding of the factor that controls the distribution of these species.

REFERENCES

Abowei, F. N. and Hart, A. I. (2009). Some Morphometric parameters of ten fin-fish species from the lower Nun River, Niger Delta Nigeria. *Research Journal of Biological Sciences*, 4 (3) 282-288.

Anene, A. (2005). Condition factor of your Cichlid species of a Man-made lake in Imo State, south east, Nigeria. *Turkish Journal of Fisheries, Aquatic Science*, 5:43-47.

Araoye, P. A. (2001). Morphology of the gonads in the reproductive cycle of *Synodontis schall* (Pisces: *Mochokidae*) in Asa lake, Ilorin, Nigeria. *Journal of Aquatic Science*, 16 (2): 105-110.

Ayoade, A. A. and Ikulala, A. O. O. (2007). Length-weight relation condition factor and stomach contents of *Hemichromis bomaculatus, Serotherodon melanotheron and Chromidotilapia guntheri* (Perciformers *Cichlidae* in Eleiyele Lake, South West Nigeria. *Rev. Bio. Trop.* 55: 3-4.

Bagenal, T. B. (1978). *Age and growth, Fish production in freshwater*. Eds;T.B. Bagenal Blackwell, Oxford, London, 120-128.

Bagenal, T. B. and Tesch, F. W. (1978). Methods for the assessment of fish production in fresh waters: Age and Growth. Oxford, Blackwell Scientific Publication London. 101-136.

Balart, E. F., Gonzalez, A. Romero-Ponee, RC Zayas-Alvarez, A, Calderon-Parra. M. Campos-Davila, L and Findlay L. (2006). Length-weight relationships of Cryptic reef fishes from the southwestern Gulf of California, Mexico. *Journal of applied Ichthyology* 22 (4): 316-318

Bankole N.O., Sule O. D., Okwundu E.C; Amadu, M. (1994). Investigation on the Frame and Catch Assessment Survey of Alau Lake. *Annual Report of NIFFRI.* 28.

Bolorunduro, P. I. (2003). Post-harvest loss assessment and adoption of disseminated technologies in the Artisanal Fisheries of North western Nigeria. *Ph.D Thesis*, Department Biological Science, University of Ibadan.

Bonga, D. (1999). Globalization of trade relation and Africa trade for fish. *Bimonthly bulletin for the West Africa programme improvement of post-harvest utilization of Artisanal Fish Catches*, 45:8-9.

Boulenger, G.A. (1916). Catalogue of the Freshwater Fishes of Africa in the *British Museum of Natural History*. Vol. IV, Trustees, London, 392Pp.

Britton, J. R. and Harper, D. M. (2006). Length-Weight Relationship of Fish species in the freshwater rift valley lakes of Kenya. *Journal of Applied Ichthyology.* 22(4): 334-336.

Chad Basin Development Authority (CBDA) (1986). A Resettlement Plan for Jere Bowl scheme Report submitted to the Chad Basin Development Authority by Askoning Nig. Ltd. 59Pp.

Dul I. J. and M. Kraljevi (1996) Weight-Length relationship of 40 fish species in the eastern Adriatic (Croatian waters) *Fisheries Resources*, 28: 243-251.

Entusa-Mensah, M., Osei-Abunyewa, A. and Palomares, M.L.D. (1995). Length-weight relationship of fishes attributes of Volta Rivers, Ghana: Part I. Analysis of pooled data sets NAGA: *ICLARM Quarterly*. 18(1):36-38.

Fasesan R.T. (2000). Zooplankton Composition and Abundance in Lake Alau, North Eastern Nigeria. *Nigerian Journal of Experimental Biology.* 1(2): 111-6.

Fish Base, (2006). "Family-Search Result, Africa-Inland Waters". In Fish base (Froese, R. and D. Pauly, ed). Available from: http://www. fishbase.org/ identification/ species. cfm? famcode= 349 & areacode=1

Fish Base Organization (2009). Retrieved on July 14, 2009, from www.fishbase.org.

Food and Agricultural Organization (FAO), 1990. Field guide to the Commercial marine resources of the Gulf of Guinea. RAFR/F1/90/2, 265:28.

F.A.O. (1994). Catalogue of small scale fishing gear in Nigeria RAFR/014/F1/94/02. 42Pp.

Hannifer, M. A., Nagaraja, M. and Gopalakarisnan, (2006). Length-Weight relationship of *Channa punctata* (Bloch, 1793) from Western Ghats Rivers of Tamil Nadu. *Journal of Applied Technology* 22 (5): 463-463.

Idowu R. T. (2004). Limnological Assessment of Lake Alau, Borno State, Nigeria. *Ph.D Thesis*, University of Nigeria, Nsukka, 189Pp.

Ikomi, R. B. (1996). Studies on the growth pattern, feeding habits and reproductive characteristics of the Mormyrid, *Brienomyrus longianalis* (Boulenger) in the Upper Warri Rivers, Nigeria. *Journal of Fisheries Research*, 26: 187-198.

Ita, E.O. (1993). Inland Fishery Resources of Nigeria. FAO, CIFA occasional paper No.20, Rome, Italy, FAO. 120Pp.

Jamu, D. M. and Ayinla, A.O. (2003). Potential for the Development of Agriculture in Africa. *NAGA*, 26(3): 9-13.

King, R. P. (1966a). Length-weight relationship of Nigerian freshwater fishes. NAGA. *The ICLARM Quarterly* 19 (3): 49-53pp.

Kumolu-Johnson C. A., Ndimele, P. E. Akintola, S. L. and Jibuike, C. C. (2010). Copper, Zinc, and Iron concentration in water, sediment and Cynothrissament (Regan, 1917) from Obge Lagoon, Lagos, Nigeria, a preliminary survey. *African Journal of Aquatic Science*, 35:87-94.

Laleye, P. A. (2006). Length-Weight and Length-Length of fishes from the Queme Rivers in Benin (West Africa). *Journal of applied Ichthyology* 22 (4): 330-333

Lalaye, P. A. (2006). Length-weight relationship of fishes from the Queme River in Benin (West Africa). *Journal of Applied Ichthyology*, 22:330-333.

Lalaye, P., Chikou, A., Gnohossou, P., Vandewalle, P., Phillippart, J.C and Tengels, G. (2006). Studies on the Biology of two species of Catfish, *Synodontis schall* and *Synodentis nigrita* (Ostariophysi Mochokidae) from the Queme River, Benin, *Belgium Journal of zoology*. 136(2): 193-201.

Le Cren. E. D. (1951). The Length-weight relationship and seasonal cycle in gonad weight and condition in perch (*Perca fliviatitis*) *Journal of Animal Ecology* 20:12-16

Miranda, R,. Oscoz, J., Launda, P. M. and Escale, M. C. (2006). Weight-Length relationship of Cyprinid fishes of Liberia Peninsula. *Journal of Applied Ichthyology*, 22 (4): 297-298.

Nwoko, C. V. (1991). Fisheries, Resources and Politics of Inland water resources development in Nigeria. With particular reference to and Zone in Arid zone Hydrology and water resources. University of Maiduguri Press, 493-500.

Odo, G. K., Nwani C. D. and Eyo J. E. (2009). The Fish fauna of Anambra River Basin, Mageroa Species abundance and morphometry. *Revista de Biologia Tropical*, 57 (1-2): 177-186.

Offem, B. O., Ayotunde, E. O., and Ikpi, G. U. (2008). Dynamics in the reproductive biology of *Heterobranchus longifilis Val*, (Pisces: 1840) in the wetlands of Cross Rivers, Nigeria. *Research Journal of Fisheries and Hydrobiology*, 3 (1): 22-31.

Oguzie, F.A. (1997). A key to some of freshwater fishes of Nigeria (Adopted from Boulenger and Welman). Dept of Fisheries, University of Benin, Benin City, 1-14.

Oni, S. K., Olayemi, J. Y. and Adegbeye, J. D. (1983). Comparative Physiology of three ecologically distinct freshwater fishes, *Alestes nurse* and *Tilapia Zilli* (Gervais). *Journal of Fisheries Biology*, 22:105-109.

Pauly, D. (1983). Some simple method for assessment of tropical fish stocks FAO. *Fisheries Technical Paper* (234) FAO, Rome, 34Pp.

Reed, W., Burchard, J., Hopson, A.J.,Jenness, J. and Yaro, I. (1967). *Fish and Fisheries of Northern Nigeria.* 1st Edition, Ministry of Agriculture press, Northern Nigeria, 225Pp.

Saliu, J. K., (2001). Observation on the condition factor of *Brycinus nurse* (Pisces: cypriniforms, characidae) from Asa Reservoir, Ilorin, *Nigeria Tropical Freshwater Biolography,* 10:9-17.

Saliu, J. K. and Fagade, S. O. (2003). The Reproductive Biology of *Brycinnus nurse* (Paugy, 1986). (Pisces: Charactolae) in Asa reservoir, Ilorin, Nigeria. *Turkish Journal of fisheries and Aquatic Science,* 3:5-9.

Soyinka, O.O., Kuton, M.P and Ayo-Olalusi, C.I. (2010). Seasonal distribution and richness of species in the Badagry Lagoon, South-west, *Nigeria. Estonian J. Ecol.*, 59 (2): 147-157.

Stiassny, M.L.J. and Rominosoa, 1994. *The fishes of the inland waters of Madagascar*. In Biological diversity of African fresh-and brackish water fishes (Teugels, G.G. J.F. Guegan and J.J. Albaret, Eds.) Geographical overviews presented at the PARADI Symposium, Senegal, and 15-20 November 1993. *Ann. Mus. R. Afr. Centr. Sci. Zool.*, 275:177.

Tauran C., Erguden D., Turan F. and Gurlek M. (2004). Genetic and morphological structure of *liza abu* (Heckel, 1843). Population from the Rivers Orontes, Euphrates and Tigris. *Turkey Journal of Veterinary/Animal Science*, 28:729-734.

Thomas, J. D. (1996). On the Biology of the Catfish *Clarias senegalensis* in a Man-made Lake in the Ghanaian Savanna, with a particular reference of its feeding habits. *Journal of Zoology,* 148:476-514.

Tuegels, G.G. and Powell, J.R. (1993). Freshwater biodiversity a preliminary global assessment: Important areas for freshwater biodiversity in Niger Basin area. *In WCMC Biodiversity series No. 8.* Available from: http://www.unep-cmc.org/information_services/publications/freshwater/4.htm

Tuegels, G. and Guegan, J.F. (1994). Freshwater biodiversity a preliminary global assessment: Important areas for freshwater biodiversity in Congo Basin. *In WCMC Biodiversity series No. 8*. Available from:http://www.unep-wcmc.org/information_services/publications/freshwater/4.htm [Accessed 20 December 2008].

United Nation Organization. (1992) International Standard for Drinking water 3rd edition. World Health organization, Genera.

Welcomme, R. L. and Halls, A. (2001). Some considerations of the effects of differentions, *Ecohydrology and Hydrobiology*, 1:313-321.

Welman, J.B. (1948). Preliminary survey of the Freshwater Fisheries of Nigeria. 8 Governments, Lagos, Nigeria. Wikipedia, 2009. Fauna of Africa. Available from: http://en.wikipedia.org/wiki/Fauna_of_Africa.

Wilson, J. P. K and Pitcher, T. J. (1983). The Seasonal cycle of condition in the pollen *Coregonus autmnalis* pollen Thomson of lough neagh, Northern Ireland. *Journal of Fish Biology*, 23:370.