



Research Article

Morphometric and Gonadosomatic Index Studies of Some Fish species Collected from Lake Alau Maiduguri Borno state Nigeria

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ABSTRACT

Morphometric studies of fish are used to determine the growth and reproductive performance. This study was designed to carry out morphometric studies of gonadosomatic index of some fish species collected from Lake Alau Maiduguri Borno state, some fish species commonly found in Lake Alau are *Clarias gariepinus*, *Gymnarchus niloticus*, *Oreochromis niloticus* and *Synodontis niloticus*. The fishes were collected using hexagonal basket trap. The trapped fishes were transported in a cool chain to the laboratory in the Department of Biological Sciences University of Maiduguri, for identification of sex, specie and onward dissection of the abdomen for Morphometric studies of gonadosomatic index (GSI) and hepatosomatic index (HSI). The results revealed relationship between GSI and total length (TL), total weight (TW) and gonad weight (GW). The mean (GSI) and (HSI) were varied significant ($P < 0.05$) with size and gonad maturation stage, it also exhibited significant difference ($P < 0.05$) in correlation with fish TL and TW. It also correlated significantly ($P < 0.05$) with GW, TL and TW. In conclusion this study provided baseline information on some aspects of growth and reproduction performance which is important in the management of some fishes obtained such as *Clarias gariepinus*, *Gymnarchus niloticus*, *Oreochromis niloticus* and *Synodontis niloticus*, *Heterotis niloticus* and *Elastic Sp* this study will guide in selection and management of fish to achieved optimum reproduction.

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INTRODUCTION

Fishery science has engaged many tools such as genetics and morphometric to distinguish fish population and determine their reproductive potential (Tasaduq *et al.*, 2022). Morphometrics can be defined as a set of statistical procedures for analysis of variables like size, length, depth, shape of organs and their weight, such parameters are used to predict growth, health status and reproduction performance of the fish. Morphometric measurements are also used to identify anatomical differences that exist between fish species (Das, *et al.*, 2023)

Fish is often the most affordable source of animal protein to humans in the tropics and sub-tropics countries (Hossain *et al.*, 2010). Therefore, fish is the most affordable source of animal protein commonly found in the diets of the low earns persons who also constitute the largest population in the communities (Allison, 2001). The importance of fish as source of animal protein and livelihood for fishermen cannot be over accentuated in most of the developing countries and Nigeria is not exempted. Fish culture is one of the efficient means of supplying animal protein to human diet (Salas-Singh *et al.*, 2022), it also generates employment among communities in Nigeria and most of the African countries (Anene, 2005). However, the global corridor of wild-caught fish are thought to be adjacent or exceeding their estimated sustainable level to meet the demands (Das, *et al.*, 2023). One of the proposed solutions to this crisis of wild-fish which contributes eighty percent of total fish production in the tropics as reported by Arellano-Martinez and Ceballos-Vazquez, (2001) has been resort to fish farming, and adequate fish production chain to be sustained through effective monitoring of the wild-fish which is necessary to ensure prevention of infection and non-infection diseases Abdan, (2023). However, high quality fish that are free from parasitic infection and microbial infection

is required to sustain the expanding aquaculture production system to meet the demand of the society. The use of wild-caught fish as fishmeal in the tropics is not negotiable irrespective of either is wholesome for the populace as reported by Ferosekhan *et al.* (2022).

For fish production to be successful there is need to make efforts to evaluate their body weight, presence of microbial and parasitic infections. These efforts will serve as indicator for wholesome fish for consumption (Esa *et al.*, 2023). However, according to Food and Agricultural Organization FAO, (FOA, 2002), *O. niloticus* is one of the most suitable fish for culture in most parts of the world due to its rapid growth rate, tolerance to harsh environmental conditions, efficient feed conversion, ease of spawning, resistance to diseases and good acceptability by the customers are key as reported by Wikondi *et al.* (2022). Fecundity assessments have been useful in racial distinction, progeny survival studies, stock evaluation and aquaculture-based induced spawning and egg incubation (Esa *et al.*, 2023). Colour, shape and size of eggs are also important parameters used in reproduction studies to characterize fish species and can also be used to predict the spawning frequency of fish as reported by Shah *et al.* (2023). Gonadosomatic index (GSI) is one of the parameters used in reproduction studies of fish. The use of GSI to detect hydrated ovaries and reproductive period which resulted to increase in total weight has been established and reported by Shah *et al.* (2023). This study was designed to determine the morphometric studies of gonadosomatic index of some fish species collected from Alau Lake, Maiduguri Borno State, Nigeria, with a view of providing scientific information that can determine reproduction potentials.

MATERIALS AND METHODS

Study Area

The fish samples were collected from Alau Lake, in Maiduguri located in the North-Eastern Nigeria. Alau is located on latitude 11° 51' N and longitude 13° 05' E at the South Eastern part of Maiduguri, Borno State, Nigeria. It is situated in Konduga local government area which is 18 kilometers away from Maiduguri (Idowu *et al.*, 2004). This study was conducted in the Department of Biological Science, Faculty of Sciences University of Maiduguri, Nigeria. Borno State Situated in North Eastern part of Nigeria. It is Cosmopolitan in nature, located at an elevation of 354 meters above sea level located between latitudes 11° and 14°N and longitudes 10° and 14°E, within the conventional Sahel zone and has a total land mass of 50,778 square kilometers (BMLS, 2007). It has a population density of 1,738 people per square kilometers, and a total population of 521,492 (NPC, 2006). The temperature ranges from 35-40°C for most parts of the year with two distinct seasons, a rainy season with mean annual rainfall of 647mm from July to October and a prolonged dry season for the rest of the year (LCRI, 2007). The state derives great economic activity from its rich livestock and fishery production (NPC, 2006).

The materials used in the research work include the following: Plastic bucket, Wire net, Hand gloves, Towel (mini size), Scalpel blade and handles, Applicators (capillary tube), Glass slides, Cover slip, Petridish, Giemsa stain Reagent, Methanol (absolute), Physiological saline solution, Weighing balance, Ruler, Hypodermic needle and syringes, Sample bottles, Pair of scissors, Masking tape, Coupling jar and Light microscope.

Trap net fishing at Lake Alau

The hexagonal basket traps (malema[®]) used (2×3 m at widest part × 0.5 m height), are woven using local fibers, and have funnel mouth

opening of 6 to 8 cm and mesh openings of 3 to 5 cm on each sides.

Collection of Fish samples

Samples were collected freshly and transported in a cool chain facility to laboratory and examined. Each sample species was identified total length (cm) and total weights (g) were evaluated. The sex of each specimen was identified firstly by visual examination of the genital organs and later confirmed after dissection and examination of the gonads according to the method described by Kihia *et al.* (2015). The gonads were detached from the other visceral organs and weighed using a sensitive weighing balance (Essen[®]). The weighted gonads, which were in pairs, were then separated and the length and width of each gonad was measured using flexible meter. A six-stage maturity scale described by White *et al.* (1998) was used to classify the gonads. Features examined on the gonads were maturity stages, degree of opacity, consistency and vascularization of the gonads, presence of oocytes or sperm visibility and coloration of the gonads were also used.

Measurement of weight and length of fish

A total of forty (40) fishes were sampled weekly within the study period of 4 weeks between 8:00 to 12:00 pm. The species was identified using key parameters provided as described by Campbell *et al.* (1987). A total of 160 fish comprising 70 females and 90 males were studied. Each fish was measured for total length (TL), Standard length (SL) and body depth (BD) in (cm) the measurement is (from the tip of the snout to the end of the caudal fin and to the dorso-ventrally at mid-point respectively). Thereafter, the fish were dissected to harvest the gonads and liver. The gonads and the liver were removed and weighed separately. Gonadosomatic index (GSI) for each fish was calculated using weight of the gonads relative to the body weight expressed as a percentage thus:

$$GSI = \frac{\text{weight of fish gonad}(g)}{\text{body weight of fish}(g)} \times 100 \text{ according}$$

to the method described by de Vlaming *et al.* (1982).

Hepatosomatic index (HSI) was calculated using this formula (weight of the liver divided by the total body weight and expressed as:

$$\text{HSI} = \frac{\text{weight of liver}(g)}{\text{body weight of fish}(g)} \times 100$$

Gomez-Marquez *et al.* (2003).

The ratio of body weight to total length was determined according to the method described by Maddock and Burton (1999). The reproductive indices were correlated with the total length, standard length and body depth.

The standard length of fish was determined using a measuring board, as distance from snout to the tip of caudal fin, while height was taken as distance at widest part of the fish specimen. Excess moisture was removed prior to weight determination, with a sensitive balance. Precision for the size and weight determined were 0.1 cm and 0.01 g respectively. Data obtained was used to calculate condition factor (B) using the modified Foulton's as used by Richter *et al.* (2000) and Wambiji, (2008).

Statistical Analyses

Data obtained were subjected to ANOVA using the general linear model procedure of IBM SPSS Version 25. Correlation analysis was used to check the association among body

measurements, hepatosomatic and gonadosomatic indices.

RESULTS

The results on morphometric studies revealed no significant difference among the various parameters observed from the species of fish collected in Lake Alau as presented in (Table 1). The findings on the morphometric analyses shows no significant difference in correlation ($P>0.05$) between gonadosomatic index and total body weight ($r= 0.053$) and between hepatosomatic index and total body weight ($r= -0.077$) among sampled of fishes collected in lake Alau as presented in (Figure 1). Also no significant correlation ($P>0.05$) was noticed between hepatosomatic index and total length ($r= -0.189$) similarly between hepatosomatic index and body depth ($r=-0.198$) among the fishes collected as shown in (Figure 1). However the correlation between gonadosomatic index, body depth ($r=0.239$), gonadosomatic index and standard length ($r= 0.238$) of the fishes were positively significant as shown in (Figure 1). There was significant difference ($p<0.05$) observed at various stages of collection of the fish within the study period of Gonadosomatic index (GSI), Hepatosomatic index (HSI) and Viscera somatic index (VSI) of some fish species collected in Lake Alau as presented in (Figure 2).

Table 1: Mean percentage of body proportion versus total length and weight of some organs of some fish species collected from Lake Alou in Maiduguri, Nigeria

Parameters	Morphometric/ Dimension										
	Species	TBW (g)	TL (cm)	SL (cm)	FL (cm)	CPL (cm)	VFL (cm)	TSC (g)	GST (g)	INT (g)	LIVER (g)
<i>Clarias gariepinus</i>	600	45	39	40	5	4.5	3	41.	9.6	14.3	16.3
<i>Gymnarchus niloticus</i>	2000	61	56	51	10	1.5	2	54.	11.5	44.9	4.8
<i>Oreochromis niloticus</i>	1000	30	25	29	1	2.5	4	51.	4.5	19.1	3
<i>Synodontis</i>	1300	30	28	25	5	2	8	19.	5	11.6	5.8
<i>Heterotis niloticus</i>	2000	46	44	42	4	1,5	6	47.	6.4	30.8	3
<i>Elastic sp.</i>	1000	5	4	3	2	0.5		18.4	4	10	3

Key: TBW = total body weight, TL = total body length, SL = standard body length, FL = fork length, CPL= caudal pedicle length, VFL= ventral fin length, TSC= truncated sarcomere capping and INT= intestine,

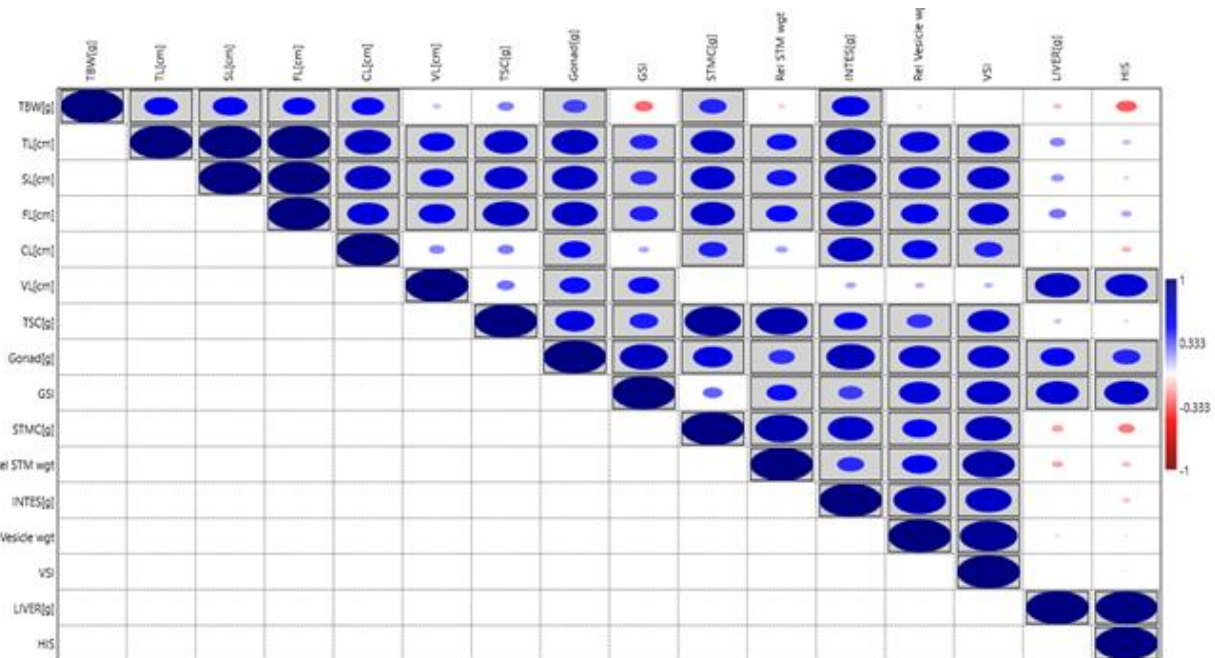


Fig 1: Correlation coefficients (r) and regression equation between Total Lengths (TL) vs. all other morphometric parameters of *Clarias gariepinus* collected from Lake Alou, Maiduguri, Nigeria.

Keys: - TBW = total body weight, TL = total body length, SL = standard body length, CL=Caudal length, FL = fork length, VW= Vesicle weight, Gonadosomatic index (GSI), Hepatosomatic index (HSI) and Viscera somatic index (VSI)

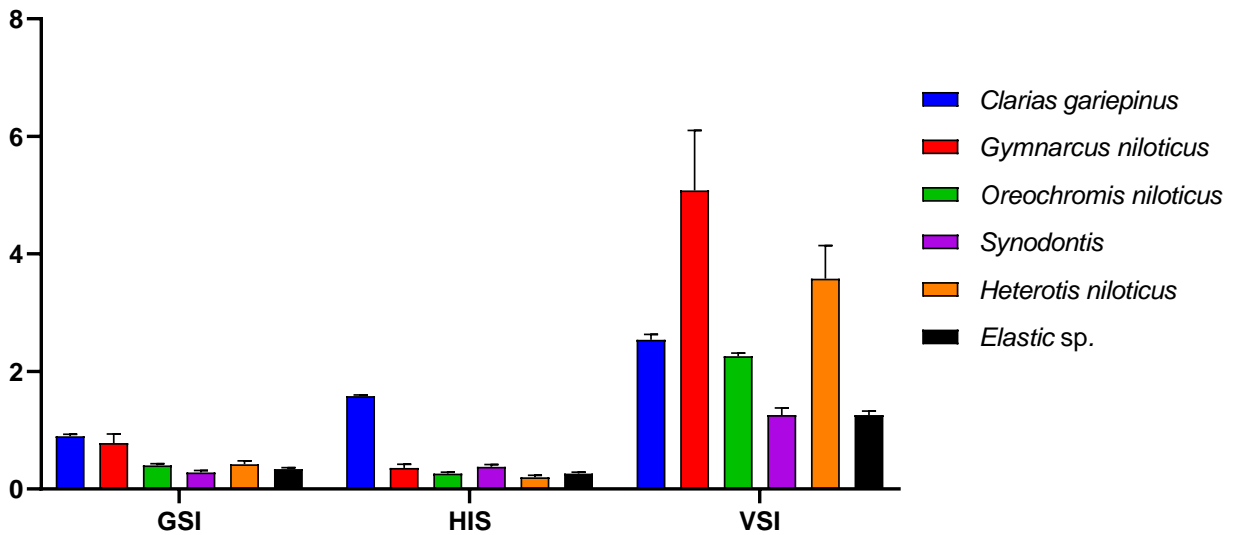


Figure 2: Evaluation of Gonadosomatic index (GSI) Hepatosomatic index (HSI) and Viscera somatic index (VSI) of some fish species collected from Lake Alau in Maiduguri, Nigeria

DISCUSSION

Dimension of fish body is usually used to determine growth and reproductive potential of the fish. It also served as one of the indicators that translate the anatomy and physiology of the fish. However, gonadosomatic index, body depth and standard length were not significant among fishes collected in Lake Alau. Although in fish biology, the length-weight relationship is significant for determination of physiology of the somatic cell growth in isometric or allometric manner as reported by Koutrakis and Tsikliras. (2003), these dimensional relationships are efficient for calculating fish stocks, evaluation of population size and reproductive performance. The present study established a positive correlation between the two parameters of length and weight with an estimated correlation coefficient that shows positive relationship between total body length and body weight of the fishes. This agreed with the assessment of growth coefficient found to be significantly influenced by the activities of the somatic cell that improved the growth pattern

and activities of the gonads as described by Tasaduq *et al.* (2022).

The body depth and standard length is one of the important factors used in determining spawning success in both sexes of fish in the current study. However, there is significant correlation that exists between body depth and gonadosomatic index as well as between standard length and gonadosomatic index in both sexes, this agree with the findings reported by Rheman, (2022). Who stated that total length is an important factor in determination of spawning success in both sexes of fish particularly the *Sarotherodon melanotheron*. The positive significance of the correlation of total length and gonadosomatic index of the fishes in both sexes is an indicator that predicts optimum reproduction performance among the fish species. These concur with the results obtained by Rawat (2014). Who reported the magnitude of length in spawning of tilapia fish and stated that the tilapias usually attain their sexual maturity at a total length of 6 to 16 cm which usually signals the commencement of reproduction. The assertion was based on the significant correlation between gonadosomatic

index and body length of some fish species which also agree with the findings found in the current study which also agreed with the findings reported by Shah *et al.* (2023). The finding in the present study also corroborated with the previous spawning success of *Tilapia* fish reported by Rheman, (2022) this reaffirmed the role of size in terms of the standard length and body depth to achieve optimum reproduction. This also agreed with the findings reported by Diyaware, (2018) how stated that Gonadosomatic index (GSI) of fish is helpful in identifying time and seasons of spawning.

Higher GSI usually indicates that the fish is about to spawn or have not spawned which was also supported by findings reported by Asuquo *et al.* (2011). He also reported that high GIS is an indication of incessant or all-year-round oogenesis among most of the fish species. While decreases in the GSI designate that the fish have previously spawned as the ovaries of gravid females speedily increase in size just prior to spawning.

There was significant correlation between hepatosomatic index and the total length and body depth in female unlike in male (Zeyl *et al.*, 2013). Equally the association between gonadosomatic index visceral somatic index and hepatosomatic index in male was not significant when compared with the female which was significant and this attested to the findings reported by Abullahi *et al.* (2017). The differences observed could be as a result of sex variation in terms of energy allocation for

gonadal formation and function. The male gonads were usually smaller than the female gonads, therefore the male fish requires less stored energy for gonadal development and activities when compared to the anatomy and physiological function of the female gonads. Therefore, the GSI observed in this study is lower than what was reported by Bag *et al.* (2012) and Jegede, (2008) in fish, the variation in the morphometric studies might be attributed to the supplementary fed given to the fish which comprised groundnut leaf meals and *Hibiscus rosasinensis* meals respectively. While in the current study no supplement were provided.

CONCLUSION

The baseline data Established on morphometric parameters of some fishes collected in Lake Alau might assist in prediction of fish growth and reproduction capacity. However is not enough to conclude on the potential surrounding the reproductive physiology and production of the fishes. Therefore, we recommend evaluation of other parameters that has linked to gonads activities that can ascertain the health status of the fish reproductive organs for optimum reproduction.

CONFLICT OF INTEREST

We declared no conflict of interest in respect to this manuscript.

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