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Population structure, Length weight relationship and condition factor of two Tilapia species in a Tropical River System: Implications for Fishery Assessment, Modelling and Conservation

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Abstract: *Fish as a whole has a lot of food potential and can therefore be expected to provide relief from malnutrition; especially in developing countries. Tilapias are important in local and export markets as well as food fish by rural farmers. Tilapia species are important in the ecology of tropical waters as well as in the resources of aquatic systems of the sub-tropical regions. Tilapia species are suitable for fish culture and are the commercially important inland water fish of Africa. The population structure, length-weight relationship and condition factor of Tilapia zilli and Oreochromis niloticus were determined in Mid-Cross River basin, South-Eastern Nigeria. A total of 120 fish samples each of T. zilli and O. niloticus were analyzed and modelled. Data were collected monthly for a period of four months. The sexes were identified with their morphological factors. The length-weight relationship and condition factors were determined by* mathematical and statistical method in FiSAT II software. *Sex ratio of T. zilli population had 30 males and 90 females, at 25% and 75% respectively. The sex ratio of male to female was 1:3. The data on length and weight of T. zilli, varied between 7.5-34.0cm and 45-327g respectively. The mean total length and weight were 17.3±0.57cm and 93.8±5.34g respectively. The slope (b) value of the length-weight relationship of T. zilli was 1.5095, thus the growth pattern of T. zilli in the River was negative allometric growth. The condition factor K value obtained for T. zilli was 1.61, indicating that the fish is in good condition. Monthly condition factor value shows that the month of July had the highest K value of 1.77 while lowest K value of 1.49 was calculated in September. One hundred and twenty (120) species of O. niloticus were collected and sampled for this study. The highest sex ratio was in July (1:2.3) and lowest sex ratio was in August (1:1.2). Overall sex ratio for the sample population was 1:1.5 indicating more females than males. The length and weight distribution for O. niloticus ranged from6.7-38.8cm TL, mean was 24.0±0.76cm TL and 55-395.2g, mean 223.83±15.34g respectively. The fish population showed a typical 'b' value of 1.3850 for the length-weight relationship which revealed that the growth pattern was a negative allometric growth. The monthly condition factor indicates that the month of September has the highest condition factor which is 3.07 while the month of August has the lowest condition factor value which is 1.93. Overall condition factor value for the population is 2.55. The sampled fishes in Mid Cross River Basin were in good condition, but not at their optimum growth. Therefore this fishery is in dire need of proper effective management. Fishermen in the area should be educated on sustainable management of this freshwater resource, by selecting the optimum mesh size which release small fish and allow each fish to produced eggs at least once in its life.*

Keywords: *population structure, length-weight relationship, condition factor, Tilapia zilli, Oreochromis niloticus*

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I. Introduction

Fish as a whole has a lot of food potential and can therefore be expected to provide relief from malnutrition; especially in developing countries [1].True tilapias however are native only to African and Middle East. Tilapias are fishes surrounded by fascinating facts [2]. They have important roles these days increasing total supply at affordable prices. Tilapia inhabits a variety of fish and less commonly brackish water habitats, from shallow streams and ponds through the rivers, lakes and estuaries. Tilapias are hardy species produced by several culture methods under a wide range of environment condition [3]. Tilapias are produced in many countries, but mostly in the tropical and subtropical regions in the developing countries contrary to some aquaculture species, tilapias are important in local and export markets as well as food fish by rural farmers [4]. *Tilapia* species are important in the ecology of tropical waters as well as in the resources of aquatic systems of the sub-tropical regions. [5] observed that *Tilapia* species are suitable for fish culture and are the commercially important inland water fish of Africa. The outstanding culturable qualities of these fish species in warm waters have been well reported [6]; [7] and [8]. There are more than 100 species of *Tilapia* and are originally found in

Africa and parts of the Middle East but can today be found in a number of other waters around the world [9]. *T. zilli* inhabit a variety of fresh and less commonly brackish water habitats from shallow streams and ponds through the rivers, lakes and estuaries. Most *T. zilli* are omnivore with a preference for soft aquatic vegetation and detritus [10].*O. niloticus* is a hardy and adaptable species that is found in a wide range of habitats, including rivers, streams, ponds, lakes and coastal plains. It occurs in both fresh and brackish waters and usually inhabits shallow areas. As a result, the production of farmed tilapia has increased from 383,654mt in 1990 to 1,505,804mt in 2002, representing about 6% of total farmed finfish in 2002 [11].The species is favored among aquaculturists due to its ability to tolerate a wide range of environmental conditions, fast growth, successful reproductive strategies, and ability to feed at different trophic levels. These same traits allow them to be an extremely successful invasive species in subtropical and temperate environments [12]. They occur in a wide variety of freshwater habitats like rivers, lakes, sewage canals and irrigation channels [13].In a fight to reduce high incidence of protein deficiency, various agencies and governments tackle the problem by fish rearing. Due to their large size, good flavor and rapid growth rate, many *Tilapias* are at the focus of major fishing and agricultural efforts set against their value as food. They are hardy species and can tolerate a wide range of ecological conditions with a high reproductive rate. Tilapia is the fifth most important fish in fish farming, with production reaching 1505,804 metric tons in the year 2000. This is because of their large size, rapid growth and palatability [14].

Length-weight relationships can be used as character for differentiation of taxonomic units. An already established length-weight relationship will be useful for assessing the data that contains only length frequency measurements. This relationship can be used in setting up of yield equations, estimate the number of fishes landed and for comparing the population over space and time. The mathematical parameters of the relationship between the length and weight of fish furnish further information on the weight variation of individuals in relation to their length (condition factor, K). This factor estimates the general well-being of the individual and is frequently used in three cases: (a) Comparison of two or more co-specific populations living in similar or different conditions of food, density or climate; (b) Determination of period and duration of gonadal maturation and (c) Observation of increase or decrease in feeding activity or population changes, possibly due to modifications in food resources. These relationships are also an important component of Fish Base [15]. In addition, the data on length and weight can also provide important clues on climate and environmental changes, and change in human subsistence practices. Condition factor is important in understanding the life cycle of fish species and it contributes to adequate management of these species, hence, maintaining the equilibrium in the ecosystem [16]. Therefore, this study seeks to determine the population structure, length-weight relationship and condition factor of *T. zilli and O. niloticus* in the Mid Cross River basin, South Eastern Nigeria; implications for fishery assessment, modeling and conservation.

II. Materials And Methods

Study area and sampling locations.

The study was carried out in mid-Cross River basin. The area lies approximately between longitude $3^o30'$E and $10^o00'$E and latitude 4^oN and 8^oN. The river basin covers an area of 54 000 km^2 with 14 000 km^2 in the Cameroon and 39 500 km^2 in Southern Nigeria (Fig. 1).Four fishing sites were sampled; Site I (Uwanna) is also a minor water transport route between Cross River State and Ebonyi State. It is also a source of municipal water supply. Minor dredging activity takes place in this station. Site II (Ozziza) is a minor transport rout, and also use for domestic activities. Site III (Ndibe) is a major commuters' and wood transport route. Dredging activities also take place here during the dry season due to the appearance of sand bank, which also attracts a lot of recreational activities to the site. Site IV (Akpoha) is a minor transport route located on the Mid Cross River floodplain. Local inhabitants preserve the fishery resources of the river using traditional fish drying and smoking method. The rainy season and the dry season are the two main seasons of the area. The vegetation around the river is predominately grasses, tall and thin palm trees, and bamboo plants and elephant grasses unevenly distributed. Hence, the vegetation and the ecological built of the area attract some activities such as recreation (escortion and picnic), fishing, lumbering farming activities as well as sand mining due to the presence of sand banks. A mini market is located beside the river where fishes are marketed immediately they are caught. However, in most cases, fishes are transported to other areas of Ebonyi state and Cross River state. There is also water fluctuation in the Cross River system with season which goes a long way to determine the agricultural activities of the occupants during each period. During the dry season, (between November and March), some areas of the river floor is seen and covered with sand hence fishing activities is usually hampered and most fishermen would abandon their fishing activities and change over to sand mining (minor dredging activities). During the raining season (April- September), water levels will increase and reverse the activities of the people[17].

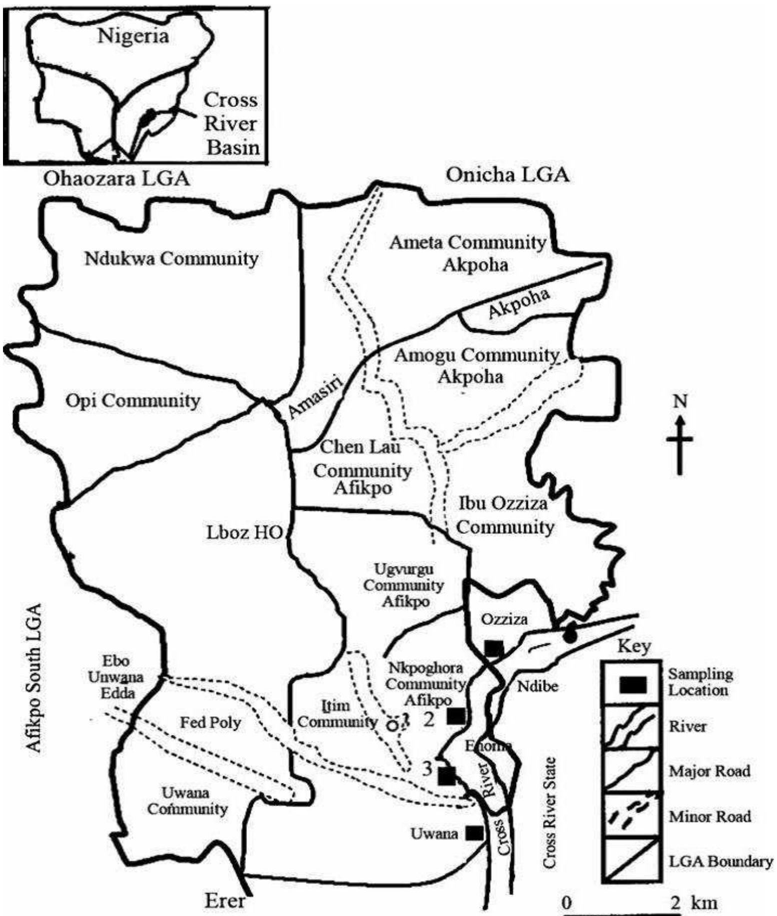

Fig. 1. Map of Afikpo North Local Government Area showing the sampling location in the Cross River basin [17].

Sampling method

A total of 120 fish specimens for both tilapias fishes were collected from local fishermen the river of Uwanna, Akpoha, Ozizza and Ndibe respectively in the morning. Daily sampling was carried out between 6.30am and 11.00am for a period of four months (June -September, 2019).The fishes used for this study were caught by local fishermen at Ndibe, Oziza, Uwana and Akpoha River of the Cross River basin using locally available crafts and fishing gears which include canoes, cast nets, gill nets, hook and lines. The fishes were preserved in 70% ethanol solution and were transported in a plastic container to the applied biology laboratory of the Ebonyi State University, Abakaliki.

Laboratory Analysis

In the laboratory, the fishes were serially numbered and mopped on a filter paper to remove excess water from their body before they were weighed in order to ensure accuracy [18]. The fishes were sorted out and identified to species level using key provided by [19]. The total length (from the snout to the tip of longest caudal fin) was measured to 0.1cm and recorded accordingly. The weight of each fish was measured to the nearest 0.1g on a top electronic weighing balance.

Statistical and Mathematical Analysis

The total length and weight of the samples were used for data analysis based on computer programme of FiSAT (FAO-ICLARM Stock Assessment Tools) software [20].

The relationship between length (TL) and weight (W) was estimated using the formula:

$W= aL^b$

Where W= weight of the fish in gram, L = Total length (TL) of the fish in cm, a = constant (Intercept) and b = slope

The power curve $W= aTL^b$ or its logarithm transformation; $LogW = Loga + bLogTL$ were used to estimate the parameters “a” and “b” in the relationship between body weight and total length.

The “a” and “b” values were obtained from a linear regression of the length and weight of fish. The correlation (r^2), which is the degree of association between the length and the weight, was computed from the linear regression analysis.
$R = r^2$
The condition factor (K) of the experimental fishes was estimated from the relationship
$K = 100W/L^3$
Where K = condition factor, W= weight of fish and L = length of fish.

III. Results

Population structure

A total of one hundred and twenty (120) species of *T. zilli* and *O. niloticus* were examined in four sampling occasions in mid-Cross River basin. The overall sex- ratio for *T. zilli* (M/F) was 1: 3. Occurrence of females were relatively higher than males in total catch as well as in samples collected in June (75%), July (76.7%) and August (85.7), while for males, sex ratio was found to occur in higher percentage in September (53.3%). Chi-square test (X^2) showed significant seasonal differences between both sexes ($P < 0.05$).The summary of the variations in number of males, females and sex ratio in monthly samples of *T. zilli* from mid-Cross River basin are presented in Table 1. Monthly frequency distribution of *T. zilli* is as seen in Fig. 2. Overall sex ratio for the *O. niloticus* population was 1:1.5 indicating more females than males. The Highest sex ratio was in July (1:2.3) and lowest sex ratio was in August (1:1.2) (Table 2). Fig. 3 represents the monthly frequency distribution of *O. niloticus.*

Table 1: Monthly sex ratio of *T. zilli* in mid-Cross River basin.

Months	No / % of males	No / % of Females	Total number	Sex-ratio (Male-Female)	Chi-square
June	10 (25.0)	30 (75.0)	40	1: 3.0	1.00
July	7 (23.3)	23 (76.7)	30	1: 3.0	0.83
August	5 (14.3)	30 (85.7)	35	1: 6.0	0.14
September	8 (53.3)	7 (46.7)	15	1: 0.9	0.01
Total	30 (25)	90 (75)	120	1: 3.0	

Chi-square values. * Significant (p<0.05)

Table 2: Monthly sex-ratio of *O. niloticus* in mid-Cross River basin.

Months	No / % of males	No / % of Females	Total number	Sex-ratio (Male-Female)	Chi-square
June	12 (42.9)	16 (57.1)	28	1: 1.3	0.06
July	8 (30.8)	18 (69.2)	26	1: 2.3	1.28
August	18 (45.0)	22 (55.0)	40	1: 1.2	0.94
September	11(42.3)	15 (57.7)	26	1: 1.4	1.28
Total	49 (40.8)	71 (59.2)	120	1: 1.5	

Chi-square values. * Significant (p<0.05)

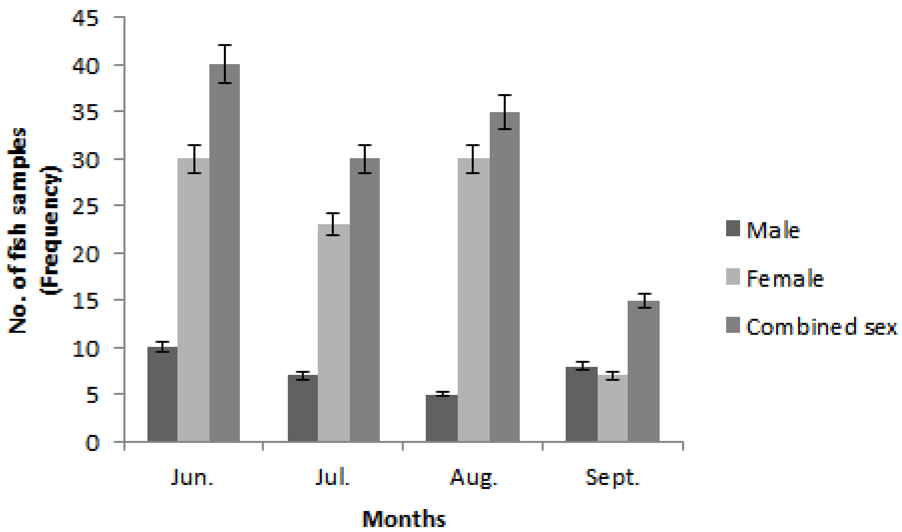

Fig. 2: Monthly frequency distribution of *T. zilli* in mid-Cross River basin.

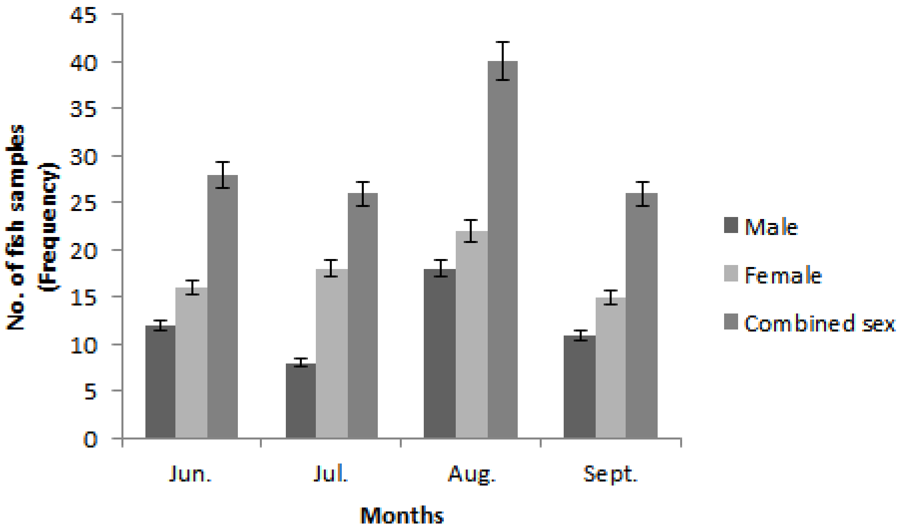

Fig. 3: Monthly frequency distribution of *O. niloticus* in mid-Cross River basin.

Length frequency distribution

The Total length (TL)-frequency distribution is as shown in Fig. 2. The total length of *T. zilli* ranged from 7.5-32.2cm TL for males, 7.8-34.0cm TL for females, and 7.5-34.0cm TL for combined sexes. The mean total lengths of male, female and combined sexes of *T. zilli* were 16.5±0.76cm TL, 17.2±0.63cm TL, and 17.3±0.57cm TL respectively. Length frequency distribution of *T. zilli* revealed that the total length class interval of 15-20 cm TL had the highest frequency value of 36 while total length class interval 30-35cm TL had the lowest frequency value of 4.

The total length of *O. niloticus* was between 6.7-36.1cm TL for males, 7.5-38.8cm TL for females, and 6.7-38.8cm TL for combined sexes. The mean total length of male was 22.5±0.68cm TL, female 24.1±0.75cm TL and combined sexes 24.0±0.76cm TL. Length frequency distribution of *O. niloticus* showed that the total length class interval of 20-25cm TL had the highest frequency value of 46 while total length class interval 35-40cm TL had the lowest frequency value of3.

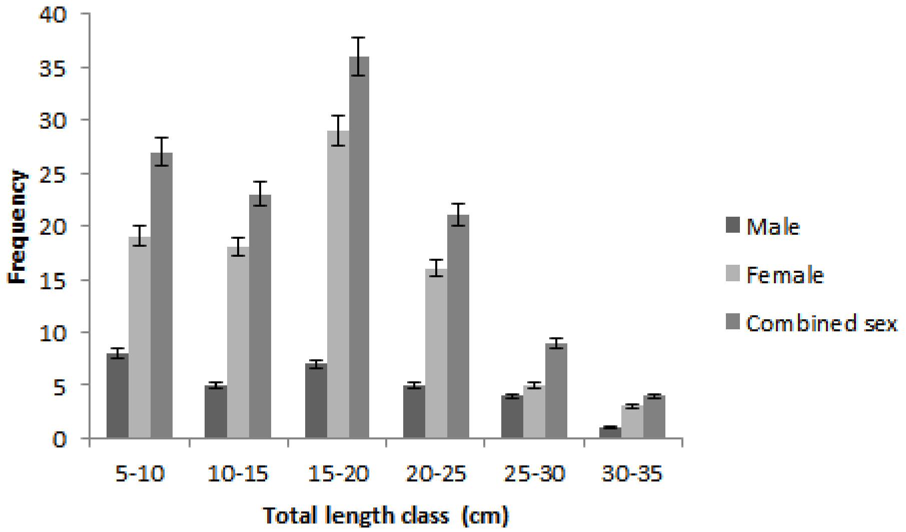

Fig. 4: Length class frequency distribution of *T. zilli* in mid-Cross River basin.

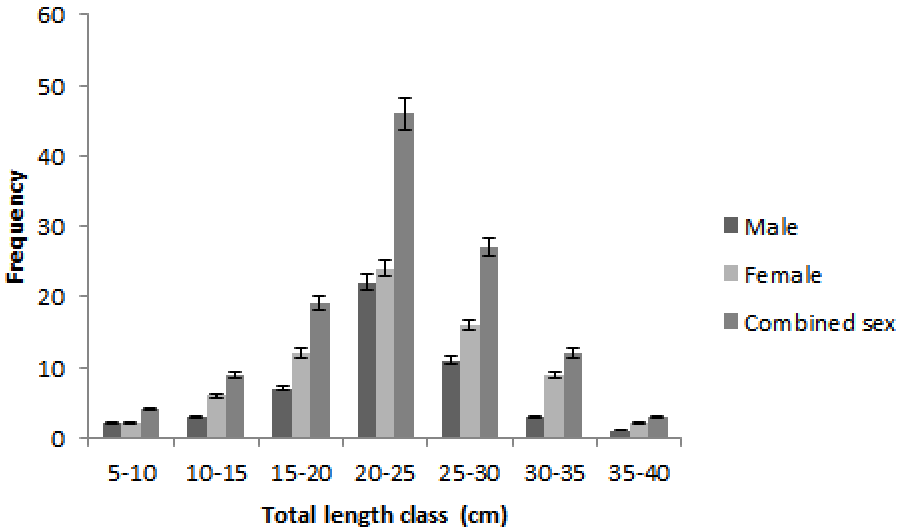

Fig. 5: Length class frequency distribution of *O. niloticus* in mid-Cross River basin.

Weight frequency distribution

The weight ranges for male, female and combined sexes of *T. zilli* were 45-325g, 49.1-327g and 45-327g respectively. The mean weights of male, female and combined sexes of *T. zilli* were 96.0±8.02g, 93.1±7.26g and 93.8±5.43g respectively. The weight frequency distribution is shown in Fig. 6.

The weight frequency of *O. niloticus* (Fig. 7) which showed that weight between the class intervals of 200-250 had the highest frequency of 37 while those between the class intervals of 50-100 had the lowest number of 8. Weight ranged from 55-347g, 57.9-395.2g and 55-395.2g for male, female and combined sexes respectively. Mean weights for male, female and combined sexes for *O. niloticus* were 206.7±11.42g, 213.1±12.76g and 223.8±15.34g respectively.

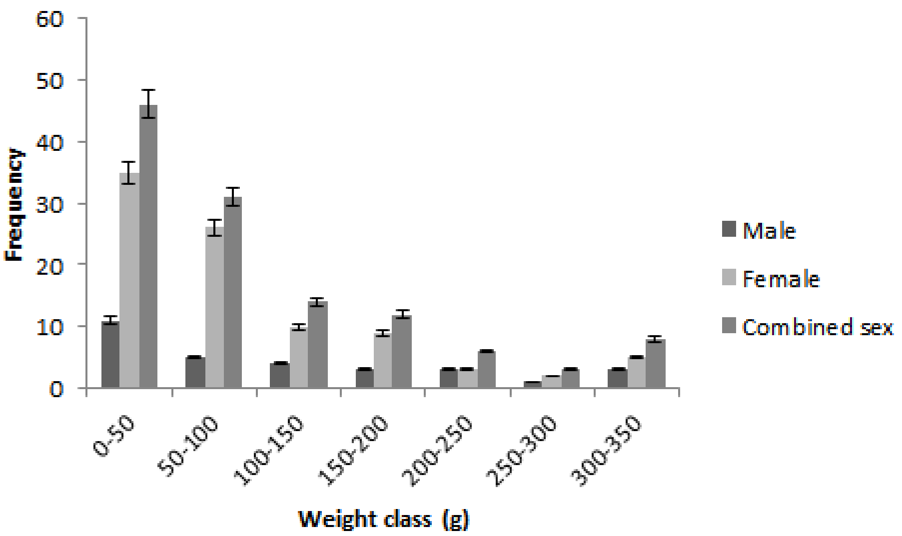

Fig.6: Total weight frequency distribution of *T. zilli* in mid-Cross River basin.

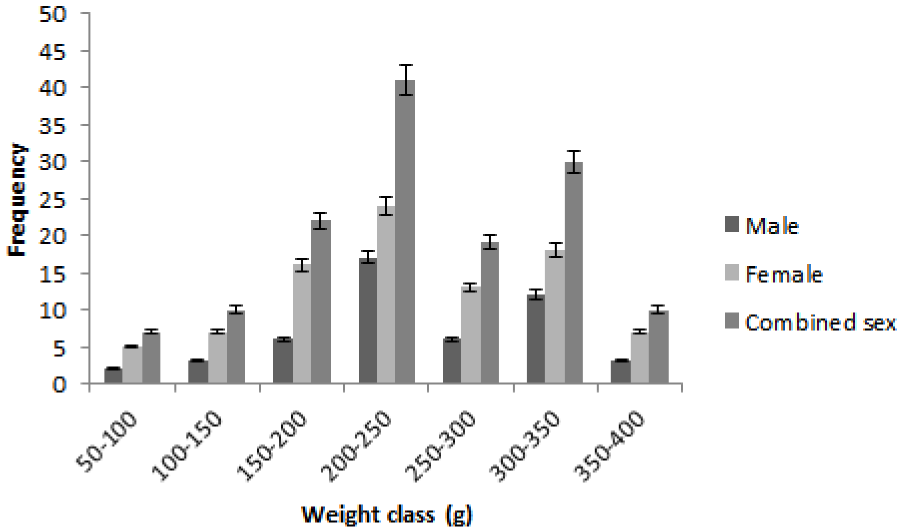

Fig.7: Total weight frequency distribution of *O. niloticus* in mid-Cross River basin.

Length-Weight Relationship of the Populations

The scatter plots of length-weight relationships of the population of *T. zilli* in mid-Cross River basin during the period of study are shown in Fig. 6. The total length (TL) of *T. zilli* ranged between 7.5cm and 34.0cm and weighed between 45g and 327g. Regression relationship between the total Length (TL) and total Weight (W) of *T. zilli* is as seen in Fig. 8a, b and c. The equation describing this relationship is W = 0.2753 $L^{1.5095}$ (r = 0.9776) (Fig. 8)

Fig. 9a,b and c show the length-weight relationship of *O. niloticus* below shows that the intercept ‘a’ = 0.5173, the slope ‘b’ is 1.3850 and the correlation co-efficient ‘r’ is 0.9407with total length (TL) of *O. niloticus* between 6.7-38.8cm TL and weight between 55g and 387g.

Regression Analyses of *T. zilli* and *O. niloticus* from Mid-Cross River Basin are as shown in Tables 3 and 4.

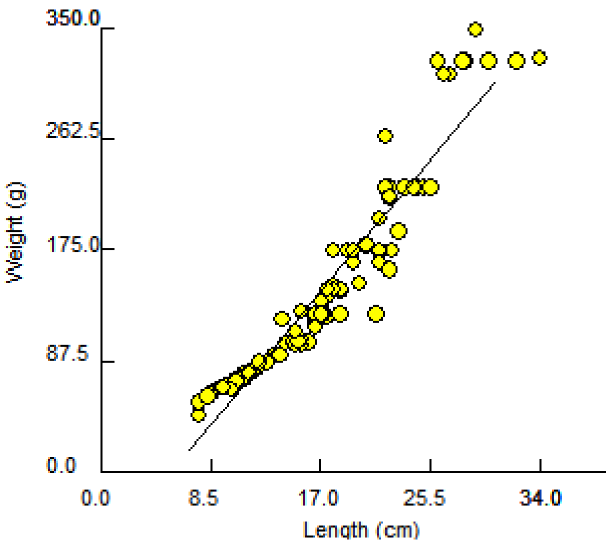

Fig.8a: Length-Weight relationship of *T. zilli* in mid-Cross River basin.

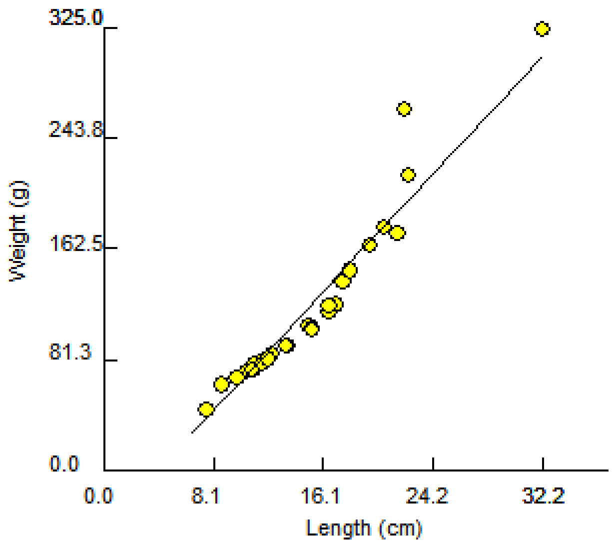

Fig. 8b: Length-Weight relationship of *T. zilli* (males) in mid-Cross River basin.

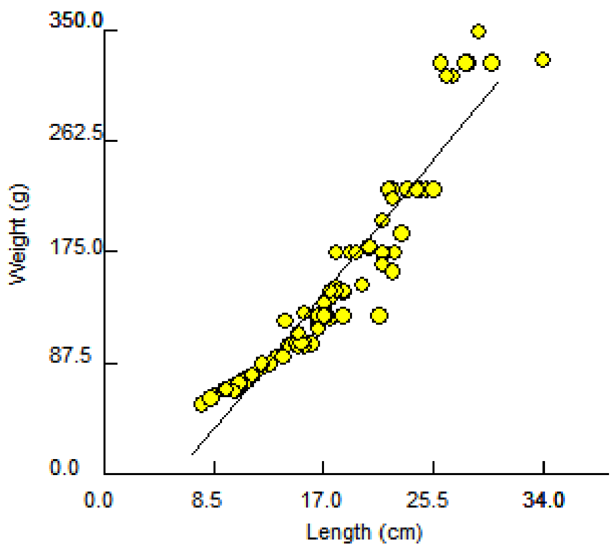

Fig. 8c: Length-Weight relationship of *T. zilli* (females) in mid-Cross River basin.

Table 3: Regression Analysis of *T. zilli* from Mid-Cross River Basin

Regression formula Log (W) = a+b* Log (L)	Combined sex	male	female
No. of Observation	120	30	90
Intercept 'a'	0.2753	0.1416	0.2294
Standard deviation 'a'	0.0362	0.0532	0.0426
Cl of intercept	0.2042	0.0325	0.1460
	0.3463	0.2508	0.3129
Slope 'b'	1.5095	1.6291	1.5445
Standard deviation 'b'	0.0299	0.0465	0.0347
Cl of slope	1.4508	1.5337	1.4765
	1.5682	1.7244	1.6125
Correlation coefficient 'r'	0.9776	0.9888	0.9785
r^2	0.9556	0.9777	0.9575
Cl of r	0.9679	0.9763	0.9675
	0.9843	0.9947	0.9858

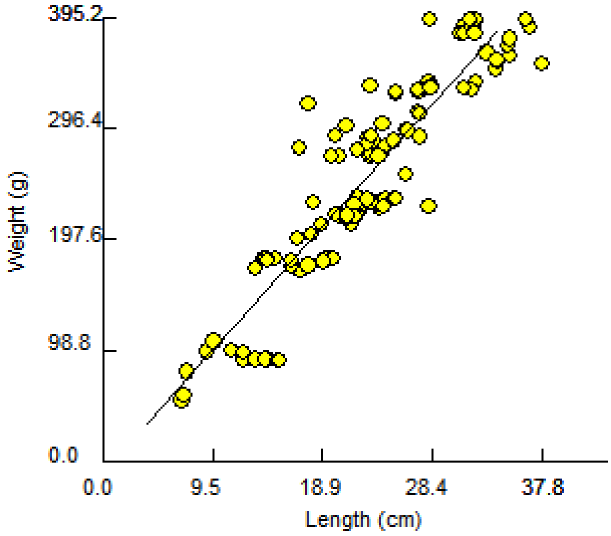

Fig. 9a: Length-weight Relationship of *O. niloticus* in mid-Cross River basin.

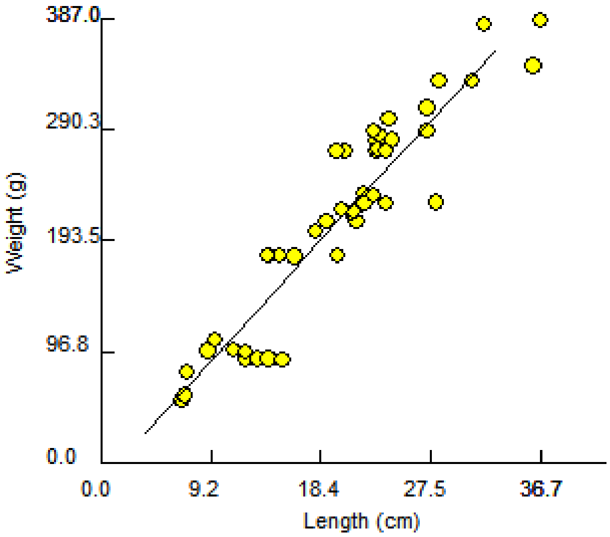

Fig. 9b: Length-weight Relationship of *O. niloticus* (male) in mid-Cross River basin.

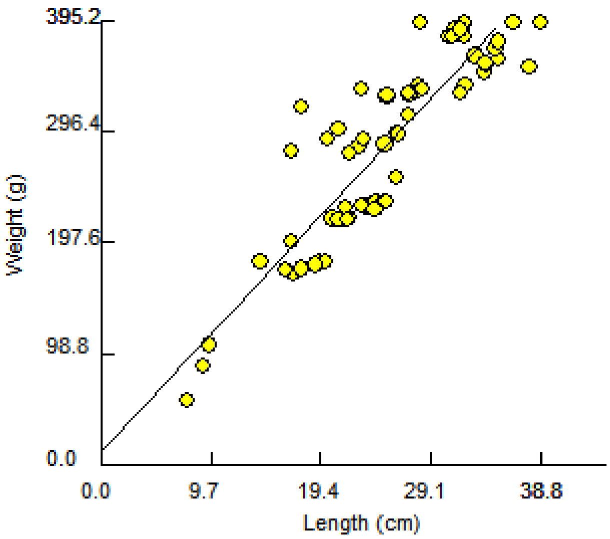

Fig. 9b: Length-weight Relationship of *O. niloticus* (female) in mid-Cross River basin.

Table 4: Regression Analysis of *O. niloticus* from Mid-Cross River Basin

Regression formula Log (W) = a+b* Log (L)	Combined sex	male	female
No. of Observation	120	49	71
Intercept 'a'	0.5173	0.3788	0.3613
Standard deviation 'a'	0.0616	0.0859	0.0760
Cl of intercept	0.3965	0.2103	0.2123
	0.6382	0.5472	0.5102
Slope 'b'	1.3850	1.4930	1.4913
Standard deviation 'b'	0.0460	0.0682	0.0549
Cl of slope	1.2949	1.3593	1.3836
	1.4751	1.6267	1.5989
Correlation coefficient 'r'	0.9407	0.9543	0.9562
r^2	0.8849	0.9107	0.9144
Cl of r	0.9159	0.9199	0.9305
	0.9584	0.9741	0.9726

Condition Factor of the two populations

Table (5) shows the monthly variation in length-weight relationship and condition factor (K) of *T. zilli* of mid-Cross River basin. The highest and lowest K values were 1.77 (June) and 1.49(September) respectively. Overall condition factor value for the population was 1.61.

Monthly condition factor of *O. niloticus* indicated that the month of September had the highest condition factor which was 3.07 while the month of August had the lowest condition factor value of 1.93. Overall condition factor value for the population was 2.55 (Table 6).

Table 5: Monthly Condition factor (K) of *T. zilli* mid-Cross River basin.

Months	No. (%) of samples	Condition Factor (K)
June	40(33.3)	1.77
July	30(25.0)	1.67
August	35(29.2)	1.51
September	15(12.5)	1.49
Total	120	1.61

Table 6: Monthly Condition factor (K) of *O. niloticus* mid-Cross River basin.

Months	No. (%) of samples	Condition Factor(K)
June	28(23.3)	2.95
July	26(21.7)	2.24
August	40(33.3)	1.93
September	26(21.7)	3.07
Total	120	2.55

The length frequency distribution and condition factor of *T. zilli* revealed that length class 20-25 cm TL had the highest K value (1.91) while length class 30-35cm TL had the lowest K value (1.25) (Table 7). The study population of *O. niloticus* showed that the highest condition factor of 3.15 was recorded at 30-35cm length range while the lowest condition factor of 1.67 was observed at length range of 10-15 cm (Table 8).

Table 7: Length frequency distribution and condition factor of *T. zilli*.

Length class	Frequency	Condition Factor (K)
5-10	27	1.33
10-15	23	1.49
15-20	36	1.85
20-25	21	1.91
25-30	9	1.84
30-35	4	1.25
Total	120	1.61

Table 8: Length frequency distribution and condition factor of *O. niloticus*

Length class	Frequency	Condition Factor (K)
5-10	4	1.77
10-15	9	1.67
15-20	19	2.71
20-25	46	2.48
25-30	27	2.95
30-35	12	3.15
35-40	3	3.10
Total	120	2.55

There was a significant variation in the condition (K) value of *O. niloticus* as the lowest condition value was 1.44 of 50-100g weight groups while the highest condition factor value was 3.89 of the 350-400g as shown in Table 10.

Table 9: Weight Distribution and Condition Factor of *T. zilli*

Weight class	Frequency	Condition Factor (K)
0-50	46	1.21
50-100	31	1.25
100-150	14	1.41
150-200	12	1.79
200-250	6	1.91
250-300	3	1.83
300-350	8	1.90
Total	120	1.61

Table 10: Weight Distribution and Condition Factor of *O. niloticus.*

Weight class	Frequency	Condition Factor (K)
50-100	4	1.44
100-150	8	2.21
150-200	19	2.36
200-250	38	2.34
250-300	17	2.68
300-350	29	2.95
350-400	9	3.89
Total	120	2.55

IV. Discussion

In the present study the overall sex ratio for *T. zilli* in mid-Cross River basin was found to be 1:3 (Male:Female) and deviated significantly from the expected 1:1 ratio (X^2 =1.99, p< 0.05). In general females dominated the catch in nearly all months except in September. The susceptibility of the females to gillnets maybe as a result of the minor breeding period which is triggered by the onset of the rainy season. [21] observed the minor breeding period of cichlid to occur between June and August, which coincidentally fall within the sampling months in this study. In this regard, the dominance of females in the catch might be attributed to the active movement of females for search of mates and building nests for courtship which makes them more vulnerable for gillnets. Earlier study on the same species in Lake Tana also indicated the preponderance of females over males and this has been attributed to the reproductive behaviour of the fish [22]; [23]. [24] pointed out that in the African lakes; it is commonly observed that males dominate over females in the cichlid population. However, studies conducted on the same species in some water bodies in Ethiopia and elsewhere in the world [25]; [26] revealed that females were more numerous than males. However, [27] described that the sex ratio could vary considerably from species to species, and from year to year in the same population, but in the majority of cases it is close to one to one. Factors affecting fish distribution and abundance have already been reported by different workers. Availability of food, spawning rates, breeding grounds coupled with shelter, presence of current, vegetation, depth of water, breeding rabbits migration and low predation have been suggested as major limiting factors affecting the distribution and abundance of various fish families in Kainji Lake [28]. [29]reported fish catch varied with type of gear used, tidal condition and period of capture, diurnally and seasonally.[16]recorded 5.5-20 cm for annual length range for *T. zilli* from Wasai Reservoir in Kanoas against 7.5-30.0cmrecorded in this study. This could be as a result of the four months sampling period when compared to the one year sampling period of the study in Wasai reservoir in Kano. The differences between these findings and the results of this study may also be due to difference in ecological conditions of the different location. The mean total length (TL) of combined sexes of *T. zilli* ranged from 12.6cm in June, and 23.2cm in September respectively. The mean Total Length of the overall population was 17.2cm which is a little above [29] mean Total Length value of 16.97cm for combined sexes from Asejire Lake, Oyo State. The weight range of combined sexes of *T. zilli* was 5-375g. The mean weight of the overall population was 109.20g. These results are in agreement with works of [2]; [5]; [4]; [29]. The results also showed that there were strong positive correlations, which were significant (P<0.01) between the lengths and weights of male, female and combine sexes of *T. zilli* observed in this study. The reason for the low mean Total Length and Weight values in the mid-Cross River basin could be as a result of high mortality of both juveniles and brood stock of *T. zilli* as a result of predatory activities, which is typical of the study area.

The length-weight relationship of the overall population of *T. zilli* showed the value of intercept 'a' to be 0.9826. [16] recorded "a" value of 1.5 during the dry season and 1.2 values during the wet season. The growth coefficients or slope 'b' value of the overall population is 2.3323. This is comparatively lower than the 'b' values of(2.9 - 4.8) obtained from [30]and (2.91) from [8]. [16] reported maximum 'b' values of 2.5 and 1.53 for wet and dry seasons respectively. Differences between these findings and the results of this study may be due to difference in ecological conditions. [31], stated that the isometric value of b=3is for an ideal fish that maintains three dimensional equality, when 'b' value is <3, the fish has a negative allometric growth and 'b' value >3 is positive allometric growth [18]. If fish have to maintain their shape as they grow, their 'b' values must be equal to 3, but there is no existing theory that says the 'b' value must be negatively or positively allometric [32].Therefore, the growth pattern of *T. zilli* in mid-Cross River basin is said to be negative allometric, this implies that *T. zilli* did not increase in weight faster than the cube of their total lengths. Meanwhile, [33] have suggested that value of 'b' less than 2.5 can be considered as subnormal growth of fish in that given aquatic environment. The coefficient of determination (r^2) value was 0.93.

The Condition factor (K) of 2.63 and 3.4 were reported during the dry and wet seasons respectively which showed higher value during the wet seasons [16]. [34];[23] on each of their study reported that values of the condition factor vary according to seasons and are influenced by environmental conditions. In this study, the mean condition factor ranged between 1.5 in September and 1.8 in June and the value comfortably fall within the ideal range set by [35]. [36] had reported that reproduction results in lower value of condition factor (K<1) marked the fish loses its weight after spawning period. But, result of this study showed that *T. zilli* (male, female and combine sex) considered had condition factors greater than 1. The results obtained from this study indicate that *T. zilli* of Mid-cross river basin are in good condition.

One hundred and twenty (120) species *of O. niloticus* were collected and sampled for four months in this study. The highest sex ratio was in July (1:2.25) and lowest sex ratio was in August (1:1.20). Overall sex ratio for the sample population was 1:1.45 indicating more females than males. This fish population showed a typical 'b' value of 1.6174 for the length-weight relationship of both male and female *O. niloticus*, which revealed that the growth pattern was a negative allometric growth. According to [37], the weight of fish increased when they consume the food stuffs that are available for growth and energy. These values may also vary significantly based on other factors featuring sex, growth phase, stomach contents and gonad development as reported by [38]. These factors are directly connected to the fish, ecosystem health related to the impacts of human activities like logging and aquaculture encompassing the damaging water quality is another cause and it is a very worrying trend for this area as it would affect all the biota its supports. Also, *b* value is dependent on environmental conditions and geographical, and biological, sampling factors and temporal [36]. The higher 'b'value of *C. apogon* in Pedu Lake reported by [39] is an indication of a more favourable environment for this species which has better growth as compared to Mid Cross River Basin.

The monthly condition factor indicates that the month of September has the highest condition factor which is 3.073 while the month of August has the lowest condition factor value which is 1.930. Overall condition factor value for the population is 2.48.The length distribution and condition factor of the study population of *O. niloticus* showed that the highest condition factor of 3.15 was recorded at 30-34 cm length range while the lowest condition factor of 1.67 was observed at length range of 10-14 cm. There was a significant variation in the condition (k) value of *O. niloticus* as the lowest condition value was 1.34 of 240-290g weight groups while the highest condition factor was 3.89 of the 140-190g. The condition (K) factor in was within this range 1.67 as the lowest while 3.15 as highest condition factor which showed that almost of the fish were in good condition. [40] suggested that if the K value is 1.00, the condition of the fish is poor, long and thin. A 1.20 value of K indicates that the fish is of moderate condition and acceptable to many anglers. A good and well-proportioned fish would have a condition (K) value that is approximately 1.40. Based on this condition, the sampled fishes are in good condition growth. However, fishermen should be encouraged to fish responsibly for sustainability of the resources because the results from were out of the range set for ideal growth of freshwater fish. [7];[16] and [35] reported k values of 2.9-4.8, 2.9-4.3 and 2.6-3.4 respectively.

V. Conclusion

Generally, females were significantly more than males as indicated in sex ratio of the total sample. The susceptibility of the females to gillnets maybe as a result of the minor breeding period which is triggered by the onset of the rainy season, this period coincidentally fall within the sampling months of this study. Thus, the spawning population in the shallow littoral part of the river should be protected from intensive fishing during this period. The study population of *T. zilli* showed negative allometric growth pattern, this implies that *T. zilli* did not increase in weight faster than the cube of their total lengths in mid-Cross River basin. The values for condition factor indicate that the fish are in good condition; this might be attributed to availability of food and favourable ecological conditions in the river. The result of this finding showed that there were significant differences obtained in length-weight and condition factor among the male and female fish of *O. niloticus*. The study in Mid-Cross River Basin revealed that females are significantly in abundance than males and the values obtained from the study revealed that *O. niloticus* were in good condition. The observed sex ratio in this study is desirable for brood stock development and hatchery operation as one male is required to fertilize at least three females. It is concluded that the *O. niloticus* examined were in good condition and healthy and can be used for commercial production. Fishermen in the area should be educated on sustainable management of this freshwater resource, by selecting the optimum mesh size which release small fish and allow each fish to produced eggs at least once in its life to conserve these viable commercially important species.

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