LENGTH-WEIGHT RELATIONSHIP, SEX RATIO AND CONDITION FACTOR OF ELEPHANT SNOUT FISH (*MORYMYRUS RUME*) AND SILVER CATFISH (*CHRYSICHTHYS ALUUENSIS*) IN OVIA RIVER.

BY

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CERTIFICATION OF THESIS

We the undersigned attest and declare that the thesis of **Victor Okiemute AKPOIWA (Mister)** titled: Length-weighy Relationship, Sex Ra5io and Condition Factor of Elephant Snout Fish (Mormyrus rume) and Silver Catfish (Chrysichthys aluuensis) in Ovia River. Has successfully passed the anti-plagiarism test and does not violate any copy right regulation.

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DEDICATION

I dedicate this report to God Almighty for His endless provision, protection and love towards me.

ACKNOWLEDGMENTS

I express my profound gratitude to God Almighty, thee source of life for the wisdom to carry out this research.

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ABSTRACT

This study examined the length weight relationship (LWR), condition factor and sex ratio of two fish species, Mormyrus rume and Chrysichthys aluuensis. The study was carried out between August 2021 and January 2022 in Ovia River (Ighoraki), Nigeria A total of eighty-two (82) fish specimens were collected during the study. Parameters of EWR were estimated. On an average, growth pattern, bin Mormyrus rume was 2.21 and 2.06 in Chrysithchys almensis indicating negative allometric growth pattern. The results indicated that the value of correlation coefficient (1) for Mormyrus rume and Chrysichthys alauensis were 0.973 and 0.967, which were closer to 1 indicating that the length-weight relationship was highly correlated. The mean condition factor (k) in Mormyrus rume was 1.03 and 1.01 in Chrysichthys aliensis. This indicated that fish species were in good condition during the study as mean k values were 1 in both species. The mean sex ratio across the study duration for Mormyrus rume and Chrysichthys aluuensis were 1.13 and 1:3 respectively. The result indicated that males of Chrysichthys aluwensis were higher than the females during the sampling period.

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background of the study

Over the years fish has been identified as one of the most valuable source of protein to man and its importance cannot be overrated as it is easily digested and absorbed into the body (Akinrotimi et al, 2011). Fish is known to provide vital nutrient such as omega-3 polysaturated fatty acid and omega 6 oil and the cholesterol level is relatively very low.

Fishes, especially those of tropical and sub-tropical water systems are known to experience growth fluctuations due to many factors such as environmental changes, food composition changes, competition within the food chain, changes in the physical and chemical properties of the aquatic medium (Adedeji and Araoye, 2005; Abowei and Davies, 2009).

Morphometric characters can be used to assess the influence of environmental factors on fish populations. In this regard, it is common to use measurements such as body depth, head length, weight, standard length, and the total length of fishes not only to assess fish habitat peculiarities and ecological criteria in water bodies, but also to measure discreteness and relationships among various taxonomic categories (Omoniyi et al, 2010) and the relationship changes with various developmental events in life such as metamorphosis, growth and the onset of maturity (Thomas et al, 2003). Besides this, the length-weight relationship can also be used in setting yield equations for estimating the number of fish landed and comparing the population in space and time (Ndiaye, 2015).

King (1996) stated that fish grow is in length as well as in weight. Bake and Sadiku (2004) described growth as the change in absolute weight (energy content) or length of fish over time, while (Adedeji and Araoye, 2005) summarized growth as a function of fish size. The study of growth patterns in fish is based principally on length – weight relationships or relationships between sizes of scales or other calcified tissues and body length because of their importance in age and growth analyses (Adeyemi *et al,* 2009).

Abowei and Hart (2009) reported that the length – weight relationship of fish, also known as growth index, is an important management tool used in estimating the average weight at a given length growth. Anderson and Neumann (1996) refer to length-weight data of population as basic parameters for monitoring study of fisheries, since it provides important information concerning the structure and function of the populations. It is widely used in fisheries biology for several purposes such as estimating the mean weight of fish based on known length (Araoye, 2004; Da Costa and Araojo, 2003). Therefore, such parameters as mean weight of fish of a given length, condition factors and modelling of fish growth can be deduced from the length-weight parameter. The relationship can be expressed by hypothetical law $W = aL^3$. The value of exponent may considerably deviate from the value 3, since most fishes change their form or shape when they grow. There are two growth patterns in fish namely the allometric growth and isometric growth. In allometric growth, when the value of b is greater than 3 the growth pattern is positive but when the b value is lesser than 3 the growth pattern is negative. Negative allometric growth implies the fish becomes more slender as it increase in weight while positive allometric growth implies the fish becomes relatively stouter or deeper-bodied as it increases in length (Sakar *et al*, 2013). In isometric growth, we have the b value to be equal to 3. Isometric growth is associated with no change of body shape as an organism grows.

Condition factors (K) is the most important biological parameter that provides information on the condition of fish species and the entire community and is of high significance for management and conservation of natural populations (Sarkar *et al,* 2009; Muchlisn *et al,* 2010) that determine the present and population success of fish species because of its influence on growth, reproduction, and survival (Richter, 2007). The condition factor is also an estimation of the general well-being of fish (Abowei, 2006; Oribhabor *et al*, 2011). It is based on the hypothesis that heavier individuals of a given length are in better condition than the lighter ones (Abowei and Hart, 2008; Ogamba *et al,* 2014). When condition factor value is one or greater than one indicates the good condition of fish while value lesser than one indicates the bad condition of fish. This factor influenced by season, sex, type of food organism consumed by fish, age of fish, amount of fat reserved and environmental factors (Mon EE *et al,* 2020) and change in human subsistence practices fluctuating according to different stages of the development.

Sex ratio variation is a longstanding theme in evolutionary biology. Fisher famously theorized that natural selection should maintain 1: 1 sex ratios by continuously favouring the rare sex, thereby always returning skewed sex ratios to equality. In nature, skewed sex ratios are a common observation across the tree of life, and explanations include differential mortality rates for males and females (Arendt JD *et al*, 2014) inbreeding and local competition for mates, endocrine- disrupting environmental pollutants (Mills and Chichester, 2005, and Rodrıguez *et al*, 2007) and adaptive maternal effects that allow differential investment in male or female offspring (Kahn *et al*, 2013). Despite the attention paid to the causes of sex ratio variation in nature, and in some cases its consequences for population growth (Thresher, 2013) theory and tests of its effects on communities and ecosystems are lacking. The widespread observations that sex ratios vary in nature and that males and females often differ in key ecological traits, suggest that sex ratio variation may have effects on communities and ecosystems.

The Ovia River is characterised with different fish species and is mainly exploited by subsistent artisanal fishermen, that use traditionally fabricated gears such as drums, gill and cast nets etc. It serves a number of communities and a wide array of human and industrial developmental activities in the Niger Delta area (Ibim and Igbani, 2014). It is a freshwater at the Aluu and Isiokpo axis and brackish at Choba axis and empties into the Atlantic at the southern tip of Bonny in the south.

The importance of Length-weight relationship, condition factors and sex ratio in fisheries and fish biology cannot be overemphasized as they give an estimation of average weight of fish of a given length by establishing a mathematical relationship between them (Sarkar *et al*, 2008; Mir *et al*, 2012). Length-weight relationship and condition factor are important to fish industries as they help to predict the best length and weight and time suited to harvest a particular species of fish (Abobi and Ekau, 2013). It is also useful when applied in fish stock assessment and they are applied in estimating the standing stock biomass and in comparing the ontogeny of a fish population from different regions (Akinrotimi *et al*, 2009; Ogamba *et al*, 2014). Sex ratio and size structure constitute some of the basic information required for assessing reproductive potential and estimating stock size (Mon *et al,* 2020).

1.2 AIM AND OBJECTIVE

There are many well documented studies which provide information on growth patterns of many freshwater fish species in Nigeria but that of *Chrysichthys aluuensis* and *Mormyrus rume* of Ovia River, Benin, is scarce. Hence, this project aim to investigate the length-weight relationships, condition factor, and sex ratio of *Mormyrus rume* and *Chrysichthys alluuensis* populations in the Ovia River, Edo state Nigeria.

The objective of this study:

- To determine the length-weight relationship and condition factor for *Mormyrus rume* and *Chrysichthys aluuensis* species by observing their growth pattern between length and weight in Ovia River, Edo state, Nigeria.
- To determine the sex ratio of *Mormyrus rume* and *Chrysichthys aluuensis* populations in Ovia River, Edo state, Nigeria.

CHAPTER TWO

2.0 LITERATURE REVIEW

In Nigeria, investigation into the biology of freshwater fishes have been conducted by several workers such as Idodo-Umeh, (2003) and Olasebikan and Raji (2003). They comprehensively recorded the fish and fisheries resources of Southern and Northern Nigeria and their work formed the basis for most fishery studies in Nigeria.

2.1 *Chrysichthys aluuensis*

Chrysichthys aluuensis commonly called silver catfish belongs to the genus Chrysichthys, family of Bagridae. They are of great ecological and economic importance as it plays a major role in the food chain and serves as food fish in Africa (Abowei and Ezekiel, 2013).

The silver catfish is widely distributed along the tropical and subtropical region. It is one of the most dominant species in the fish base region of Nigeria, mostly found along the Niger Delta region through the Cross River region towards Cameroon. It also plays a vital role in the ecology and fisheries of Nigeria (Erondu, 1990; Hart and Abowei, 2007; Francis and Sikoki, 2012).

Chrysichthys aluuensis have an oval, broad and rounded head, broad and terminal mouth with smooth, long and slender gill rakers, maxillary barbels shorter than the head length, long nasal barbels, short dorsal fin, straight and serrated dorsal spine, caudal peduncle longer than its width and slightly curved and serrated pectoral spine (Idodo-Umeh, 2003). It inhibit rivers and estuaries (Idodo-Umeh, 2003). They occur sympatrically with *Chrysichthys nigrodigitatus* (Teugels *et al*, 1992) and have a grey body and fin but a light grey belly. They feed mainly on insects, plant materials and detritus (Idodo-Umeh, 2003). Unlike *Chrysichthys nigrodigitatus,* *Chrysichthys aluuensis* is scares and as such research on this species of fish is rare. Hence, research on *Chrysichthys nigrodigitatus* is discussed more since it share close similarities with *Chrysichthys aluuensis*

Onisokyetu *et al*, (2016) studied a total of 329 fish specimen of *Chrysichthys nigrodigitatus* in the New Calabar River and were measured for total length and weight from July to November and the result of regression statistics showed that *Chrysichthys nigrodigitatus* has the highest b-value in the month of July and the lowest b-value in the month of November.

2.1.1 Length-weight relationship

Onisokyetu *et al*, (2016) recorded the shortest total length specimen of *Chrysichthys nigrodigitatus* in the New Calabar River in the month of July as 8.60cm, while the longest total length was recorded in the month of November as 101cm and the least weight of 100g was recorded in the month of July while the greatest individual weight was recorded in November as 13000g. The result of this study indicated that the fish exhibited a negative allometric growth pattern which means that the length and body weight of the fish did not grow in the same proportion, i.e. the fish grew faster in weight than in length and this is in agreement with the work done by Francis and Elenwo (2012) who also reported negative allometric growth (mean=2.00) in same New Calabar River from January to July.

2.1.2 Condition factor

According to the result of Onisokyetu *et al*, (2016), the condition factor for *Chrysichthys nigrodigitatus* from the New Calabar River had the highest value in the months of July, August and October while the least condition factor was in the month of November. The mean condition factor recorded by Onisokyetu *et al*, (2016) study (K=1.34) agrees with the work of Francis and

Elenwo (2012) who recorded mean of K=1.31, this indicates that the well-being of this fish has not been altered despite environmental changes that may have occurred in that river between 2012 and 2015.

2.2 *Mormyrus rume*

Mormyrus rume Valenciennes, 1846 (Pisces: Mormyridae) are found in fresh waters of tropical Africa (Idodo-Umeh, 2003; Fawole, 2002). They occur in fast moving waters with demersal habits. Members of the family have rudimentary electric organs situated on each side of the terminal portion of the tail and they possess large brains (Idodo-Umeh, 2003). They are curious looking fish, highly variable in the shape of their head and the extent of their unpaired fin. They are reported to be bottom dwellers feeding on insect larvae (Babatunde and Raji, 2004).

Mormyrids are increasingly becoming important in the world aquarium business, aquaculture and neurological studies (Gosse, 1984). The growth of Mormyrid fish depends on many factors such as heredity, relative velocity of growth, ability to derive food and resistance to diseases, temperature, the quantity and quality of food, the composition and purity of chemical medium (available oxygen) and survival of fish in time and space (Idodo-Umeh, 2003). The knowledge of some aspects of the biology of *Mormyrus rume* will provide a basis for comparative studies and also for the proper management of the species in culture for maximum yield.

Mormyrus rume have a trunk-like snout, terminal and small mouth, 81-96 soft rays of dorsal fin, 18-21 soft rays of anal fin, and 20-24 scale around the caudal peduncle (Idodo-Umeh, 2003). It can grow to a length of 1 metre with a weight of about 7kg. It is greyish-yellow dorsally and silvery ventrally and is commonly caught during the day (Idodo-Umeh, 2003).

Fawole, (2002) identified detritus and plant parts in the diet of *Mormyrus rume* in Lekki lagoon, Nigeria. *Mormyrus rume* are readily available, tasty and relatively cheap (Onimisi and Shittu, 2015). Adedeji *et al.* (2014) also reported that *Mormyrus rume* flesh contains the highest amount of crude protein among the fish species studied. In support of this finding, Idowu *et al*. (2015) recorded that the head region of *Mormyrus rume* has higher protein concentration in their study on nutritive value of fishes from Lake Gerio in Yola, Nigeria.

Odedeyi, (2007) reported that *Mormyrus rume* flourished in the River Ose, a major perennial river in the Southwestern part of Nigeria. According to the result of Odedeyi, (2007), 791 specimens of *Mormyrus rume* were examined and the total length ranged from 17.0 to 50.0 cm, the standard length ranged from 15.0 to 45.0 cm, while the weights ranged from 74.50 to 610.0g.

2.2.1 Length-weight relationship

According to the length-weight regression analysis of Odedeyi, *et al.* (2007) study, the females had higher b values indicating the possibilities of better growth patterns than males which was evidence that the weight of *Mormyrus rume* increases as the length increases. Odedeyi *et al.* (2007) reported allometric growth value of 1.699, 2.134 and 1.990 for males, females and combined sexes of *Mormyrus rume* respectively from river Ose, southern Nigeria with varying condition factor decreasing with increasing sexes. The mean condition for males, females and combined sex were 0.787, 0.859 and 0.823, respectively.

In 2015, Onimisi and Shittu measured the weight of 220 specimens *of Mormyrus rume* which ranged from 14.0g (SL = 12.2cm) to 79.4g (SL = 21.0cm) in male and 12.2 to 20.5cm in female with the mean value of 42.9g (11.5cm SL) in the lower River Niger at Idah. The fish exhibited positive allometric growth with b value of 3.2 to 3.3 which agrees with the cube law and confirm the report of Fawole, 2002 who reported the fish to exhibit isometric growth in Lekki lagoon, Nigeria.

2.2.2 Condition factor

The study of Odedeyi *et al.* (2007) showed that the females were in a better condition than the males which agrees with the results of Oben *et al.* (1999) on *Mormyrus rume* in Lekki lagoon. Onimisi and Shittu, (2015) reported the average condition factor value of 0.93, 0.86 and 0.89 for male, female and combined sexes of *Mormyrus rume* and concluded that the condition factor increases with sexual maturity.

2.3 Sex ratio

Quarcoopome, (2017) reported that the observed monthly sex ratio for *Chrysichthys auratus and Chrysichthys nigrodigitatus* were statistically significant at 95 percent confidence interval (P>0.05) which suggest that sex ratio in both species is not 1:1 and that observed differences are not due to chance or sampling error.

CHAPTER THREE

MATERIALS AND METHODS

Study Area

The study was carried out between August, 2021 and January, 2022 in Ovia River (Iguoriakhi), Edo State, Southern Nigerian, which took it source from the Akpata hills in Ekiti State, Nigeria. Iguoriakhi is located about 23.9km from Benin City, off Lagos-Benin Express Road, Nigeria (Lat. 06˚23'42.76" – 06˚27'10.15"N; Long 005˚25'55.0"- 005˚29'36.20"E), within the tropical rainforest belt of Nigeria. This region has two distinct regions: wet and dry season, which starts from April to October and November to March respectively.

The vegetation is predominantly shrubs and trees. The dominant terrestrial vegetation here includes *Chrysophyllum albidum* and grass vegetation. The human activities witnessed here include, fishing, laundry, bathing, dredging, traditional practices and lumbering.

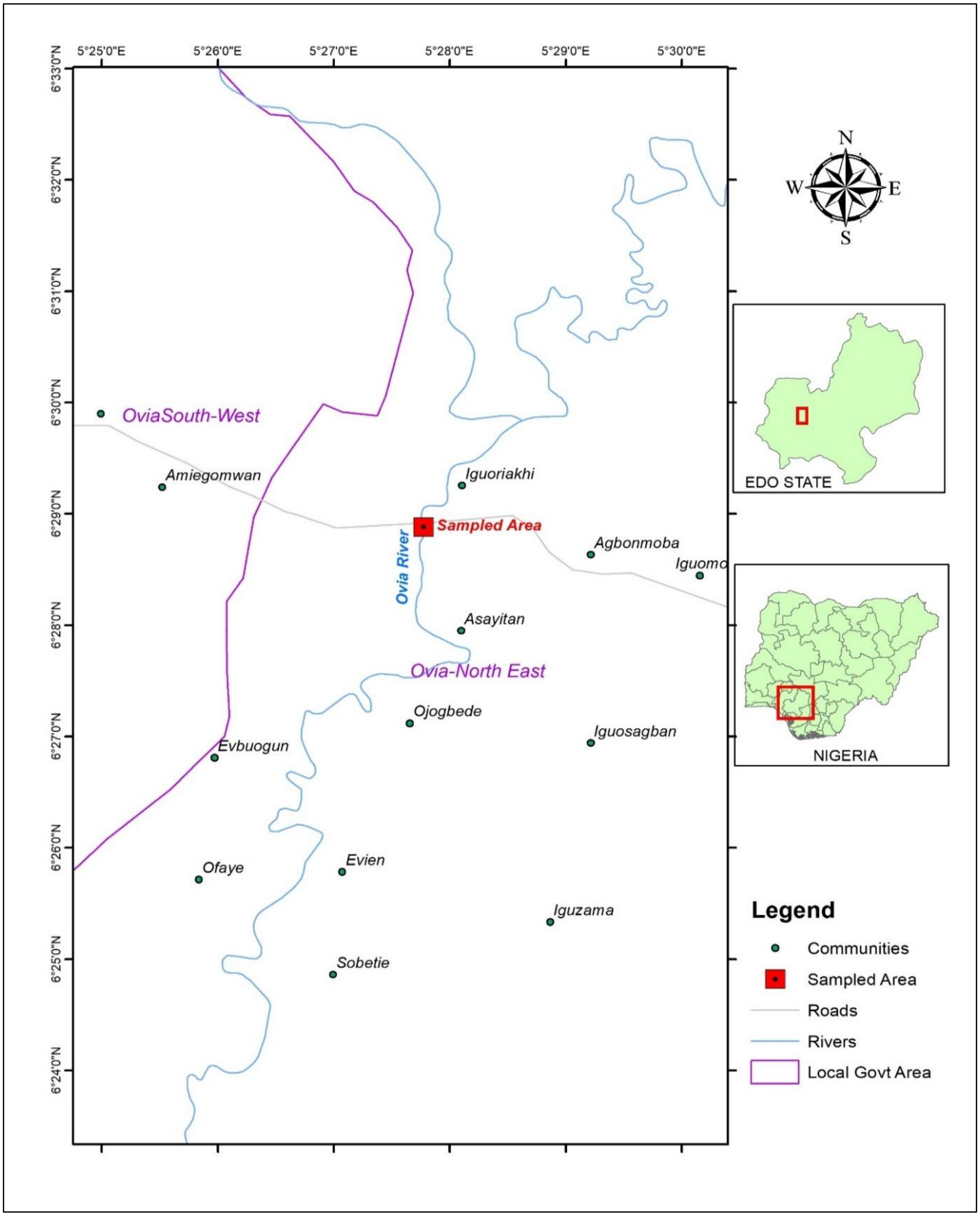

Figure 3.1: Map of the study area showing location of Iguoriakhi River and the sampling stations, with map of Edo State.

Fish collection

The fish specimens were collected in a bucket from one source once monthly for a period of six months, directly from landings of fishermen from Ovia River and transported to the University of Benin, Laboratory. Analysis was done on the fish samples immediately, and any leftover samples were preserved with 10% formalin for further analysis. The total of 84 specimens of fish were collected throughout the sampling period using fishing crafts, nets, lines, and hook. The craft is mainly the dugout unmotorized canoe that is mechanically moved by paddle.

Fish identification

The fish specimens collected in the Ovia River were identified to species level in the laboratory using the morphometric and meristic features provided by Idodo-Umeh (2003). Identification of sex was based on visual examination of the papilla. The samples were sorted by sex into two categories, the male and female.

Fish Measurement

In the laboratory, measurements of the standard length (SL), total length (TL), body depth (BD), and the head length (HL) were taken using a meter rule to the nearest 0.1cm. The weight of individual fish was taken using a weighing balance to the nearest 0.1g.

Standard length (SL)

The standard length was measured from the tip of the snout to the posterior end of the midlateral portion of the hypural plate.

Total length (TL)

The total length was measured from the tip of the snout to the tip of the longer lobe of the caudal fin.

Head length (HL)

The head length measurement was taken from the tip of the snout or mouth which is the most anterior to the most posterior of the gill plate of the fish.

Body depth (BD)

The body depth was measured from the point of insertion of the dorsal fin to the ventral part of the fish.

Body weight (BW)

The weight was measured on a weighing balance and recorded to the nearest 0.1g.

Data Analysis

Length-weight relationship

Length-weight relationship was calculated using equation $W = aL^b$, (Mon *et al*, 2020)

The equation was linearized by a logarithmic transformation (Oliva-Paterna *et al*., 2009) to give:

Log W = Log a x b Log L,

Where:

W = body weight of fish (g)

L = standard length of fish (cm)

a = constant

b = the growth factor.

Length-weight relationship allows the conversion of growth-in-length equations to growth-in-weight which is used in stock assessment models; an estimation of biomass from length observations; an estimate of the condition of the fish (Relative well-being of the fish) and also for useful comparison purpose. Fish can attain either isometric growth, negative allometric growth or positive allometric growth. Isometric growth is associated with no change of body shape as an organism grows. Negative allometric growth implies the fish becomes more slender as it increase in weight while positive allometric growth implies the fish becomes relatively stouter or deeper-bodied as it increases in length (Sakar *et al*., 2013).

Condition factor (K)

The condition of the fish was expressed by Fulton's condition factor (K), calculated using the formula:

$K = W \times 100/L^b$.

Where:

K = Fulton condition factor

W= wet weight (g) of the fish

L = total length (cm) of the fish

b = growth exponent.

Sex ratio

Monthly sex ratio for each species was computed and tested for statistical significance by the chi-square method based on the null hypothesis of 1:1 ratio of male and female at 95 per cent confidence interval (CI). Sex ratio for various length groups of the two species was computed and tested for significance at 95 per cent confidence level.

CHAPTER FOUR

4.0 RESULTS

4.1 MORPHOMETRIC CHARACTERISTICS OF *MORMYRUS RUME AND CHRYSICHTHYS ALUUENSIS* ACROSS THE SAMPLING DURATION FROM AUGUST 2021 TO JANUARY 2022.

A total number of eighty-four (84) specimens were caught across the sampling duration from August 2021 to January 2022. Forty-two (42) specimens belongs to *Mormyrus rume* and forty-two (42) specimens belongs to *Chrysichthys aluuensis*.

SPECIMEN 1 (*Mormyrus rume*)

KINGDOM - Animalia

PHYLUM - Chordata

CLASS - Actinopterygii

FAMILY - Mormyridae

GENUS - Mormyrus

SPECIES - *Mormyrus rume*

SPECIMEN 2 (*Chrysithchys aluuensis*)

KINGDOM - Animalia

PHYLUM - Chordata

CLASS - Actinopterygii

FAMILY - Claroteidae

GENUS - Chrysichthys

SPECIES - *Chrysithchys aluuensis*

Plate 1: *Mormyrus rume*

Plate 2: *Chrysichthys aluuensis*

TABLE 1: Length-Weight Relationship of *Mormyrus rume* and *Chrysichthys aluuensis*.

SPECIES	Length - weight Relationship	a	b	R2	GROWTH PATTERN
Mormyrus rume	Log W = 1.2927 Log L - 2.2056	1.29	2.21	0.923	-ve allometry
Chrysichthys aluuensis	Log W = 0.8193 Log L - 2.0558	0.82	2.06	0.967	-ve allometry

4.1 Length – weight relationship of *Mormyrus rume*

The entire population of *Mormyrus rume* sampled in this study had standard length that ranged from 17.6cm to 34.7cm and the body weight ranged from 64.9g to 408.4g (Table 4.1 and Table 4.2).

Appendix 1 shows the data of the entire population of *Mormyrus rume* caught from Ighorahki, Ovia River. Figure 4.1 shows the relationship between the log standard length and the weight of the entire population of *Mormyrus rume.* The fish measured (n=42) to evaluate this relationship showed a significant correlation (r=0.923). This relationship showed an increase in weight with increasing body length. The regression equation which describes it is: BW= -2.2056 + 1.2927L, where BW represents body weight and L represents the standard length. (Figure 4.1)

The value of the regression co-efficient b (2.21) is less than 3 indicating negative allometric growth.

Table 4.2: Morphometric Characteristics of *Mormyrus rume*

Morphometric Characteristics	Mean	Minimum	Maximum
Total length	21.32	20.5	35.0
Standard length	4.82	17.6	34.7
Head length	4.14	3.7	7.6
Body depth	14.85	4.1	7.5
Weight	114.68	64.9	408.4

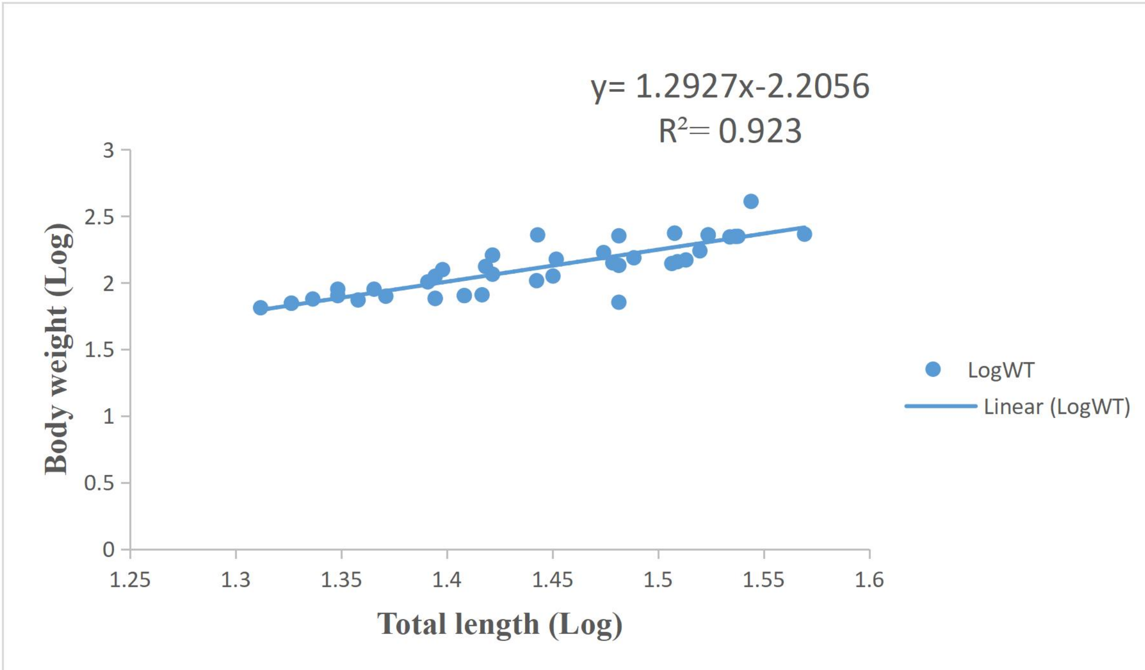

Figure 4.1: Regression curve showing length – weight relationship of *Mormyrus rume in Ovia River*.

4.2: Length – weight relationship of *Chrysichthys aluuensis*

The entire population of *Chrysichthys aluuensis* sampled in this study had standard length that ranged from 13.3cm to 27.7cm and the body weight ranged from 43.3g to 378.4g (Table 4.1 and Table 4.3).

Appendix 1 shows the data of the entire population of *v* caught from Ighorahki, Ovia River. Figure 4.1 shows the relationship between the log standard length and the weight of the entire population of *Chrysichthys aluuensis.* The fish measured (n=42) to evaluate this relationship showed a significant correlation (r=0.967). This relationship showed an increase in weight with increasing body length. The regression equation which describes it is: BW= -2.0558+ 0.8193L, where BW represents body weight and L represents the standard length. (Figure 4.2)

The value of the regression co-efficient b (2.06) is less than 3 indicating negative allometric growth (Table 4.1).

Table 4.3: Morphometric Characteristics of *Chrysichthys aluuensis*

Morphometric Characteristics	Mean	Minimum	Maximum
Total length	27.0	16.1	35.7
Standard length	21.0	13.3	27.7
Head length	6.2	3.6	8.5
Body depth	5.1	2.8	6.8
Weight	202.4	43.3	378.4

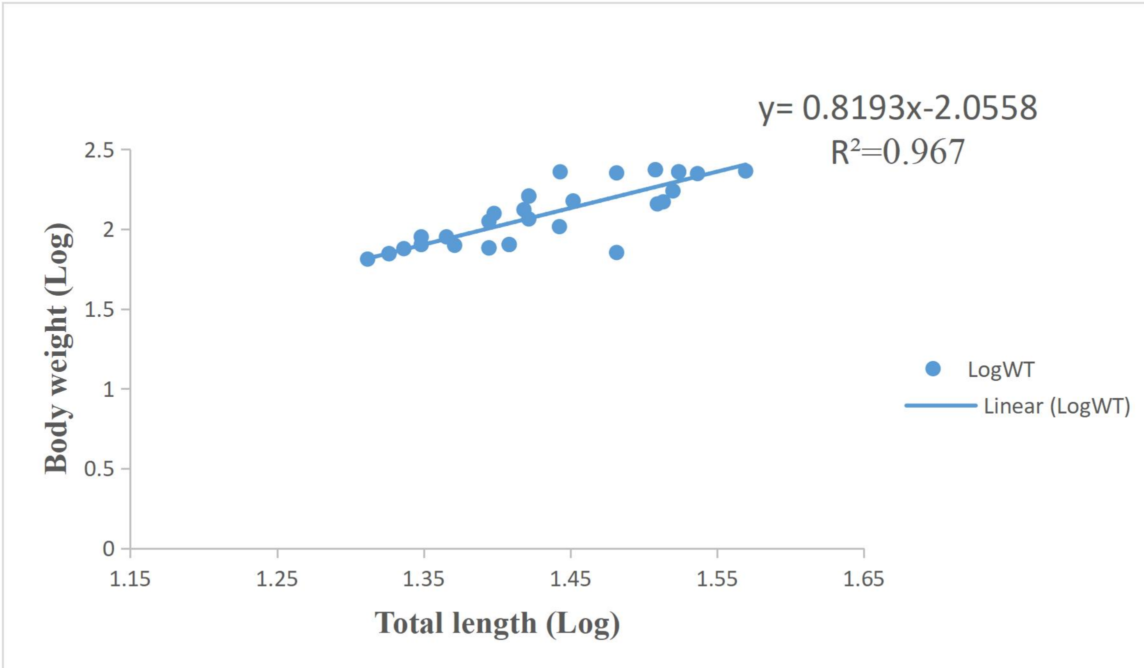

Figure 4.2: Regression curve showing length – weight relationship of *Chrysichthys aluuensis in Ovia River*

4.3 Condition factor

4.3.1 Condition factor of *Mormyrus rume*

Appendix 1 and Table 4.4 shows the individual condition factor (K) recorded for the whole population of *Mormyrus rume.* The condition factor values ranged between 0.70 and 1.70. The values fluctuated within the range throughout the study period. The highest condition factor (K) of 1.7 was recorded for a fish with body weight 71.4g and the total length of 22.3cm while the individual fish with the lowest condition factor (K) of 0.70 had a body weight of 64.9g and a total length of 20.5cm. However, the total populations have condition factor (K) values greater than 1.0 indicating a healthy fish population and good growth conditions across the duration. The mean differences were further compared using Single Factor ANOVA to test for significant differences. There was no significant difference ($P>0.05$) in k-factor of the specimens sampled across the duration of the study for *Mormyrus rume* indicating close variations in the growth conditions of the fish across the months.

Table 4.4: Condition factor (K) of *Mormyrus rume* from August to January

S/N	August	September	October	November	December	January
1	*1.191*	*0.726*	*1.561*	*1.274*	*1.335*	*1.614*
2	*1.044*	*0.978*	*0.763*	*0.820*	*0.994*	*1.270*
3	*0.991*	*1.091*	*0.718*	*0.944*	*0.990*	*0.874*
4	*1.054*	*1.087*	*0.924*	*0.934*	*0.981*	*0.741*
5	*0.835*	*0.840*	*1.670*	*0.781*	*0.849*	*0.929*
6	*0.931*	*0.784*	*1.400*	*1.312*	*1.041*	*0.926*
7	*0.989*	*0.696*	*1.698*	*1.060*	*0.878*	*0.875*
MEAN	***1.005***	***0.886***	***1.248***	***1.018***	***1.010***	***1.033***

4.3.2 Condition factor of *Chrysichthys aluuensis*

Appendix 2 and Table 4.5 shows the individual condition factor (K) recorded for the whole population of *Chrysichthys aluuensis.* The condition factor values ranged between 0.85 and 1.34. The values fluctuated within the range throughout the study period. The highest condition factor (K) of 1.34 was recorded for a fish with body weight 225.3g and the total length of 30.3cm while the individual fish with the lowest condition factor (K) of 0.85 had a body weight of 236.2g and a total length of 29.1cm. However, the total populations have a mean condition factor (K) values greater than 1.0 indicating a healthy fish population and good growth conditions across the duration. The mean differences were further compared using Single Factor ANOVA to test for significant differences. There was no significant difference ($P>0.05$) in k-factor of the specimens sampled across the duration of the study for *Chrysichthys aluuensis* indicating close variations in the growth conditions of the fish across the months.

Table 4.5: Condition factor (K) of *Chrysichthys aluuensis* from August to January

S/N	August	September	October	November	December	January
1	*1.335*	*0.886*	*0.886*	*0.854*	*0.908*	*1.118*
2	*0.994*	*0.877*	*0.874*	*0.859*	*0.940*	*0.861*
3	*0.990*	*1.082*	*1.101*	*1.102*	*0.914*	*1.124*
4	*0.981*	*1.075*	*1.093*	*1.066*	*1.152*	*0.906*
5	*0.849*	*1.030*	*0.976*	*0.965*	*1.023*	*0.992*
6	*1.041*	*1.041*	*1.057*	*1.096*	*0.962*	*1.058*
7	*0.878*	*1.031*	*1.048*	*1.097*	*1.130*	*0.972*
MEAN	***1.010***	***1.003***	***1.005***	***1.006***	***1.004***	***1.004***

4.4 Sex ratio

4.4.1 Sex ratio of *Mormyrus rume*

Table 4.6 and Figure 4.3 below represents the summary of sex ratios of *Mormyrus rume* collected across the sampling duration. From the table, 25 male and 17 female specimens were randomly sampled. Highest similar counts (5) were recorded for males and females in August and January respectively, while lowest (2) were recorded in August and January for female and male respectively. Mean sex ratio was 1:1.3, indicating slightly higher number of males to females in the *Mormyrus rume* population during the sampling duration, with highest value in August and January (1:2).

Table 4.6: Sex ratio of *Mormyrus rume* across the sampling duration

MONTH	FEMALE	MALE	SEX RATIO
AUG	2	5	1:2
SEPT	3	4	1:1
OCT	4	3	1:1
NOV	3	4	1:1
DEC	3	4	1:1
JAN	2	5	1:2
TOTAL	17	25	1:1
MEAN			1:1.3

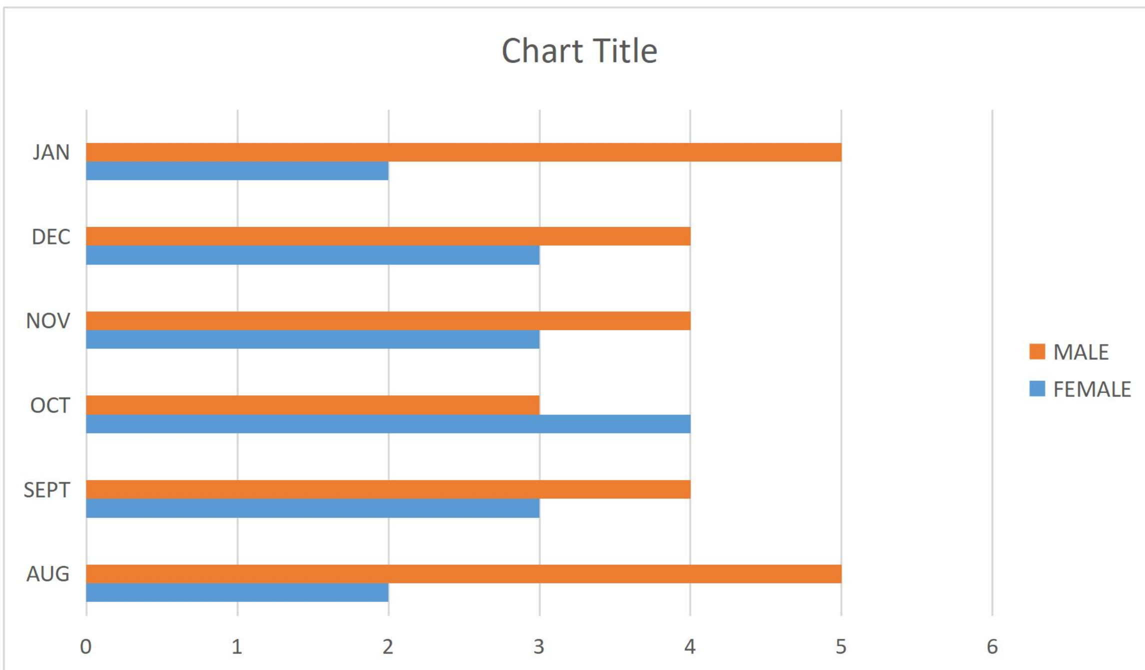

***Figure* 4.3:** Bar chart showing the Sex ratio of *Mormyrus rume* across the sampling duration

4.4.2 Sex ratio of *Chrysichthys aluuensis*

Table 4.7 and Figure 4.4 below represents the summary of sex ratios of *Chrysichthys aluuensis* collected across the sampling duration. From the table, 27 male and 15 female specimens were randomly sampled. Highest counts (6) were recorded for males in October and November while lowest count (1) were recorded in January. Highest counts (5) were recorded for males in January while lowest count (1) were recorded in October and November. Mean sex ratio was 1:3, indicating a higher number of males in the *Chrysichthys aluuensis* population during the sampling duration, with highest value in October and November (1:6).

Table 4.7 Sex ratio of *Chrysichthys aluuensis* across the sampling duration

MONTH	FEMALE	MALE	SEX RATIO
AUG	3	4	1:1
SEPT	2	5	1:2
OCT	1	6	1:6
NOV	1	6	1:6
DEC	3	4	1:1
JAN	5	2	2:1
TOTAL	15	27	1:2
MEAN			1:3

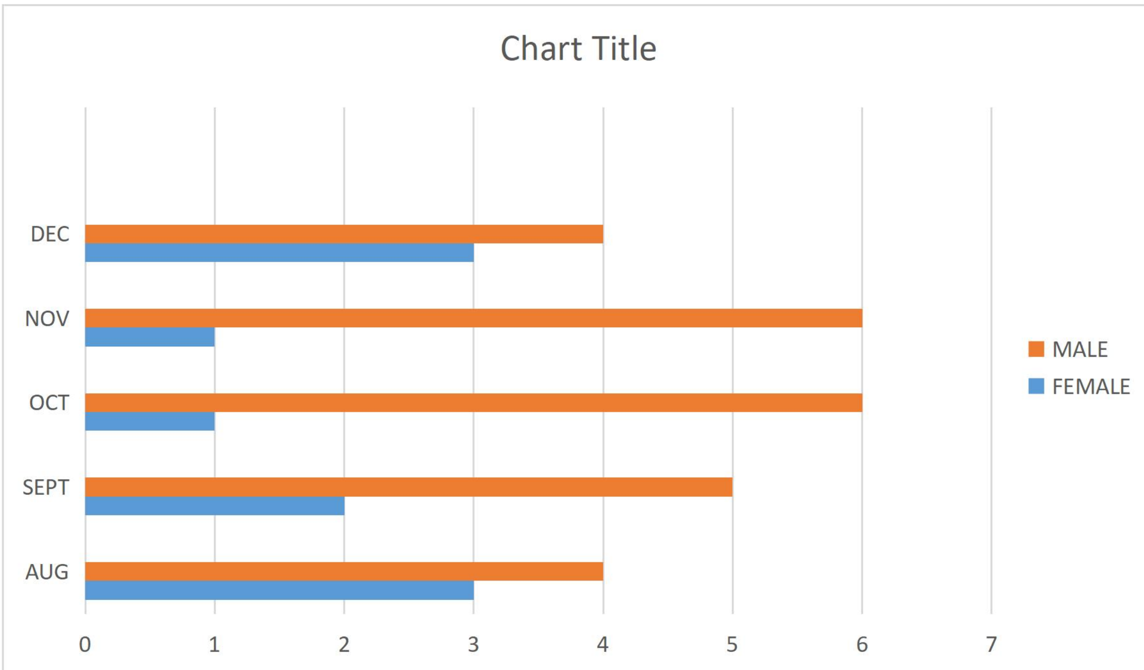

Figure 4.4: Bar chart showing the Sex ratio of *Chrysichthys aluuensis* across the sampling duration.

CHAPTER FIVE

5.0 DISCUSSION

Fish can exhibit different growth patterns namely isometric growth (b=3) where there is no change in body shape with increase in length, negative allometric growth (b3) where fishes become fatter with increase in length indicative of good environmental factors such as dissolved oxygen, optimum temperature, availability and/or abundance of food.

The parameter b may vary seasonally, even daily and between habitats. Thus, the length-weight relationship in fish is affected by a number of factors including gonad maturity, sex, diet, stomach fullness, health, and preservation techniques as well as season and habitat (Erguden *et al,* 2009). With regard to the b-value of the family Mormyridae, 1.99 in *Mormyrus rume* from Ose River, Southern Nigeria (Odedeyi *et al,* 2007) and the b-value of the family Claroteidae, 3.23 in *C. auratus* and 2.91 in C. *nigrodigitatus* from Kpong Reservoir, Ghana (Quarcoopome, 2017). In the present study, the exponents b-value of the length-weight relationship (combined sexes: b=2.21; males: b=? and females: b=?) of *Mormyrus* rume and the exponents b-value of the length-weight relationship (combined sexes: b=2.06; males: b=? and females: b=?) of *Chrysichthys aluuensis* were both estimated in Ighoraki and both showed negative allometric growth.

The results of length weight relationship of *Mormyrus rume* and *Chrysichthys aluuensis* were compared with the available literature. For *Mormyrus rume*, negative allometric pattern (b<3) obtained in this study is similar to findings observed in Ose River (Odedeyi *et* al, 2007) while the negative allometric pattern (b<3) obtained in this study for *Chrysichthys aluuensis* is different to findings observed in Kpong Reservoir. The value of exponent ‘b’ of different size of *Mormyrus* *rume* was 1.99 and 2.13 from Ose River while the value of exponent 'b' of *C. auratus* and *C. nigrodigitatus* were 3.23 and 2.91 respectively. In the present study, the b-value of *M. rume* is slightly higher than the result of Ose River while the b-value of *C. aluuensis* is lower than the result of Kpong Reservoir. This negative allometric growth pattern in both species could be attributed to low food items for these species in the ecosystem or reduction of their body size to escape predation or high fishing mortality or intensity and adverse effects of environmental pollution on the growth (Law R, 2003).

The overall result of this study revealed that *Mormyrus rume* and *Chrysichthys aluuensis* showed negative allometric pattern of growth with the b-values less than ideal value (3.0) which indicates that as the length of the fishes increased, they became lighter, thinner or less plumpy or simply put, they shows poor growth of length and weight (Mon *et al,* 2020).

The reason for the different result of b-value there may be ecological differences or variability such as temperature and food availability. Individuals in any fish population growing in the same areas during the growth of the individuals in different populations some differences can be observed (Tirasin EM, 1993). If fish grow isometrically than it retains its body shape and its specific gravity will also remain unchanged during the life time, therefore, in such cases, its b-value must be equal to 3.0. Hence, this growth pattern in fish will follow the cube law. But under natural condition, most fish do not show the cube law, because they change their body shape as they grow or increase in size and become heavier in one season and lighter in the other season (Wootton RJ, 1998).

Fish condition factor (K) is an index which expresses the degree of well-being, relative robustness, and interactions between biotic and abiotic factors in fish physiological condition (Froese, 2006). When condition factor values are higher it means that fishes have attained a better condition and are better adapted to the environment. The variations in K values of *Mormyrus rume* and *Chrysichthys aluuensis* species might be due to the differences in the maturation of gonads, increases or decreases in feeding behaviour, amounts of fats or population changes that may occurs due to the changes in food items (Akombo *et al*, 2011).

In the present study, the mean condition factor estimated from the equation K=W*100/L3 was 1.03 in males, 1.04 in females and 1.03 in combined sexes for *Mormyrus rume* and 1.00 in males, 1.01 in females and 1.01 in combined sexes for *Chrysichthys aluuensis*. Males of *Mormyrus rume* (1.04) showed the highest mean values of condition factor (K) than females, indicating that males of *Mormyrus rume* at a given length were heavier than females of similar length. Meanwhile females of *Chrysichthys aluuensis* (1.01) showed the highest mean values of condition factor (K) than males, indicating that females of *Chrysichthys aluuensis* at a given length were heavier than males of similar length. The highest K values recorded for *Mormyrus rume* and *Chrysichthys aluuensis* was indicating that both species can survive well even when environmental condition. These observations on condition factors of both species could be attributed to changes in feeding activity and, or degree of nourishment, food availability, gonadal activity, stress, sex, season, and other water quality parameters (Quarcoopome 2017; Khallaf *et al*, 2003).

Sex ratio studies provide information on the proportion of male to female fish in a population and are expected to be 1:1 in nature. Any deviation from this ratio may indicate the dominance of one sex over the other (Shamsan and Ansari, 2010). It is suited that dominance of one sex relative to the other can be due to different behaviours in the two sexes leading to an easier catch of one sex, differences in fishing methods and equipment, different fishing factors related to season and schooling in feeding and spawning ground and spatio-temporal segregation of the sexes (Hakimelani *et al*, 2010). Month wise analysis of sex ratio of present study showed that the overall sex ratio of males to females was 1:1.5 and 1:3 in *Mormyrus rume* and *Chrysithcys aluuensis* respectively and this clearly gave an indication of lower reproduction efficiency since male population was higher than the female population.

For combined sex of *Mormyrus rume* and *Chrysithcys aluuensis* from the Ovia River, differences in sex ratio were significant at 95 per cent confidence interval indicating that there was departure from the expected sex ratio of one male to one female. The reason for the departure from 1:1 sex ratio in both species is not clear but could have been influenced by differentiation in fish growth of the sexes as well as food availability (Vincentini & Araujo, 2003). There were significantly more males than females at 95 per cent confidence interval for the months of October and November with respect to *Chrysithcys aluuensis*. Similarly, there were significantly more males than females at 95 per cent CI for the months of August and January for *Mormyrus. rume*. This observation could be attributed to differential growth rates of males and females coupled with abundance and availability of preferred food which favour males.

5.1 CONCLUSION

Mormyrus rume belongs to the family Mormyridae which is one of the largest groups of fishes. On the other hand, *Chrysichtys aluuensis* belong to one of the most important commercial catfish family, Claroteidae in Ovia River. The ability of both species to feed on a wide range of organisms at different trophic levels (food chain) was the possible reason for their healthy fish population and good growth conditions, making them promising candidates for commercial culture. Since the species are widely accepted and used as human food throughout the area in which they occur, they could be easily incorporated into local polyculture systems with minimal inputs of expensive animal protein in their diet.

The knowledge of the biology of these two species is essential for increase in yield and proper management of fishery resources. Though it is not feasible to exhaust the knowledge of the biology these two species, it is hoped that the information provided in this study will pave way for further understanding of these fish species and other related species. Nonetheless, more works should be carried out on other aspect of the biology of these fish species such as spawning pattern, diet composition and feeding habit, especially *Chrysichthys aluuensis*.

To support food security, reservoir fishery development and sustainable management interventions, fish species in Ovia River require regular assessment of biological, ecological and environmental characteristic.

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