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Morphometrics, Condition Factor and Organo-somatic Indices of *Hydrocynus forskalii*, *Coptodon zillii* and *Alestes baremose* in Yuna Landing Site Kainji Lake Niger State, Nigeria

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ABSTRACT

A six-month study was conducted on the morphometrics, condition factors, organo-somatic indices and length-weight relationship of *Hydrocynus forskalii*, *Coptodon zillii* and *Alestes baremose* from Yuna landing site. Thirty (30) samples of each species collected monthly from artisanal fishermen were assessed on length, weight, and organosomatic indices. All organosomatic parameters of *H. forskalii* correlated positively except for the pOL and TL. The correlation was higher (1.00), between PAL and SL and lower between ED and BW (r = 0.10. Correlation in *C. zillii* was higher between SL and TL (r=0.93) and lower (r=0.19) between pOL and pPVL (r=0.19). All morphometrics of *A. baremose* correlated positively. It was highe between SL and TL (r=0.99), and lowest between ED and pOL (r=0.68). The growth exponent "b" was negative allometric for *H. forskalii* (b = 2.84) and *C. zillii* (b = 2.99) while it was positive allometric for *A. baremose* (b = 3.54). The mean condition factors (K) for *H. forskalii*, *A. baremose* and *C. zillii* were, 1.04±0.31, 1.41±0.27 and 4.16±0.47, respectively. The gonadosomatic index (GSI) of *H. forskalii*, *C. zilli*, and *A. baremose* were 5.92±8.11, 0.54±0.80, and 1.02±0.82, respectively. While hepatosomatic indices of *A. baremose*, *C. zilli* and *H. forskalii* were 2.00±1.33, 1.24±0.69 and 1.03±0.74, respectively. Cardiosomatic indices recorded for *H. forskalii* was .13±0.06, *C. zillii* had 13±0.04 while *A. baremose* was observed to have 15±0.08). The condition factors showed robustness and wellbeing. Correlation between length-weight of the species were strong. The organo-somatic indices showed good health.

Key words: Morphormetric, organosomatic indices, landing sites, some fish species Lake Kainji

INTRODUCTION

Fisheries management and research often require the use of biometric information in order to transform data collected into appropriate indices (Ecoutin *et al.*, 2005). These indices help to show the present condition of fish in terms of their health status, well-being, robustness, growth and also the productivity of the environment. Condition factors (K) are widely used in fisheries to determine the well-being of fish species in relation to conduciveness of the aquatic environment for the survival of fish. This factor is calculated from the relationship between the weight and the length of the fish, in order to establish the health condition of that individual fish (Froese, 2006).

Length-weight relationship (LWR) allows the estimation of the average weight of fish of a given length by establishing a mathematical relationship between them (Mir *et al.*, 2012). The LWR can be used as a factor for the differentiation of taxonomic unit and the relationship between changes with various developmental events in life, such as metamorphosis, growth, and onset of maturity (Thomas *et al.*, 2003). The relationship between growth and organ indices in fishes differ when considering habitat, geographical zone and the species. These are influenced by environmental and biotic factors. As fish grow in length, they also, increase in the corresponding body and gonad weights (Paugy *et al.*, 2003). The African tiger fish (Family: *Alestidae*). *Alestidae* is an important fish species in Kainji Lake (Balogun, 1982). The Genus *Hydrocynus*, which are commonly referred to as tiger fish and are particularly prized as game fish. These fish species are found in many rivers and lakes on the continent and are boisterous predator. Froese and Pauly (2017) described the African tiger fish as a fish that can grow up to 10 kg and above. Tilapia, commonly known as cichlids with nearly 100 species of freshwater and some brackish water origin are hardy species found under a wide range of environmental conditions

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(Getahun, 2003). Tilapia has tremendous economic potential and plays a significant role in environmental biodiversity in a number of countries around the world (Fortes 2005; Jegede, 2016). The importance of studying length-weight relationship, condition factor and organ indices in fish biology and management cannot be over-emphasized. The objectives of the study were to determine the morphometric characters, length-weight relationship, organo-somatic indices and condition factor of selected fish species from a Yuna landing site of Kainji Lake.

MATERIALS AND METHODS

Study area

Yuna landing site (Table 1) lies at latitude 9° 55' 41.19" N and longitude 4° 33' .00" E near Yuna community along the bank of Kainji Lake, New-Bussa. The lake is located in the Guinea savannah region of North Central Nigeria between Latitude 9° 30' and 10° 35' N and Longitude 4° 20' and 4° 40' E. The lake came into being after the damming of the River Niger in August, 1968 (Abiodun, 2002). The lake has a surface area of 1270 km^2, with a maximum depth of 60 m while its mean depth is 11metres, which extends for 136.8 km upstream beyond Yelwa and a maximum width of 24.4 km. Ayeni and Mdaihli, (1998). Although, the primary purpose of its constructing was for the generation of hydroelectric power, the Lake offered great opportunities for a variety of developmental projects, such as fishing, irrigation for agriculture and improved navigation (Balogun and Ibeun, 1995).

Sample collection, transportation and measurement

Thirty (30) samples each of the species C. *zilli*, *A. baremo* and *H. forskalii* with average weight (1000 - 1,500 g and average length 35.30 cm - 45.20 cm) were collected randomly monthly for the period of six (6) months from fishermen at the Yuna landing site. The fish samples were washed and rinsed prior to identification using Pitcher *et al.* (1998) keys for identification. Fish samples collected were stored in an ice - chest box to prevent deterioration and then transported to the hydrobiology laboratory of the National Institute of Freshwater Fisheries Research New Bussau, Niger State for various analyses.

Morphometric measurement

Eleven (11) morphometric characteristics (Table 1) were measured during the study.

Table 1: Morphometric characteristics of experimental samples

Parameters	Code	Description
Total Length	TL	Mouth tip to the tip of the caudal fin
Standard Length	SL	Mouth tip to the caudal peduncle
Head Length	HL	Mouth tip to the posterior edge of
Eye Diameter	ED	Length (along axis) of the orbit
Pre-Dorsal Length	pDL	Mouth tip to the dorsal fin origin
Body Depth	BD	Distance between points at deepest part of the body (measured vertically)
Pre- Pectoral Length	pPL	Horizontal distance from tip of snout to the articulation of first pectoral fin ray
Pre- Anal Length	pAL	Horizontal distance from tip of snout to the articulation of first anal-fin ray
Pre-Pelvic Length	pPL	Horizontal distance from tip of snout to the articulation of first pelvic-fin ray
Pre-Orbital Length	pOL	Mouth tip to the beginning of the orbit
Body Girth	BG	The minimum vertical depth, excluding fins

Length-weight relationship

The total length (TL); starting from the tip of the snout to the posterior end of caudal fin) and Standard Length (SL); starting from the tip of the snout to the beginning of the caudal fin of the fish were recorded using a wooden measuring board to the nearest 0.1 cm. The weights were recorded after blot drying with a clean hand towel using top loading electronic balance (Model: citizen product, Model MP-600) to the nearest 0.1 grams. Logarithms of the length and weight values were computed. The 'b' (exponent) of the length-weight relationship (LWR) was determined using the following formula according to

Pauly (1984) as: $W = aL^b$, Which, is log transformed as Log W = a + b Log L, Where: W = Weight of fish (g), L = Length of fish (cm), b = exponent, a = intercept.

Organo-somatic indices

The organo-somatic indices of the liver and gonad were estimated for each of the thirty (30) fish species, according to the method described by Dogan and Can (2011) in order to get the organ to body weight ratios of the fish samples as follows: Weight of the organ / weight of the fish x 100, Hepatosomatic index (HIS) = liver weight/fish weight x 100, gonadosomatic index (GSI) = gonad weight / fish weight x 100.

Condition factor (K)

Condition factor (K) of fish samples were estimated according to Pauly (1984) formula: $K = 100W/L^3$, Where: K = condition factor, W = body weight (g), L = length (cm).

Data analysis

Descriptive statistics such as percentages were used to analyse the morphometric characters, while Spearman's correlation was used to determine the relationship amongst various organs of the samples.

RESULTS

The correlation of morphometric parameters of *H. forskalii, C. zillii* and *A. baremose* are shown in tables 2, 3 and 4, respectively. Pre-Anal Length increased with an increase in SL. Pre- Anal Length and SL exhibited the highest positive correlation of (1.00). The eye diameter and body weight on the other hand showed the lowest correlation (r = 0.10).

Table 3 showed that the weight, standard length, pre-dorsal length, pre-anal length, body girth and head length exhibited a positive correlation with respect to other parameters measured in *C. zillii*. Correlation between standard length and total length was highest (r = 0.93), while the relationship between Pre-orbital Length and Pre-pelvic Length was the lowest (r=0.19.

All morphometric parameters measured for *A. baremose* showed positive correlation as shown in table 4. The highest was in the correlation between standard length and total length (r=0.99), while eye diameter and pre-orbital length showed the lowest correlation (r=0.68)

Table 2: Correlation matrix of morphometric parameters of *H. forskalii* from Yuna landing site, Kainji Lake

Parameter	Wt	TL	SL	pDL	pPL	pPVL	pAL	pOL	BG	BD	HL	ED
Wt	1											
TL	0.90*	1										
SL	0.91*	0.99*	1									
pDL	0.89*	0.88*	0.91*	1								
Ppl	0.89*	0.89*	0.93*	0.86*	1							
pPVL	0.73*	0.89*	0.88*	0.79*	0.76*	1						
pAL	0.91*	0.99*	1.00*	0.92*	0.93*	0.88*	1					
pOL	0.79*	0.69	0.75*	0.74*	0.87*	0.65*	0.74*	1				
BG	0.93*	0.88*	0.91*	0.93*	0.90*	0.82*	0.91*	0.86*	1			
BD	0.94*	0.88*	0.91*	0.96*	0.88*	0.79*	0.91*	0.81*	0.97*	1		
HL	0.89*	0.89*	0.92*	0.86*	0.96*	0.81*	0.91*	0.91*	0.94*	0.89*	1	
ED	0.10	0.32	0.35	0.35	0.37	0.56*	0.36	0.42	0.39	0.30	0.40	1

* = Values are significantly correlated at 0.05 level **Key: Wt** = Body weight, **TL** = Total length, **SL** = Standard length, **pDL** = Pre-dorsal length, **pPL** = Pre-pectoral length, **pPVL** = pre-pelvic length, **pAL** = Pre-anal length, **pOL** = Pre orbital length, **BG** = Body girth, **BD** = Body depth, **HL** = Head length, **ED** = eye diameter

Table 3: Correlation matrix of morphometric character of *C. zillii* from Yuna landing site, Kainji Lake

Parameter	Wt	TL	SL	pDL	Ppl	pPVL	pAL	pOL	BG	BD	HL	ED
Wt	1											
TL	0.86*	1										
SL	0.88*	0.93*	1									
pDL	0.59*	0.54*	0.57*	1								
pPL	0.67*	0.83*	0.80*	0.42	1							
pPVL	0.65*	0.72*	0.71*	0.51*	0.73*	1						
pAL	0.83*	0.85*	0.90*	0.57*	0.80*	0.63*	1					
pOL	0.56*	0.39	0.44	0.41	0.22	0.19	0.43	1				
BG	0.81*	0.71*	0.76*	0.55*	0.53*	0.50*	0.78*	0.28	1			
BD	0.78*	0.69*	0.71*	0.49	0.46	0.41	0.70*	0.33	0.92*	1		
HL	0.72*	0.81*	0.78*	0.66*	0.76*	0.65*	0.85*	0.32	0.71*	0.64*	1	
ED	0.67*	0.48	0.59*	0.61*	0.39	0.34	0.63*	0.44	0.57*	0.54*	0.47	1

* = Values are significantly correlated at 0.05 level. **Key**: Wt = Body weight, TL = Total length, SL = Standard length, pDL = Pre-dorsal length, pPL = Pre-pectoral length, pPVL = pre-pelvic length, pAL = Pre anal length, pOL = Pre orbital length, BG = Body girth, BD = Body depth, HL = Head length, ED = eye diameter

Table 4: Correlation matrix of morphometric characters of *A. baremose* from Yuna landing site, Kainji Lake

Parameter	Wt	TL	SL	pDL	pPL	pPVL	pAL	pOL	BG	BD	HL	ED
Wt	1											
TL	0.95*	1										
SL	0.92*	0.99*	1									
pDL	0.93*	0.98*	0.97*	1								
pPL	0.94*	0.92*	0.91*	0.88*	1							
pPVL	0.97*	0.97*	0.95*	0.94*	0.96*	1						
pAL	0.97*	0.97*	0.94*	0.94*	0.94*	0.98*	1					
pOL	0.77*	0.82*	0.79*	0.77*	0.74*	0.78*	0.80*	1				
BG	0.95*	0.96*	0.94*	0.94*	0.94*	0.95*	0.95*	0.81*	1			
BD	0.98*	0.95*	0.92*	0.93*	0.93*	0.95*	0.95*	0.76*	0.97*	1		
HL	0.94*	0.95*	0.94*	0.91*	0.95*	0.97*	0.95*	0.79*	0.92*	0.92*	1	
ED	0.94*	0.89*	0.87*	0.90*	0.88*	0.93*	0.91*	0.68*	0.91*	0.92*	0.87*	1

* = Values are significantly correlated at 0.05 level. **Key**: Wt = Body weight, TL = Total length, SL = Standard length, pDL = Pre-dorsal length, pPL = Pre-pectoral length, pPVL = pre-pelvic length, pAL = Pre-anal length, pOL = Pre orbital length, BG = Body girth, BD = Body depth, HL = Head length, ED = eye diameter

Length-weight relationship

The Length-weight relationship/growth pattern of the three fishes during the period of study are represented in Figures 1, 2 and 3. Figures 1 and 2 indicated *H. forskalii* and *C. zillii* had negative allometric growth with b-values: 2.84 and 2.99 respectively. Figure 3 on the other hand showed *A. baremose* with positive allometric with a b-value of 3.54. The coefficient of determination for the samples as shown in the figures 1,2 and 3 as $r^2 = 0.91$, $r^2 = 0.85$ and $r^2 = 0.97$ respectively. The results indicate a high coefficient of determination of the three species. This implies that the percentage of variation of the response variable explained by the linear model was 91, 85 and 97 % respectively. The high coefficient of determination of the samples also indicates the closeness of the data to the fitted regression line which is a pointer to the highest degree of the possibility of predicting the weight of the species from a known length.

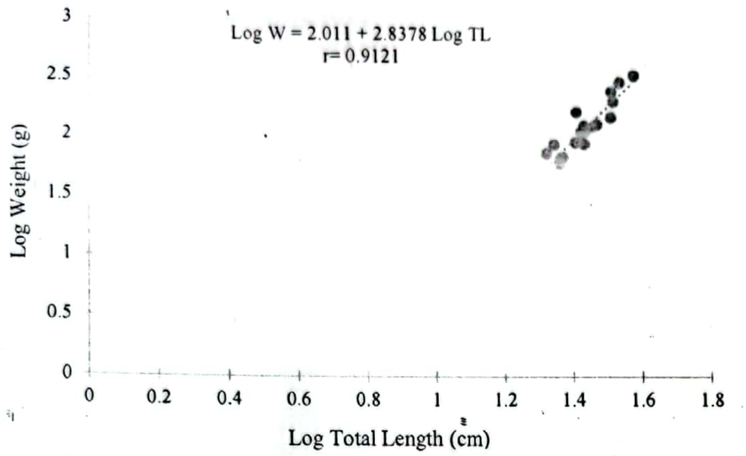

Fig. 1: Log length- log weight relationship of *Hydrocynus Forskalii* Yuna landing site of Kainji Lake

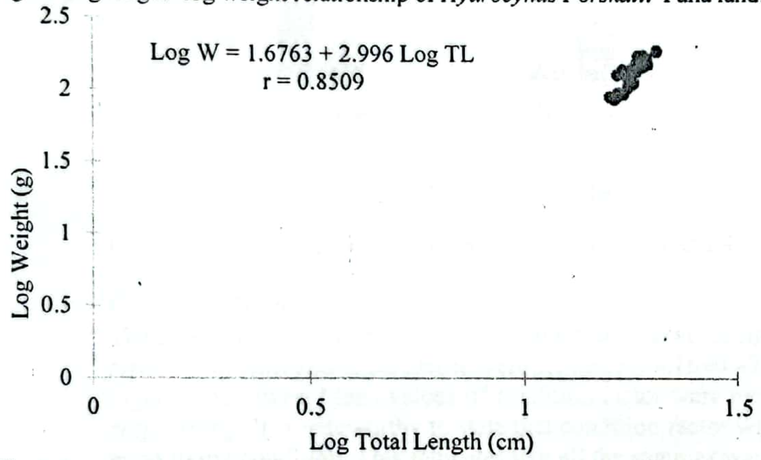

Fig.2: Log length- log weight relationship of *Coptodon zilli* from Yuna landing site of Kainji Lake

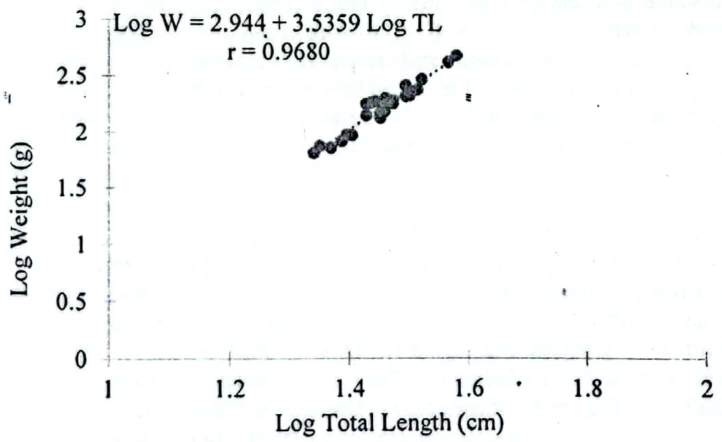

Fig.3: Log length- log weight relationship of *Alestes baremose* Yuna Landing site of Kainji Lake

Organo-somatic indices

Figure 5 showed Organosomatic indices of *H. forskalii, C. zillii* and *A. baremose*, from Yuna landing site. The gonadosomatic index was 5.92±8.11 in *H. forskalii*, while hepatosomatic index was highest (1.24±0.69) and kidney index was low (0.11±0.09) in *C. zillii*, while hepatosomatic index was higher (2.00±1.33).

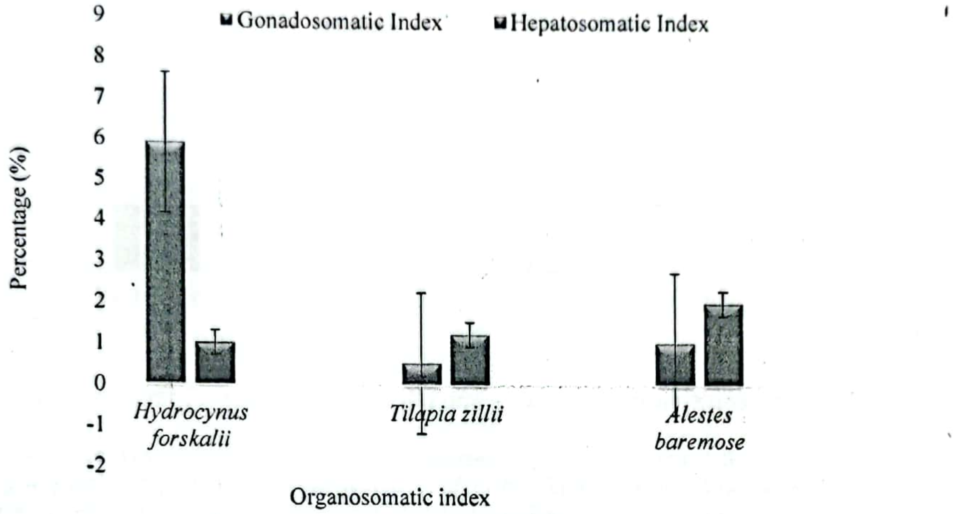

Fig 5: Organosomatic indices of *H. forskalii*, *C. zillii* and *A. baremose*, from Yuna landing site

Condition factor (K)

The mean condition factors of the 3 species are shown in fig. 4. The condition factors of *H. forskalii*, *C. zillii* and *A. baremose* were 1.04±0.31, 4.16±0.47 and 1.41±0.27, respectively. The highest and lowest Mean values of condition factor were recorded in *C. zillii* and *H. forskalii respectively*. It is noteworthy to state that condition factor with the value 1 and above indicate good living condition. This indicates that all the samples were in good living conditions.

Hydrocynus forskalii and *C. zillii* showed negative allometric ($b<3$) growth pattern as against the positive allometric growth (b>3) of *C. zillii* and *Alestes baremose*. A negative allometric growth is /where increase in length is faster than increase in weight. A similar finding was reported by Ogbe *et al.* (2012) with a reported negative allometric growth of *H. forskalii* in Benue and Cross Rivers. On the contrary, Entsua-mensah *et al.* (1995) reported isometric growth in species from Volta River. Variation in growth pattern may be due to location, food availability, water condition and other biotic and abiotic factors.

The negative allometric growth of *C. zillii* (b < 3) is contrary to Ogidiaka and Esenowo (2015), in their reported positive allometric growth for the species as well as Britton *et al.* (2007) in their reported isometric growth patterns of the species. sometric growth (b = 3) in *C. zillii* has been reported in a number of works such as (Sekharan, 1998; Britton *et al.*, 2006). Isometric growth *in C. zillii* is considered ideal because the length and weight grow at the same proportion with respect to its ideal fusiform shape. Sinha (1973) reported factors such as changes in physiological condition during spawning periods, gonad development and physical-chemical conditions of the environment as having a profound influence on a growth pattern.

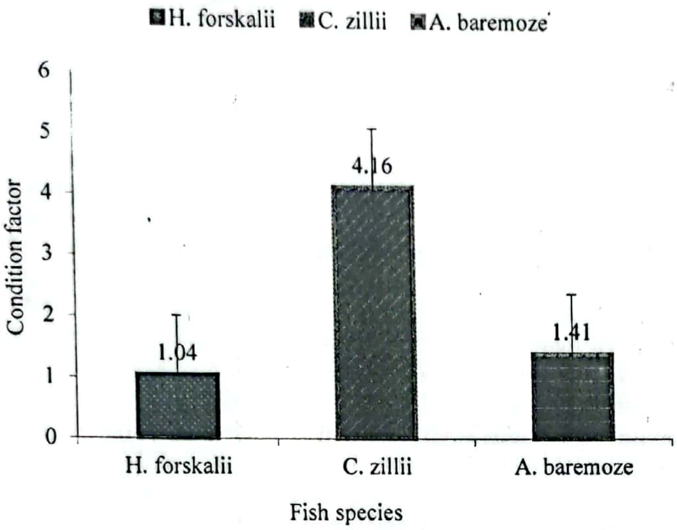

Fig 4: Mean condition factor for *H. forskalii, C: zillii and A. baremose* from Yuna landing site

Growth in *A. baremose* was positive allometric (b>3): increase in weight is greater than the length. Similar finding was earlier reported by Entsua-mensah *et al.* (1995) in *A. baremose* from Volta River. The coefficients of determination (r) showed $r^2 > 0.82$ indicating that over 82 % of the total variation in y (weight) is explained by the model (x and y relationship). High percentage of closeness to the fitted regression line was equally reported by Abobi and Ekau (2013) for *H. forskalii* (r = 0.99), Dan-kishiya (2013) for *C. zillii* (r = 0.844) and Ahmed (2013) for *A. baremose* (r = 0.99). It goes to show that the fish growth can be easily predicted.

The mean condition factor (K) for *H. forskalii* in this study: 1.04±0.31 were similarly reported by Ezenwaji *et al.* (2009), they obtained K=1.14±0.29 in tropical fishes such as *Brycinus nurse*, *H. forskalii*, *Labeo coubie* and *Micralestes acutidens* in Anambra Rivers. The mean condition factor for *C. zillii* (4.16±0.47), aligns with findings in Ilorin Reservoir as reported by Chioma and Achionye (2010).

While the mean condition factor (K) of *A. baremose* was 1.41±0.27 agrees with the findings of Ibrahim *et al.* (2012) in Kontagora Reservoir (K-value 1.98) and Ebonyi River (K-value 2.1). K > 1, is an indication that the species were doing well in their environments. Although values less than 2.9 and up to 4.8 reported by Bargenal and Tesch (1978) were for mature freshwater fishes. Variation in condition factor could be attributed to variation in weight of individual fish sampled with the exception of *C. zillii* with the highest K-value. In addition, condition factor is strongly influenced by both biotic and abiotic environmental conditions.

Gonadosomatic index (GSI) was highest in *H. forskalii* (5.92±8.11), probably because the samples were in their pre-spawning season, and lowest in *C. zillii* (0.54±0.80). Anene and Keke (2005) reported GSI value (1.57) for *C. zillii* while Oso *et al.* (2013) reported GSI range 0.12 - 2.38 and 0.19 - 2.80 for males and females respectively for *C. zillii* which are higher than the values in this study. Kasozi *et al.* (2013) also reported higher GSI (5.30) for *A. baremose*. These variations observed could be due to the various developmental stages of the fish ranging from sexual maturity, spawning, size and age.

The mean HSI of *H. forskalii, C. zillii* and *A. baremose* from the Yuna landing site were higher than the HSI values reported by Nunes *et al.* (2011) with mean values of 1.21±1.63 and 1.21±1.56 for *Sardina* *pilchardus*. Hepatosomatic index may vary with sex, health condition, pollution, reproduction as well as increasing body weight and length of the fish.

Conclusion and recommendation

The study concluded that the three species from a Yuna Landing site showed good and robust living condition. The species; *H. forskalii*, *C. zillii* and *A. baremose* showed allometric growth pattern and good state of health. The study also showed a larger extent, sound ecology of the river environment with respect to productivity and pollution level. Further studies on other aspects of the biology of these species such as fecundity, food and feeding habit should be carried out in order to provide a holistic assessment and understanding of the species and the aquatic environment which are crucial for the proper use and management of the fishery of the site and the Lake in general.

REFERENCES

Abiodun, J. A. (2002). Evaluation of Fisheries Catch trend on Lake Kainji in Nigeria from 1995-2001. *Journal of Applied Sciences and Environmental Management*, 7(2):9-13.

Abobi, S. M. and Ekau, W. (2013). Length-weight relationships and Condition Factors of *Alestes Baremoze*, *Brycinus nurse* and *Schilbe intermedius* from the Lower Reaches of White Volta River (Yapei), Ghana. *International Journal of Fisheries and Aquaculture*. 5(6):152-165.

Anene, A. and Keke, R. I, (2005). Some aspects of the reproductive biology of *C. zillii* from a small lake in Imo State, Nigeria. *Animal Production Research Advances*. 1(2):70-75.

Avisar, J. C. (1994). *Molecular Markers, Natural History and Evolution*. Chapman and Hall, New York. 36Pp.

Ayeni, J. S. O. and Mdaihli, M. (1998). *Kainji Lake. Nigerian German Kainji Fisheries Promotion Project*. Goshen Print Media Ltd., Ilorin Nigeria. 14Pp.

Bargenal T.B, Tesch A.T. (1978). Conditions and growth patterns in fresh water habitats. Blackwell Scientific Publications, Oxford, 75 -89Pp.

Balogun, J. K. (1982). Preliminary studies of some aspects of the biology of the fish Family Characidae in Lake Kainji, Nigeria..In: *Kainji Lake Research Institute Annual Report*. 35-37.

Balogun, J. K. and Ibeun, M.O. (1995): Additional information on fish stocks and fisheries of Lake Kainji (Nigeria). In: Current status of fisheries and fish stocks of four largest African reservoirs (Eds R.C.M. Crul and F.C. Roest). *CIFA Tech. Pap.* No. 30. FAO, Rome 1-18.

Britton J. (2007). Reference data for evaluating the growth of common riverine fishes in the UK. *J. Appl Ichthyology*, 23:555–560.

Chioma, G. and Achionye, N. (2010). Fecundity, sex ratio, length-weight relationship of the Characidae (tiger fish) and Cyprinidae (African carp) from a Reservoir in Ilorin, Nigeria. *Asian Journal of Experimental Biology*. 1(4):898-901.

Dogan, D. and Can, C. (2011). Endocrine disruption and altered biochemical indices in male *Oncorhynchus mykiss* in response to dimethoate. *Pesticide Biochemistry and Physiology*, 99(2):157-161.

Ecoutin. J. M., Albert, J. J. and Trape, S. (2005). Length- weight relationship for fish populations of a relatively undisturbed tropical estuary, *Gambia. Cybium*, 72(2-3):347-351.

Enstua-Mensah M, Osei-Abunyew A, Palomares MLD. (1995). Length-weight relationships of fishes from the tributaries of the Volta river, Ghana: Part I. Analysis of pooled data sets. *Naga, ICLARM Q*. 18:36–38.

Ezenwaji, N. E. and Ezenwajil, H. M. G. (2009). Length-weight relationships and condition factor of *citharinus citharus* and *Alestes baremose* from Anambra River Basin, Nigeria. *Animal Research International* 6 (3):1107 – 1109.

Fortes R. D. (2015). Review of the techniques and practices in controlling Tilapia populations and identification of methods that may have practical applications in Nauru including a National, 2005. *International Journal of Fisheries and Aquatic Studies.* 4(4): 315-318.

Froese, R. and D. Pauly. Editors. (2017). FishBase. World Wide Web electronic publication. www.fishbase.org, (06/2017).

Froese, R. (2006). Cube law, condition factor and weight-length relationships: history, meta-analysis and recommendations. *Journal of Applied Ichthyology*, 22:241-253.

Getahun, A. (2003). Breeding season, length-weight relationship and condition of introduced fish, *C. zillii* Gerv. 1 848 (Pisces: Cichlidae) Lake Zwai, Ethiopia. *Ethiopian Journal of Science*, 26(2):115-122.

Ibrahim, B. U., Auta, J. Balogun, J. K., Bolorunduro, P. I. and Dan-kishiya, A. S. (2012). Length-weight relationship and condition factor of *Barilius niloticus* (Family: Cyprinidae) in Kontagora Reservoir, Niger State, Nigeria. *Biological and Environmental Sciences Journal for the Tropics*, 9(2):155-158.

Kasozi N., Degul, G. I., Atibunil, K., Kaseko, M., Owori-Wadunde, A. and Mugerwa, S. (2013). Classification of ovarian stages of *Alestes baremose* (Joannis, 1835): A step towards understanding its reproductive biology. *Frontiers in science*. 3(4): 107-113.

Mir, J. I. (2012). Length-weight relationship and condition factor of rosy barb, *Puntius conchonius* (Hamilton, 1822) from river Jhelum in Kashmir Valley. *Indian Advanced Biological Research*, 6:186-190.

Mohamed, H. A. and Al-Awadi, A. S. (2015): Taxonomic Revision of the Tiger Fish *Hydrocynus* Vittatus (Castelnau, 1861), *H. Brevis* (Cuvier & Valencience, 1849) and Forskalii, H. (Cuvier, 1819) from the Nile in Sudan, *International Journal of Aquaculture*, 5 (5):1-9.

Nunes, C., Silva, A. and Soares, E. (2011). The Use of Hepatic and Somatic Indices and Histological Information to Characterize the Reproductive Dynamics of Atlantic Sardine *Sardina pilchardus* from the Portuguese Coast. *Marine and Coastal Fisheries: Dynamics, Management, and Ecosystem Science*, 3:127–144.

Ikongbeh O. A, Ogbe F. G. and and Solomon S. G. (2012). Length-weight relationship and condition factor of Bagrus docmac from Lake Akata, Benue state, Nigeria. *Journal of Animal &Plant Sciences*, 15 (3):2267-2274.

Ogidiaka E., Esenowo I. K. (2015). Length weight relationship and condition factor of *C. zillii* (Perciformes: Cichlidae) in Warri River, Southern Nigeria. *International Journal of Fisheries and Aquatic Studies*. 2 (4):359-361.

Omoniyi, I. T. (1986). Comparative racial studies of some Cichlid fishes from three man-made lakes around Ibadan. M.Sc. dissertation. University of Ibadan. Department of Fisheries and Aquaculture. 60Pp.

Oso, J. A., Ogunleye O. A., Idowu, E.O. and Majolagbe, F. A. (2013). Gonado-somatic index, Sex ratio and fecundity of *C. zillii* in tropical reservoir, South west Nigeria. *Journal of Biology*, 1(2):42-45.

Paugy, D. C. Lévêque and Teugels, G.G. (2003). The fresh and brackish water fishes of West Africa, Volume 1. *Coll. faune et flore tropicales 40. Institute de recherche de dévelopment, Paris, France, Muséum national d'histoire naturelle,* Paris, France and *Musée royal de l'Afrique* Central, Tervuren, Belgium, 457Pp.

Pauly, D. (1984). *Fish population tropical water*: A manual for use with programmable calculators. ICLARM. Manila, Philippines, 32Pp.

Pitcher, T.J., P.J.B. Hart and D. Pauly, (1998). *Reinventing Fisheries Management*. Fish and Fisheries Series 23, Kluwer. Academic Publishers, Dordrecht, 435Pp.

Sinha, A.L. (1973). Length-weight relationship of a freshwater catfish, *Clarias batrachus* (Linn.). *Ind. J. Zool.* 14(2):97-102.

Jegede, T. (2016). Histological assessment of organs of *C. zillii* (Gervais, 1852) Fingerlings subjected to malachite green (Triarylmethane dye) toxicity. *International Journal of Fisheries and Aquatic Studies*. 4 (4):315-318.

Thomas, J., Venu, S. and Kurup, B. M. (2003). Length - weight relationship of some deep-sea fish inhabiting the continental slope beyond 250m depth along the West Coast of India. NAGA, the *World Fish Centre Quarterly*, 26(2):17-21.

Turan, C. (1999). Notes on the examination of the morphometric differentiation among fish populations: The Truss System. *Turkish Journal of Zoology*, 6:259-263.