MORPHOMETRIC CHARACTERISTICS OF *Hydrocynus forskahlii* (Cuvier 1819) FROM UREJE DAM, ADO EKITI

BY

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DECLARATION

I, OJO OLUWANIFEMI ESTHER hereby declare that this project was written by me and it is a record of my own research work. All borrowed ideas were duly and properly acknowledged.

OJO, OLUWANIFEMI

21st/March/2019

DATE

CERTIFICATION

This is to certify that this work has been carried out in the Department of Fisheries and Aquaculture of the Federal University, Oye-Ekiti, Ekiti Stateby **OJO OLUWANIFEMI ESTHER** with Matriculation number **FAQ/13/0993** under the supervision of Professor, P.A, Araoye and has not been submitted in any form for any degree or diploma at any other institution.

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Professor, P.A, ARAOYE **DATE**

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HEAD OF DEPARTMENT

DEDICATION

This project is dedicated to God Almighty, the maker of heaven and earth, who has seen me through this five years journey and has sustained me and also to my parents for their full support in my life and academics.

ACKNOWLEGMENT

My profound gratitude goes to Almighty God the owner of the universe who made this work a success. I also wish to express my appreciation to my parents Mr. and Mrs.Ojo for their support financially, morally, spiritually and also to my siblings Ojo Oluwatimilehin and Ojo Oluwabusayomi, for their good counsel towards the success of this project.

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ABSTRACT

For the course of this study, a total of 100 specimens of *Hydrocynus forskahlii* were collected at different stages of life from Ureje Dam, Ado Ekiti, Ekiti State, between the period of September and October, all fish samples of *Hydrocynus forskahlii* was carefully examined to avoid damage to any of the morphometric characteristics of the fish. The measurements for the morphometric characteristics of each of the investigated tiger fish specimen was carried out in the Fisheries and Aquaculture Laboratory in Federal University Oye Ekiti, Ekiti State using a measuring board (cm). From the 100 specimens of *Hydrocynus forskahlii* collected, 39 of them are male while 61 pieces of them are female, the variation observed in the number of the samples collected are largely due to availability at the time of collection. All specimens were examined for estimating the morphological characteristics of *Hydrocynus forskahlii* collected from Ureje dam, of the area of Ado Ekiti, Ekiti State. The morphological characteristic measured and analysed includes Body Weight (Bwt), Standard length (STL), Total length (TL), Mouth Gap (MG), Forked Length Distance (FLD), Pelvic Fin Length (PLFL), Adipose Fin Length (ADFL), Dorsal Fin Length (DFL), Anal Fin Length (AFL), Pectoral Fin Length (PCFL), Body Depth (BD), Head Length (HL) of the fish samples while the fish condition factor was further taken and the length-weight relationship of both sex was measured. The dominant morphological characteristics of the species were significantly different at $P<0.05$. Likewise, all morphometric characteristics of the male fish showed strong positive correlation to each other while negative correlation was recorded in some of the morphometric characteristics of the female fish. This study therefore gives information to fisheries biologists and taxonomists about the morphometric characteristics of *Hydrocynus forskahlii* from Ureje dam, Ado Ekiti, Ekiti State.

TABLE OF CONTENTS

CHAPTER FOUR

CHAPTER FIVE

LIST OF TABLES

LIST OF FIGURES

CHAPTER ONE

1.0 INTRODUCTION

1.1INTRODUCTION

Hydrocynus forskahlii (Tiger fish) are important food and income source for locals. Not only do they provide a natural source of protein, the presence of the fish also promotes tourism through recreational and sport fishing. The fish is a species of predatory characin from the family Alestidae which is found in northern and western Africa. *Hydrocynus forskahlii* is preserved by salting, especially in Upper Egyptian Nile, but most are now imported as salted fish from Sudan. *H. forskahlii* are rare in the aquarium trade but this species is the most commonly traded and kept species.The fish is a commercially important species as it suffers from heavy fishing pressure. In addition, it is threatened by dams, water pollution, groundwater extraction and drought.

Hydrocynus forskahlii forms shoals, it is an open water predator often found near the water surface, it feeds on fishes, preferring long bodied fish as they are easier to swallow and also takes insects, grass and snails. Cannibalistic and preyed upon by fish eagle *Haliaeetus vocifer*. Its breeding migrations have been reported up several tributaries of Lake Kariba during the rains.*Hydrocynus forskahlii*is generally found in Africa: Cross, Wouri and Sanaga basin in Lower Guinea ichthyofaunal province. Also in Chad, Niger, Ogun, Ekiti, Ouémé, Mono, Volta, Comoé, Bandama, Sassandra, Nipoué, St. Paul, Mano, Little Scarcies, Gambia and Senegal basins in West Africa; Nile River, including Lake Albert; Lake Turkana, Omo River and Congo River basin.

Morphometric characters are widely used to identify fish stocks (Turan *et al.*, 2004) and they remain the simplest, most direct method of species identification. From previous studies, (Creech, 1992; Mamuris *et al.*, 1998; Bronte *et al.*, 1999; Hockaday *et al.*, 2000), it is understood that the analysis of phenotypic variations in morphometric characters is the most commonly used method to describe fish stocks. It has often been used in discrimination and classification studies by statistical techniques (Agnew, 1988; Avsar, 1994).

Morphometric characteristics are important in providing accurate information about the identity of the fish species as do the genetic studies, so it cannot be ignored as valuable for species recognition (Wägele,2005; Harrison et al., 2007; Ibañez et al., 2007; González-Castro et al., 2008). The morphometric procedures are known to be quicker, more practical, and less expensive than molecular studies, thus allowing many individuals to be screened in the field (Ibañez et al., 2007). Morphometric characters are genetically (Narrow range), intermediate (Moderate range) and environmentally (Vast range) controlled (Johal et al., 1994). Among several taxonomic methods for identifying fish, morphometric techniques are more suited to be used in the field. There are several morphometric characters that reflect eco phenotypic variation and are commonly used in biometric and population identification studies, including body length and width, and length of other body parts (Waldman, 2005). Moreover, morphometric techniques are preferred over their molecular counterparts when it comes to cost, making it even more suitable when large quantities of fish are to be identified, as is common in field studies. Diversity studies based on morphometric, therefore, may prove essential in determining key areas for conservation and management. In the light of the need for conservation and promise of morphometric tools to estimate biodiversity, this study presents some morphometric parameters of tiger fish, *Hydrocynus forskahlii* from Ureje dam, Ado Ekiti, Ekiti State, Nigeria.

1.2 SIGNIFICANT OF THE STUDY

This research will provide scientific information about the morphometric characteristics of *Hydrocynus forskahlii* from Ureje Dam, Ado Ekiti and facilitate others to make further research about the fish, the threats it faces, its growth, reproduction, abundance in the wild and also to plan conservation strategies for the fish species.

1.3 OBJECTIVES OF THE STUDY

The objective of this study to be able to provide scientific information about the morphometric characteristics of *Hydrocynus forskahlii* from Ureje dam, Ado Ekiti, Ekiti State, Nigeria.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 IDENTIFICATION

Hydrocynus forskahlii has pronounced stripes along the length of the body. There are two scales between the pelvic fin insertion and the lateral line, less than for other species of tiger fish such as *Hydrocynus brevis* which has 23-5 scales in the same position. The lateral line scale count is between 46 and 53 scales and the anal fin ray count is 3 soft, unbranched rays with 11-14 branched rays. It is a slenderer species than other *Hydrocynus* species and the depth of the body averages 22.6 percent of its length and the head averages around 20 percent of the body length. It has 9 to 14 teeth in the upper jaw and 8 to 12 in the lower jaw and the jaws are frequently short and upturned. They are similar in color and pattern to *Hydrocynus vittatus* being bright, silvery white in color, but with a grayish tail that has red, orange or yellow color only on its lower lobe (George, Albert Boulenger 1907).

They are normally less than 30 cm in length, although large specimens may be 45 cm and they normally weigh about 2.3 kg, the world record rod caught specimen was 4.08233 kg. Although a maximum weight of 15.5 kg has been reported by George Albert Boulenger 1907.

2.2 TAXONOMY

Hydrocynus forskahlii was previously considered synonymous with *Hydrocynus vittatus* sensu lato, hence the confusion mentioned under Ecology above, but this view is not supported by recent molecular studies. In fact, it is suggested that there are two species within the lineage currently recognized as *H. forskahlii*, with the newly identified lineage being confined to the Sanaga River.

The generic name *Hydrocynus* is from the Greek word, hydro meaning water and kyon meaning dog and is a direct translation of the Egyptian Arabic name for this species Kelb el bahr, or water dog. The specific name commemorates the Swedish explorer and naturalist Peter Forsskål.

2.2.1 CLASSIFICATION

TABLE 1: **SHOW CLASSIFICATION OF *HYDROCYNUS FORSKALII***

Kingdom:	Animalia
Phylum	Chordata
Class:	Actinopterygii
Order:	Characiformes
Family:	Alestidae
Genus:	Hydrocynus
Species	*H. forskahlii*

2.3 ECOLOGY

Little known, the sources quoted in Fishbase and the IUCN Red List of Threatened Species for the behavior of *Hydrocynus forskahlii* appears to refer to *Hydrocynus vittatus* in Lake Kariba. The West African pike characin *Hepsetus odoe* avoids competition with and predation by *Hydrocynus forskhali* by showing a preference for the upper courses of rivers where *H. forskahli* is less abundant or is absent in Kainji Lake, Nigeria reported by Dalu et al. 2011, *Hydrocynus forskahlii* preys mainly on small clupeids, however the largest specimens feed more heavily on the characid *Alestes baremoze*. The tiger fish constitutes about 8.2% of the fish biomass in the reservoir (Dalu et al. 2011). This species is a member of the Alestiidae, a piscivorous and pelagic predator that is widely distributed in Zimbabwean inland waters, (Thorstad et al. 2002, Marshall 2011). Tiger fish can grow up to 70 cm in fork length and 15 kg in weight, although such large specimens are rare (Marshall 2011). The populations of tiger fish have declined in many rivers due to pollution, water extraction and migration barriers, such as weirs and dams (Skelton 2001). Tiger fish is also one of the most popular angling species and was introduced into the Malilangwe reservoir for that sole purpose.

The tiger-fish is one of the most sought-after sport fishes on the Mrican continent. The southern limit of its distribution is the Pongola River. The Incomati River system used to provide some very fine fishing for this species in the lower reaches. However, rapid agricultural development in the past few years has necessitated the withdrawal of large quantities of water from the streams and the construction of new weirs; this has created unfavorable stream conditions during the dry season and in recent years. Anglers 2004 reported that tiger-fish has disappeared from some of its earlier haunts. It was, therefore, deemed necessary to survey the fishery resources of the River system before further deterioration of the river habitat takes place.

The ecological dependence of *Hydrocynus* on well-oxygenated freshwaters contrasts against other fishes (e.g. *Clariasgariepinus*) which, being more eurytopic, can tolerate a far wider range of eco-physiological conditions. This enables such eurytopes not only to cross shallow watersheds but also to persist in marginal aquatic habitats even where main rivers dry out (Sarah et.al 2011).

2.3.1 HABITAT

Hydrocynusforskahlii is a pelagic, potamodromous species of open water; it prefers the well oxygenated surface waters. Tigerfishes are largely absent from east Africa, east of the Albertine Rift, pertinently from Lake Victoria. Their absence from Lake Malawi is equally anomalous. Yet, their occurrence in the Omo and Albert Nile drainage systems stands out, as does *H. tanzaniae* isolated in the Ruvu and Rufiji-Ruaha drainage basins (eastern Tanzania) from those in the Congo, Nile and Zambezi basins (Sarah et.al 2011).

Tiger fish is one of the most important predatory fishes in African freshwaters. Tiger fish have large effects on the fish communities where they are present, both by direct predation and by influences on prey fish behavior and life history (Eva. et.al, 2002).

2.3.2 MIGRATION

In the River system, tiger-fish spawn in down-stream, the movement during the spawning season was change in abundance of tiger-fish, nearly 40 miles upstream of the nearest spawning grounds. Abundant increased from April to August and decreased again from October to January. Downstream migration takes place from October, and an upstream migration after the spawning season (Sarah et.al 2011). Upstream movement of tiger-fish may be caused by the upstream migration of small prey fishes or the existence of unsuitable living conditions in the lower reaches of the river. It is known that towards the end of

summer, large numbers of young *Labeo cylindricus* move upstream from the spawning grounds and it is thought that the tiger-fish follow this source of food. Additional to their patchy distribution across Africa's drainage basins, the ecology of *Hydrocynus* is of key relevance to this phylogeographic investigation. Tigerfishes are restricted to relatively warm, fast-flowing and/or open, oxygen-rich habitats in large rivers and lakes as recently confirmed by stable isotope signatures in fossil and extant *Hydrocynus* because their stenotype confines them to larger river channels and open lakes, tiger fish are absent from headwater marshes and streams along watersheds (Sarah et.al. 2011).

The stationarity of some of the tiger fish also implies that smaller sanctuaries can protect adult fish, because some of them may be staying in the protected area. However, smaller sanctuaries will not protect the long-distance moving fractions of the tiger fish population, and when management actions to protect tiger fish are needed, gear or effort restrictions may be more effective (Eva. et.al. 2002). The creation of extensive floodplains during the rainy season obviously affects the conditions for the fish. The tiger fish are utilized to an increasing extent in temporary water covered areas during rising and high water, although only one fish moved out onto the classical floodplain habitat. Individuals utilizing temporary water covered areas were larger than those remaining in the permanently water covered areas (Eva. et.al. 2002).

2.4 FEEDING HABIT

The tiger fish in the reservoir were shown to undergo ontogenetic diet shifts during early life history stages (Jensen et al. 2004). These shifts had large implications for the individuals, populations and communities which eventually resulted in piscivory as observed with the tiger fish in the reservoir. This switch to piscivory is viewed as favorable to individuals because of the associated increase in growth and survival (Jensen et al. 2004, Graeb et al.

2005). Most of the tiger fish caught fed primarily on fish with macro invertebrates forming a smaller percentage of their diet and this can be explained by optimal foraging theory which suggests that early switching to piscivorous diet result in faster growth because they derive higher energetic returns from fish prey than alternative prey such as macro invertebrates (Graeb et al. 2005). The predation on juvenile fish species by Tiger fish has a significant impact on population natural mortality, as it an important parameter in stock assessment models (Mhlanga 2003).

Therefore cichlids were consumed by the tiger fish compared to other fish groups. Tiger fish fed primarily on fish less than 20 cm SL (Tatenda et.al 2012). The empty stomachs during September and October can be attributed to high temperatures (mean 30° C) which resulted in low dissolved oxygen levels (≤ 4.5 mgl-1) throughout the water column. This might have resulted in the tiger fish feeding less as they slowed down their metabolism with decline in dissolved oxygen levels causing a significant reduction in food conversion and growth amongst the species (Tatenda et.al 2012) and (Handeland et al. 2008) in the Atlantic salmon post-smolts. Also the effect of temperature on fish metabolism could also account for the high numbers of empty stomachs since higher temperature implies higher digestion rate (Tatenda et.al 2012).Thus fish caught overnight on gill nets would digest the food in their stomachs faster under higher temperature (Tatenda et.al 2012).

Little is known about the feeding ecology of introduced tiger fish in small lakes and reservoirs with most studies having been done in large lakes such as Lake Kariba (Mhlanga 2003). This considers the food composition of *H. vittatus* in Malilangwe reservoir in an attempt to determine how much dietary overlap there was between different size-classes. It was hypothesized that the greatest overlap would be amongst small individuals, but the overlap would decrease amongst larger individuals because of a tendency to specialize on certain food items.

2.5 REPRODUCTION

In nature, *Hydrocynus* species spawn for just a few days each year during the rainy season, usually in December and January. They migrate to upstream river and into small streams. The female lays a large number of eggs in very shallow water among submerged vegetation. After the eggs hatch, the young live in the shallows until flood waters force them out into larger waterways (I.G Gaigher 2015).

2.5.1 EGGS AND FRY

I. G. Gaigher 2015 assumed that fry fewer than 20 mm in length were incapable of moving over long distances and their presence would thus indicate the breeding site. All small fry were found in lentic waters with a depth of less than two feet.

2.5.2 SPAWNING FREQUENCY

The bottom of the breeding site consisted of clay or sand and submerged grass or weeds were always present. Spawning probably only takes place after flood-plains.Tiger fish spawning activities take place from October to January with the peak in November or December. Tiger-fish stocks depend upon upstream movement after the spawning season (I. G. Gaigher 2015).

2.5.3 GROWTH RATE AND GONAD DEVELOPMENT

In *Hydrocynus* species, females were distinctly larger than males. Females grow faster than males. Males also appear to have a shorter life span than females as there is a progressive decrease in the proportion of males with advancing age (I. G. Gaigher 2015). The gonads of male fish under 150 mm in length were undeveloped, males reach sexual maturity at a length of 200 mm in their third year of life, the maturity time is short and so few male can be

matured. It can thus be assumed that female tiger-fish attain sexual maturity at a length of approximately 360 mm. This corresponds to the fifth or sixth year of life (I. G. Gaigher 2015).

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 STUDY AREA

The study area, Ureje Dam lies at Longitude 005° 18' 25.87"E and Latitude 07°36' 23.82"N (Olowekayode. et.al 2015). It is a small concrete dam that was commissioned in 1957, it serves Ado-Ekiti metropolitan city only. Its source is from the Ureje River; its height above sea level is 423. The reservoir area is 25,000m^2; the height of the dam is 12m. The direct user of the reservoir is the Ekiti State water Co-operation.

3.2 COLLECTION OF FISH

During the present study, a total of 100 fish samples of *Hydrocynus forskahlii* were collected from Ureje Dam, Ado Ekiti, Ekiti State. Fish samples were transported to the Fisheries and aquaculture laboratory of Federal University Oye-Ekiti, Ekiti State. In the laboratory, the sex of fish samples was accurately determined. All fish samples were measured in centimeters and weighed in grams using a digital weighing balance.

3.3 MORPHOMETRIC MEASUREMENTS

12 morphometric characteristics of *Hydrocynus forskahlii* were taken using a meter rule (cm). All morphometric characteristics were examined by the same person in order to minimize artificial error.

3.4 STATISTICAL ANALYSIS

Coefficient of correlation and descriptive statistics were used to determine the strength of the relationship between the morphometric characteristics. Sex of each fish samples was determined.

For studying the length-weight relationship, the following well known formula was used: $W = aL^b$ or (Log W= log a + b Log L) (Le-Cren 1951). Where, W = Weight, L = Length, a = the intercept, and b = the exponent or regression slope. The values of constant 'a' and 'b' are determined empirically from data, as the coefficient of condition. These values may change with age, sex, seasons and system of measurement. In fisheries practice, knowledge of length - weight relationship is very useful.

The condition factor (K) value was calculated using the formula suggested by Offem et.al. (2009) which is:

$$K = \frac{W*100}{L^3}$$

Where, W = total body weight (grams), and L = total body length (mm).

CHAPTER FOUR

4.1: Average Morphological characteristics of *Hydrocynus forskahlii* collected from Ureje dam, Ado Ekiti, Ekiti state, Nigeria.

Results for the morphometric characteristic of *Hydrocynus forskahlii* collected from Ureje dam, Ekiti state, Nigeria is presented in Table 4.1. Body weight of the male fish, *Hydrocynus forskahlii* ranges between: 127.81g and 433.22g which are significantly different ($p<0.05$) from the minimum (129.32g) and maximum (415.08g) body weight of the female. Thus, the female fish have a higher body weight 256.07±14.22 as compared to 212.37 ± 10.49 recorded in the male. *Hydrocynus forskahlii* standard length in male (20.53 ± 0.66), total length (23.98 ± 0.83), were significantly different ($p<0.05$) from the standard length (22.78 ± 0.76) and total length (26.71 ± 0.97) recorded in female. Mouth gap in male (2.61 ± 0.23) and female (3.07 ± 0.24) were similar ($p>0.05$). Also forked length distance in male (4.42 ± 0.27) and female (5.27 ± 0.36) show significant difference ($p<0.05$). However, Pelvic fin length (2.49 ± 0.18), Adipose fin length (1.51 ± 0.15), Dorsal fin length (2.49 ± 0.18), Anal fin length (2.69 ± 0.16), Pectoral fin length (2.32 ± 0.14), Body Depth (4.01 ± 0.17), Head length (2.83 ± 0.13) for male were similar ($p>0.05$) to the values (2.95 ± 0.19, 1.55 ± 0.17, 2.87 ± 0.18, 2.93 ± 0.18, 2.85 ± 0.15, 4.50 ± 0.18, 3.12 ± 0.14) recorded in female respectively. Condition factor were however higher in male (1.71 ± 0.12) and significantly different ($p<0.05$) from the condition factor (1.49 ± 0.11) estimated in female *Hydrocynus forskahlii*.

In summary, all the morphometric parameters of sampled *Hydrocynus forskahii* except the condition factor were higher in female fish sample compared to the value recorded for male.

Table 4.1: Average Morphological characteristics of *Hydrocynus forskahlii* in Ureje dam, Ado Ekiti, Ekiti state, Nigeria.

	MALE			FEMALE			
Parameters	**Mean ± S.E**	Minimum	Maximum	**Mean ± S.E**	**Minimum**	**Maximum**	**T Ratio**
Body Weight(g)	212.37 ± 10.49^{a}	127.81	433.22	256.07 ± 14.22^{b}	129.32	415.08	-2.73
Standard length (cm)	20.53 ± 0.66^{a}	12.80	30.40	22.78 ± 0.76^{b}	12.90	29.80	-2.62
Total length (cm)	23.98 ± 0.83^{a}	0.94	3.86	26.71 ± 0.97^{b}	0.91	3.94	-2.51
Mouth Gap (cm)	2.61 ± 0.23^{a}	14.9	35.80	3.07 ± 0.24^{a}	14.90	35.50	-1.40
Forked length distance(cm)	4.42 ± 0.27^{a}	0.50	5.10	5.24 ± 0.36^{b}	0.70	6.30	-2.02
Pelvic Fin Length (cm)	2.49 ± 0.18^{a}	2.40	11.50	2.95 ± 0.19^{a}	1.80	11.00	-1.84
Adipose Fin Length (cm)	1.51 ± 0.15^{a}	0.60	4.90	1.55 ± 0.17^{a}	0.70	5.10	-0.19
Dorsal Fin Length (cm)	2.49 ± 0.18^{a}	0.30	4.20	2.87 ± 0.18^{a}	0.20	3.50	-1.36
Anal Fin length (cm)	2.69 ± 0.16^{a}	1.10	5.30	2.93 ± 0.18^{a}	0.90	5.30	-1.07
Pectoral Fin Length (cm)	2.32 ± 0.14^{a}	1.30	5.70	2.85 ± 0.15^{a}	1.40	5.50	-2.51
Body Depth (cm)	4.01 ± 0.17^{a}	1.20	4.90	4.50 ± 0.18^{a}	1.20	5.10	-2.23
Head Length (cm)	2.83 ± 0.13^{a}	2.50	6.50	3.12 ± 0.14^{a}	2.20	7.00	-1.77
Condition Factor (K)	1.71 ± 0.12^{b}	1.50	4.60	1.49 ± 0.11^{a}	1.50	5.10	1.62

Mean ± S.E with different super script are significantly different from each other.

4.1.2: Correlation Matrices on morphometric features of Male sampled *Hydrocynus forskahlii* from Ureje dam of Ado Ekiti, Ekiti State, Nigeria.

Result of Correlation Matrices on morphometric features of Male sampled *Hydrocynus forskahlii* in Ureje dam of Ado Ekiti, area of Nigeria is presented on table 4.2. There were positive correlation between body weight and other morphological parameters, showing strong correlation with total length (0.96), Standard length (0.96), Dorsal fin length (0.83), Anal fin Length (0.81), Forked length distance (0.76), Mouth gap (0.75), pelvic fin length (0.73), and slight correlation with Adipose fin length (0.58), however it has weak correlation with body depth (0.41) and Head length (0.39). Equally, Total length has strong correlation with standard length (1.00), Anal fin length (0.82), Dorsal fin length (0.78), Mouth gap (0.74), Pelvic fin length (0.72), Forked length distance (0.71), Adipose fin Length (0.66), and Pectoral fin length((0.65), but has weak correlation with body depth (0.32) and head length (0.32). Also strong correlation was observed between standard length and Anal fin length (0.82), Dorsal fin length (0.78), Mouth gap (0.74), Pelvic fin length (0.73), forked length distance (0.71), pectoral fin length (0.69) Adipose fin length (0.64), Dorsal fin length (0.62), with weak correlation observed with body depth (0.35) and head length (0.33). Furthermore, there was strong correlation between mouth gap and Anal fin length (0.70), Adipose fin length (0.64), and Dorsal fin length (0.62), while slight correlation was observed with forked length distance (0.53) and Pelvic fin length (0.53), but weak correlation was observed between mouth gap and Pectoral fin length (0.41), Body depth (0.24) and Head length (0.19). Also, the correlation between forked length distance and Anal fin length (0.68), Pelvic fin Length (0.65) were strong, but slight correlation with Pectoral fin Length (0.57), and Dorsal fin length (0.52) with weak correlation observed with Adipose fin length (0.33), Body depth (0.20) and Head Length (0.17). Likewise strong correlation was observed between Pelvic fin

length and anal fin length (0.64), Dorsal fin length (0.61), slight correlation with Adipose fin length (0.57), and Pectoral fin length (0.50) but weak correlation with head length (0.34) and Body depth (0.23). It was however observed that the correlation between Adipose fin length and anal fin length (0.70) and Dorsa fin length (0.61) were strong, but weak correlation with Head length (0.23), Pectoral fin length (0.12) and Body depth (0.05) in correlation matrix result between Dorsal fin length and Anal fin length (0.74), and Pectoral fin length (0.61) was strong, but weak correlation with Head length (0.40) and Body depth (0.36). Slight correlation was observed between anal fin length and Pectoral fin length (0.57) but weak correlation with Head length (0.36) and body depth (0.29). But in the correlation between pectoral fin length and Body depth (0.44), with Head length (0.38) are weak. Finally, strong correlation was observed between body depth and head Length (0.83).

Table 4.2: Correlation Matrices of morphological characteristics of male *Hydrocynus forskahlii* in Ureje dam of Àdo Ekiti, Ekiti state, Nigeria

	BWt (g)	TL (cm)	SL(cm)	MG (cm)	FLD (cm)	PlFL (cm)	AdFL(cm)	DFL (cm)	AnFL(cm)	PcFL (cm)	BD(cm)	*HL (cm)*
BWt (g)	1.00											
TL (cm)	0.96	1.00										
SL(cm)	0.96	1.00	1.00									
MG (cm)	0.75	0.74	0.74	1.00								
FLD (cm)	0.76	0.71	0.71	0.53	1.00							
PlFL (cm)	0.73	0.72	0.73	0.53	0.65	1.00						
AdFL (cm)	0.58	0.66	0.64	0.64	0.33	0.56	1.00					
DFL (cm)	0.83	0.78	0.78	0.62	0.52	0.61	0.61	1.00				
AnFL	0.81	0.82	0.82	0.70	0.68	0.64	0.70	0.74	1.00			
PcFL	0.72	0.65	0.69	0.41	0.57	0.50	0.12	0.61	0.57	1.00		
BD	0.41	0.32	0.35	0.24	0.20	0.23	0.05	0.36	0.29	0.44	1.00	
HL	0.39	0.32	0.33	0.19	0.17	0.34	0.23	0.40	0.36	0.38	0.83	1.00

Where: Bwt = body weight, TL=total length, SL= standard length, MG= mouth gap, FLD= forked length distance, PlFL = pelvic fin length, AdFL= adipose fin length, DFL= dorsal fin length, AnFL = Anal fin length, PcFL = pectoral fin length, BD = body depth and HL is head length.

4.1.3: Correlation Matrices on morphometric characteristics of female sampled *Hydrocynus forskahlii* from Ureje dam of Ado Ekiti, Ekiti State, Nigeria.

Result of Correlation Matrices on morphometric features of female sampled *Hydrocynus forskahlii* in Ureje dam of Ado Ekiti, area of Nigeria is presented on table 4.3. There were positive correlation between body weight and other morphological parameters, showing strong correlation with total length (0.96), Standard length (0.96), Dorsal fin length (0.86), Anal fin Length (0.82), Pectoral fin Length (0.81), Pelvic fin length (0.73), Forked length distance (0.71), and Mouth gap (0.59), with weak correlation with Adipose fin length (0.49), head length (0.16), and Body depth (0.16). Equally, strong correlation was observed between Total length and Dorsal fin length (0.86), Anal fin length (0.79), Pectoral fin Length (0.78), Forked length distance (0.71), Mouth gap (0.60), with slight correlation with Adipose fin length (0.51) and very weak correlation with Head Length (0.05), and Body depth (0.02). Similarly, strong correlation was also observed between standard length with Dorsal fin Length (0.86), Anal fin length (0.79), Pectoral fin length (0.79), Pelvic fin length (0.74), Forked length distance (0.71), Mouth gap (0.60), with also slight correlation with Adipose Fin length (0.51), and weak correlation with Head length (0.06) and Body depth (0.02). However negative correlation and weak correlation was observed between Mouth gap and other morphological parameters, weak correlation was observed between mouth gap and Anal fin length (0.47), Pectoral fin length (0.45), Adipose fin length (0.45), Pelvic fin length (0.42), Forked length distance (0.41), Negative correlation with head length (-0.05), and body depth (0.05), however it has strong correlation with Dorsal fin length (0.64). in addition Forked length distance has strong correlation with Anal fin length (0.73), Dorsal fin Length (0.69), Pectoral fin Length (0.63), Pelvic fin length (0.57) with weak correlation with adipose fin length (0.15), Head length (0.12), and Body depth (0.08), Also in the correlation between

Pelvic fin length and other morphological parameters, strong correlation was observed with Dorsal fin length (0.66), Anal fin length (0.64), pectoral fin length (0.62), with weak correlation with Adipose fin length (0.39), Head length (0.18), body depth (0.16) and head length (0.16), But poor correlation was observed between Adipose fin length and Anal fin length (0.40), Dorsal fin length (0.39), Pectoral fin length (0.25) and Negative correlation with Body depth (-0.05) and Head length (-0.04). However strong correlation was observed between Dorsal fin length and Anal fin length (0.79) and Pectoral fin length (0.77) with weak correlation with head length (0.15), and Body Depth (0.12), equally strong correlation was observed between Anal fin length and Pectoral fin Length, but weak correlation with head length (0.17) and Body depth (0.13). But weak correlation was observed between and Pectoral fin length and other morphological parameters (Body depth and Head length both having 0.21). Finally strong correlation was observed between Body depth and Head length (0.93)

Table 4.3: Correlation Matrices of morphological characteristics of female sampled *Hydrocynus forskahlii* in Ureje dam of Ado Ekiti, Ekiti State, Nigeria.

Parameters	BWt (g)	TL (cm)	SL (cm)	MG(cm)	FLD (cm)	PIFL (cm)	AdFL (cm)	DFL (cm)	AnFL (cm)	PcFL (cm)	BD (cm)	HL (cm)
BWt (g)	1.00											
TL (cm)	0.96	1.00										
SL (cm)	0.96	1.00	1.00									
MG(cm)	0.59	0.60	0.60	1.00								
FLD (cm)	0.71	0.71	0.71	0.41	1.00							
PIFL (cm)	0.73	0.74	0.74	0.42	0.57	1.00						
AdFL (cm)	0.49	0.51	0.51	0.45	0.15	0.39	1.00					
DFL (cm)	0.86	0.86	0.86	0.64	0.69	0.66	0.39	1.00				
AnFL (cm)	0.82	0.79	0.79	0.47	0.73	0.64	0.40	0.79	1.00			
PcFL (cm)	0.81	0.78	0.79	0.45	0.63	0.62	0.25	0.77	0.79	1.00		
BD (cm)	0.13	0.02	0.02	-0.08	0.08	0.16	-0.04	0.12	0.13	0.21	1.00	
HL (cm)	0.16	0.05	0.06	-0.05	0.12	0.18	-0.05	0.15	0.17	0.21	0.93	1.00

Where: Bwt= body weight, TL=total length, SL= standard length, MG= mouth gap, FLD= forked length distance, PIFL = pelvic fin length, AdFL= adipose fin length, DFL= dorsal fin length, AnFL = Anal fin length, PcFL = pectoral fin length, BD = body depth and HL is head length.

4.1.4: Length-weight relationship of sampled *Hydrocynus forskahlii* from Ureje dam of Ado Ekiti, Ekiti State, Nigeria

The result of length-weight relationship of sampled male and female *Hydrocynus forskahlii* is presented in figures 4.1 and 4.2 respectively. It shows that changes in weight of male *Hydrocynus forskahlii* was caused by 94.8% change in length. Coefficient of determination for female *Hydrocynus forskahlii* was 0.987. This implies that changes in weight of the female fish were as a result of 98.7% change in the length of the fish. Results equally show that slope (b) in male fish was lesser (1.37) than 3, while the "b" (allometric growth) value was greater than 3 (5.32) in female *Hydrocynus forskahlii.*

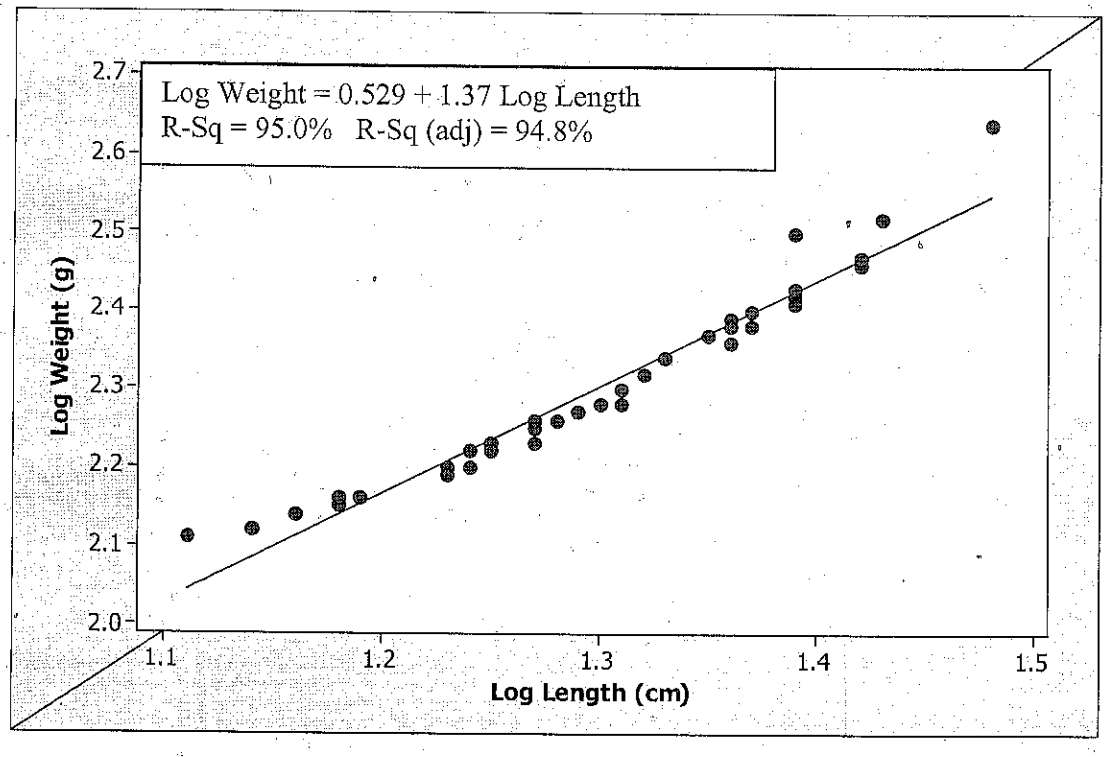

Figure 4.1: Length-weight Relationship of male *H. forskahlii*

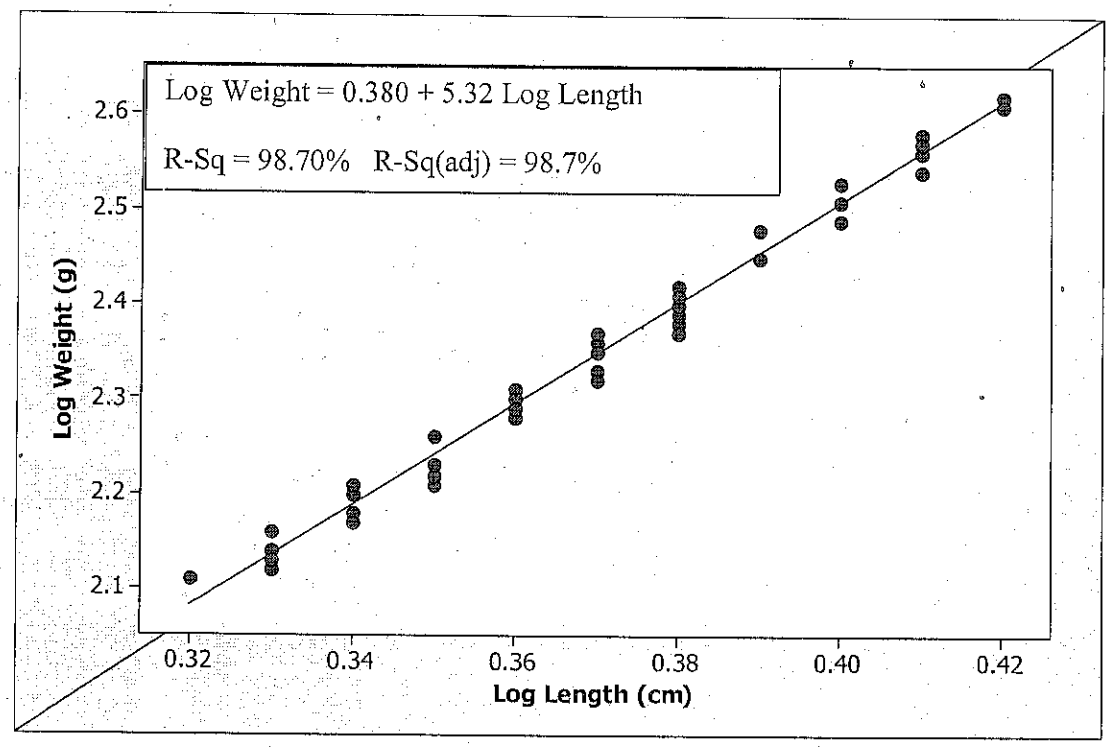

Figure 4.2: Length-weight Relationship of female *H. forskahlii*

4.2 DISCUSSION

Variation in body form has important fitness consequences in fish both in cultured and the wild species (Gatz, 1998, Gulliet *et al* 2003), which may sometimes form a base for identification, as this study is relevant to add to knowledge of the morphological information, condition factor and length-weight relationship of *Hydrocynus forskahlii*, as there are scanty information in respect to the morphological information on the fish species, in this study, significant variation occurred in the body weight (BW), total length (TL), standard length (SL), forked length distance (FLD), and the condition factor (K)with the female showing a little more growth rate than the male, while variation was also expressed in the condition factor observed, however similarities occurred in the other parameters such as Mouth gap, Pelvic fin length, Adipose fin length, Dorsal fin length, Anal fin length, Pectoral fin length, Body depth and Head length among the Morphometric characteristics of *Hydrocynus forskahlii* from Ureje dam, Ado Ekiti, Nigeria. Average standard length of 20.53cm and 22.78cm for male and female respectively, is similar in range with the report of Hamid (1996) who reported that the range of *Hydrocynus forkskahlii* in Lake Nubia and JebekAulia ranges between 15-45cm and 20-54cm respectively, while Akinyemi and Okunye reported in its studies that the standard length of *Hydrocynus forskahlii* to be 17.29, but report given by Angela and Her colleague Richard (2005), reported that the size of the *Hydrocynus* (Tiger fish) to be 13.20cm in trans-Atlantic clade. The average body weight (212.37g for male and 256.07g for female) of *Hydrocynus forskahlii* from Ureje dam, Ado Ekiti, Nigeria in this study is however larger than the weight (83.79g) reported by Akinyemi and Okunye (2011), which was from samples of *Hydrocynus forskahii* gotten from Ogun river, Abeokuta area of south west of Nigeria, and they further reported that *Hydrocynus fasciatus* weight of 47.20g which is even more lower in body weight, from the report of Akinyemi and his colleague on

Head length, they reported that *Hydrocynus fasciatus* have an average head length of 2.89cm similar to the result in present study of 2.83cm and 3.12cm from male and female respectively, however different from their report of *Hydrocynus forskahlii* having an average head length of 4.46cm, interestingly there were precise similarities between the result of present study and that of Akinyemi and Okunye on Body depth, with both studies having a body depth length of 4.10cm for the male and 4.50cm for the female. However, similarities observed, having no significant difference in other morphological parameters of both sex of male and female agreed with findings of; (Narejo et al., 2000; Lashari et al., 2004; Narejo, 2010; Dars et al., 2012), also agreed with the conclusion advanced by Minos et al. (1995), Cavalcanti et al. (1999), Sabadin et al. (2010), Díaz de-Astarloa et al. (2011) and Zhan and Wang (2012) that morphometry can be used to distinguish among species of fish, while the variation might be due to genetic differentiation and other factors such as the environmental factors or their interactions (Kara *et. al,* 2011). Condition factor (K) reflects the Physiological condition of the fish to its environment, in relation to the water quality of the environment, availability of food, space and in general the welfare of the fish. According to Getso*et al.* (2017) fishes with a low condition index are presumably believed to have experienced adverse physical environment or insufficient nutrition. *Hydrocynus forskahlii* fish species sampled from Ureje dam of Ado-Ekiti, area of Ekiti state, Nigeria, indicated from the result that both male and female had condition factors greater than 1 (>1), with the male having 1.71, while the female having condition factor value of 1.49, which are within the normal ranges recommended by Ujjania *et al.* (2012) who stated that condition factor greater or equal to one is good, indicating a good level of feeding, and proper environmental condition. However Bagenal and Tesch (1978) recommended K value range (2.9-4.8) as suitable for matured fresh water fish and the result being below 2 may be due to poor water management, due to release of effluent or other anthropogenic activity in the dam, while the

below-result of the female fish species sampled may be due to reproductive activity, which may be accompanied by low availability of food as also reported in the report of Olawusi-Peters *et al* (2014). Further result shows significant positive correlation between the morphometric parameters of male *Hydrocynus forskahlii* of Ureje dam of Ado ekiti, Ekiti state, with averagely strong correlation (r> 0.50) between the morphometric parameters, except between the body depth, and head length and also between pectoral fin length and mouth gap likewise adipose fin length where weak correlation (r<0.50) is observed, similarly averagely strong correlation was observed in the report of Jawad and Al-janabi (2016) on catfish, and also in the report of Jin *et.al,* (2007) and the head sizes (Liao *et.al,* 2006) which in both report show weak correlation between the head length, body depth and body size. Further correlation analysis was conducted on the female *Hydrocynus forskahlii*, where negative correlation was observed between body depth and Mouth gap, and Adipose fin length, also between Head length and mouth gap with head length, also weak correlation was observed between other parameters which includes mouth gap relationship with other parameter excluding Dorsal fin length, few others, similar to the report of Iqbal *et al.*(2015) on morphometric Characteristics of *Silver Pomfret.* However, Average strong correlation was observed in the correlation between other parameters, the variation between morphological parameters of the body of the sexes maybe due to breeding and feeding (Kara *et. al,* 2011), which could serve as a base of sex differentiation, hence, useful in the systematic classifications of this species (Iqbal *et al.* 2015)

In this study, further research was conducted on length–weight relationship, on Male sampled *Hydrocynus forskahii* of Ureje dam of Ado-ekiti, Ekiti State, where the male growth had negative allometric growth pattern because the value of 'b' (1.37) was less than 3, Masoma*et al.* (2015) also observed negative allometric growth pattern on four mullet species, *Mugil incilis* on Sindh coast and in the report of Imam *et al.* (2011), similarly Iqbal *et al.* (2015)

also reported in its report value of 'b' of *silver pomfret* below idea of 3, also Zubia, and Rehana, (2011) on four *Gobiid* species. This implies that the increase in body length was not proportional to therate of increase in body weight of the male. The female exhibited a positive allometric growth patterns because the 'b' value (5.32) was greater than 3, as was reported in the report of Omobepade and Ajibare (2015), likewise in the report of Kosai *et al.* (2014) on Nile tilapia. Hence, there was a correspondent positive increase in the length of the female fish as the male increases. Results further shown that observed change in length of the male fish was as a result of 94.8% changes in the weight of the fish. For the female fish, the length changed by a corresponding 98.7% change in weight of the fish.

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATION

5.1 CONCLUSION

From this study, results showed that 5 morphometric characteristics including the condition factor ofthe male and female *Hydrocynus forskahlii* were significant to each other while the remaining 8 morphometric characteristics were similar to each other. Also, all morphometric characteristics showed strong, positive correlations to each other indicating that growth in one area of the fish is correlated to growth in another area of the fish while some morphometric characteristics recorded in the female fish showed negative correlations to each other. This morphological data will be of help to fisheries biologists and taxonomists who are concerned about this fish.

5.2 RECOMMENDATION

Further studies on *Hydrocynus forshaklii* are recommended in larger samples to ascertain the results gotten from this present study.

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