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Aspects of the Growth and Reproductive Biology of the Guinean Tilapia, Tilapia guineensis (Bleeker, 1862) in a Tropical Freshwater Lake, Nigeria

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Abstract
Aspects of the growth and reproductive biology of the Guinean Tilapia, *Tilapia guineensis* from Asejire Lake was investigated from January, 2013 to December, 2013. Significant relationships(r> 0.89) occurred between the length and weight of *T.guineensis* for the combined, male, female and every month. The values of the parameter slope (b) in the length-weight relationship being less than 3 indicated negative allometric growth. The mean condition factor (2.023 ± 0.01) being greater than one showed the fish is in good condition in the freshwater environment. The multiple peaks observed in the gonadosomatic index signify the species is a multiple spawner. Fecundity of *Tilapia guineensis* ranged from 3418 – 9852 eggs for a fish with total length 18.9 cm to 29.7 cm respectively
Keywords: *Tilapia guineensis*, length weight relationship, gonad maturity stages, fecundity, freshwater environment

1. Introduction

The Guinean tilapia, *Tilapia guineensis* (Bleeker, 1862) is an indigenous African fish that belongs to the order Perciformes and family Cichlidae. Members of the family Cichlidae are of great economic importance and prominent in the fisheries in areas where they are found (Ikomi and Jessa, 2003). They are highly abundant because of their great adaptability and reproductive habits which makes them to be highly fecund and prolific (Balshine – Earn, 1997).

Tilapia guineensis is a euryhaline species found along the West Coast of Africa (Philippart and Ruwet, 1982). *T. guineensis* is usually found in creeks, lagoons and adjoining river. Experiments were carried out on the suitability of the species for brackish water aquaculture by various authors including Magnet and Kouassi, 1979; Cisse, 1986; Legendre, 1986; Legendre and Ecoutin, 1989. The species is the only popular and true estuarine species that is commonly cultured in the brackish water region in Nigeria (Musa *et al*., 2006). It has been successfully raised in ponds, enclosures, cages, and tanks. (Campbell, 1987).

Studies on the reproductive biology of the species in the wild are limited to the estuarine environment (Fagade, 1979; Isaac – Harry, 1986; Etim *et al*., 1989; Uka and Sikoki, 2011). Keremah and Ndah, 2013 reported reproduction of *T.guineensis* under experimental set up.

There is dearth of information on the growth and biology of the species in the Asejire Lake, a freshwater environment. Therefore this research is aimed at investigating aspects of the biology of *T.guineensis* in a freshwater tropical lake. This will enhance effective management and conservation of the species in this lake; also better understanding of biology in freshwater habitat and possible culture in this environment

2. Materials and Method

2.1 Sample collection

Samples of *T.guineensis* caught from Asejire Lake in Ibadan(latitude 07°21′45″N and longitude 4°08′00″E) were obtained from local fishermen (who used a cast net of 35 mm mesh size) monthly from January 2013 to December 2013. The lake usually experiences an equatorial climate characterized by high temperatures, high humidity and rainfall with two distinct seasons, dry and rainy seasons; and this is typical of the southern part of Nigeria. The dry season is usually from November to April while the rainy season extends from May to October (Ayoade *et al.*, 2006). The rainy season generally has a break in August. Individual fish was measured for total length (TL) and standard length (SL) to the nearest 0.1cm. The fish was also weighed for total weight (W) to the nearest 0.1g.

2.2 Length- Weight Relationship

The relationship between the TL and W of the fish was expressed by the equation (Pauly, 1983):

$W=a\ TL^b$ (1)

where a and b are constants obtained from the regression analysis. A logarithmic transformation was used to make the relationship linear log W=log a + b log L. The length–weight relationship of the fish species was calculated for combined sexes, for each sex separately and monthly. The correlation coefficient (r) is the degree

of association between the length and weight was determined from the linear regression analysis. The recorded individual total lengths and total weights were used to determine the condition factor (K) (total weight expressed as a percentage of cube total length).

2.3 Reproduction

For each fish specimen, the sex and stages of development of the gonad were determined by visual inspection and graded as stages I, II, III, IV, V and VI according to Nikolsky (1963). To estimate the length at first maturity of the fish species, the TL of mature females and males was plotted against the frequency percentage of mature individuals during the spawning season and then the length at which 50% of the total individual number was considered as the length at first maturity (Pitt, 1970). The gonado-somatic index (GSI: gonad weight expressed as a percentage of the fish's body weight) and fecundity (*sensu* Bagenal and Braun, 1978) of each specimen were determined. The relationship between the fecundity and TL and W of the fish species was determined as expressed by the equation (Pauly, 1983):

$$F = aX^b \quad (2)$$

A logarithmic transformation was used to make the relationship linear:

$$\text{Log } F = b \text{ Log } X + a \quad (3)$$

Where F is fecundity; X is total length or weight of fish; a and b are constants obtained from least squares regression analysis using log transformed data.

3. Results

*3.1 Length Weight R*elationship *of Tilapia guineensis*

The total length of *T. guineensis* ranged between 11.4cm and 29.7cm (17.41 ± 3.2cm), while the weight ranged from 39.9g to 628.7g (117.07 ± 75.27g). The weight of largest female was 628.7g and largest male weighed 528.9g. The correlation coefficient r was greater than 0.90 for both sexes and combined reflecting the increase in weight with increase in length. The regression coefficients b for male was 2.82; female, 2.90 and combined 2.86 (Table 1).The values of b were in September (3.41) and April (3.15) while the lowest value 2.52 was obtained in June (Table 2). The monthly correlation coefficient r was greater than 0.94 except in June with r value of 0.89.

Table 1: Length Weight Relationship of male and female *Tilapia guineensis* in Asejire Lake (n = Fish sample size; a = Regression intercept; b = Regression coefficient; r = Correlation coefficient)

Sex	**n**	**Total Length Range (cm)**	**Weight Range (g)**	**a**	**b**	**r**
Male	297	11.4 – 27.5	39.9 – 528.9	- 1.4767	2.8199	0.9497
Female	231	11.9 – 29.7	40.8 – 628.7	- 1.5751	2.9025	0.9477
Combined	528	11.4 – 29.7	39.9 – 628.7	- 1.5203	2.8566	0.9487

Table 2**:** Monthly variations in length-weight relationship parameters of *Tilapia guineensis* in Asejire Lake

Month	**a**	**b**	**r**	**Female K ± SE**	**Male K ± SE**	**Combined K± SE**
January	-1.446	2.759	0.955	1.82±0.02	1.91±0.03	1.86±0.09
February	-1.348	2.713	0.972	2.04±0.04	2.02±0.03	2.02±0.02
March	-1.456	2.805	0.964	1.97±0.04	2.03±0.04	2.00±0.03
April	-1.869	3.150	0.973	2.11±0.04	2.07±0.04	2.09±0.03
May	-1.573	2.926	0.950	2.18±0.06	0.35±0.03	2.19±0.03
June	-1.077	2.518	0.891	2.224 ± 0.09	2.08±0.08	2.16±0.06
July	-1.609	2.926	0.940	1.97±0.04	2.02±0.04	1.997±0.03
August	-1.613	2.920	0.944	1.96±0.04	1.93±0.04	1.95 ± 0.03
September	-2.202	3.408	0.988	2.04±0.00	1.94±0.05	1.96 ± 0.04
October	-1.677	2.949	0.988	1.84±0.03	1.82±0.04	1.83 ± 0.03
November	-1.256	2.616	0.968	1.82±0.03	1.80±0.04	1.81 ± 0.03
December	-1.491	2.859	0.984	1.82±0.02	2.17±0.04	2.19 ± 0.03

(a = Regression intercept; b=Regression coefficient; r = Correlation coefficient; K ± SE = Condition factor)

3.2 Condition Factor: Table 3: Length Class Relationship with of condition factor of *T.guineensis*

Length class (cm)	Condition factor (K)		
	Minimum	Maximum	Mean ± Standard Error
(14.0 - 17.9)	1.522	3.589	2.020 ± 0.02
(18.0 - 21.9)	1.231	2.897	1.999 ± 0.02
(22.0 - 25.9)	1.039	2.088	1.819 ± 0.03
(26.0 - 29.9)	1.64	2.635	2.267 ± 0.11

The condition factor calculated for *T.guineensis* varied from 1.04 to 3.59(2.02 ± 0.01). Temporal changes occurred in K with highest values obtained in December (2.19); May (2.19) and June (2.16). There was a gradual decrease from July (1.997) to November (1.81) Table 2. The mean K values obtained for female and male were higher than 1.81 during the sampling period expect in May when a value lower than 1 (0.35) was obtained for male. The smallest and largest size groups had higher K value, 2.14 ± 0.03 and 2.27 ± 0.11 respectively Table 3. Generally, the condition factor decreased with size groups and the difference is significant ($p>0.05$).

3.3 Gonad Maturity Stages and Length at First Maturity of Tilapia guineensis

Six gonad maturity stages were observed in specimens of *T. guineensis* in Asejire Lake. For female specimens > 70% were in the immature/maturing stages (stages I – III) during the sampling period, while for the male > 80% were in (stages I – III). Female fish with ripe gonads were encountered throughout sampling period except in October; for males, ripe gonads were found in May, June and September, Figure 1. The length at first maturity for female and male *T.guineensis* in the lake was 17.3cm and 16.9cm respectively (Figure 2a &b).

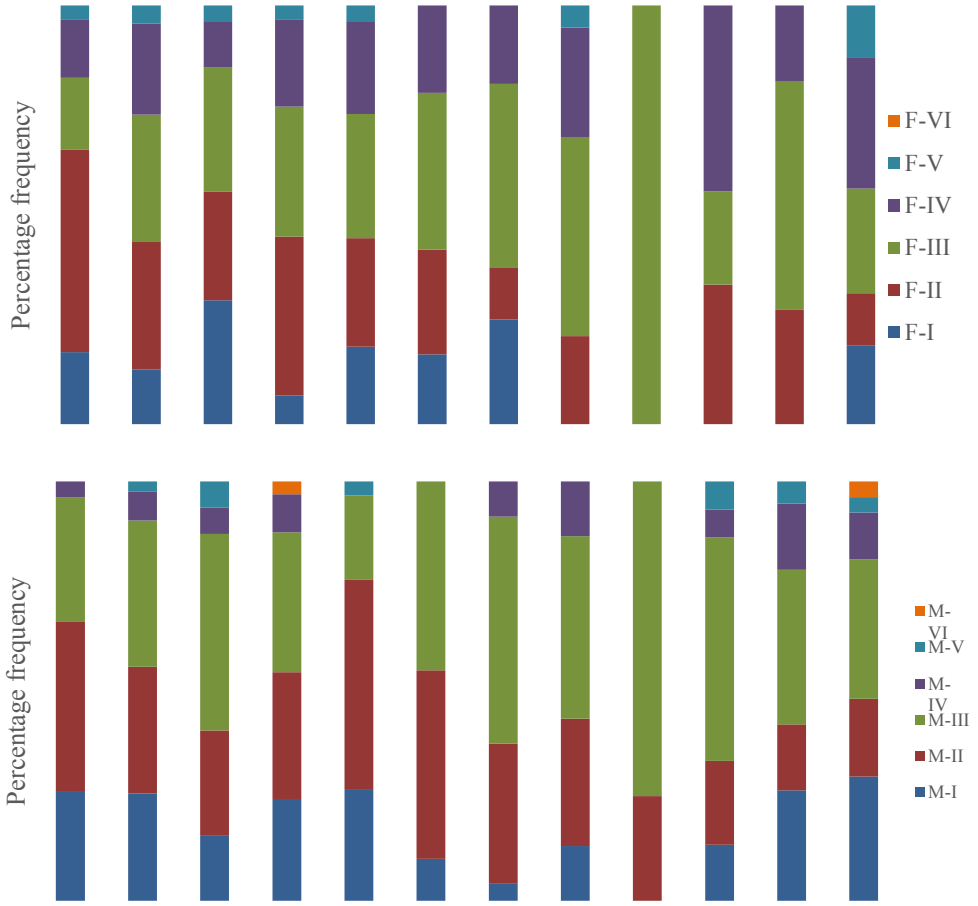
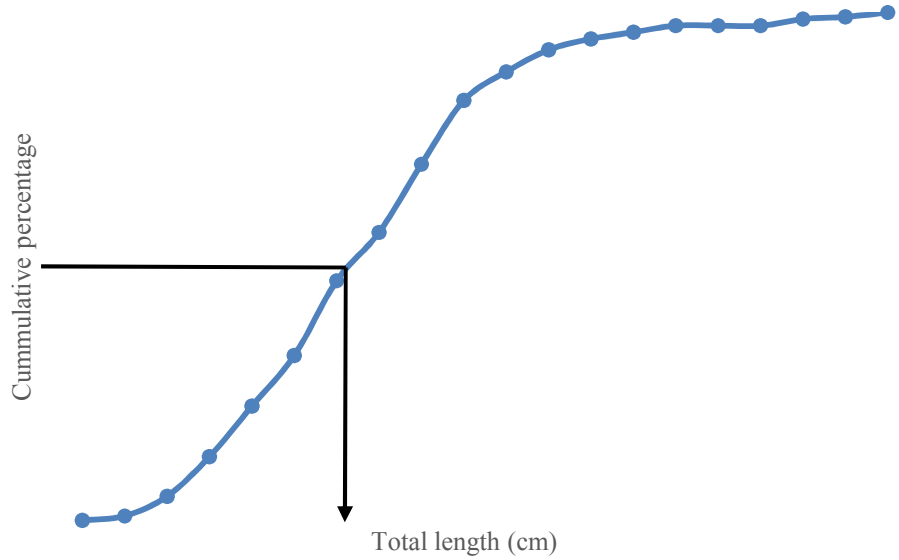


Figure 1: Monthly percentage frequency of occurrence of different gonad maturation stages of *Tilapia guineensis* in Asejire Lake (F = female gonadal maturation stage; M = male gonadal maturation stage

A



B

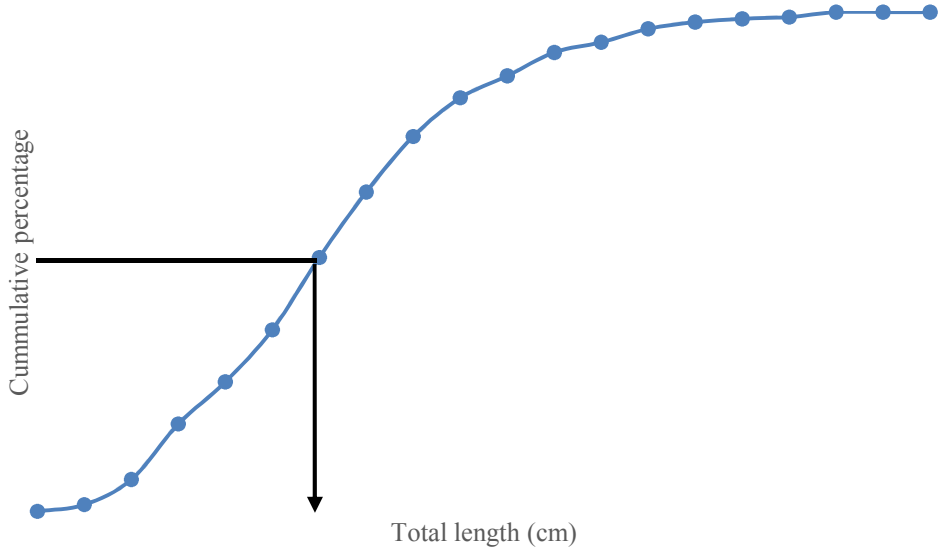


Figure 2: Length at first maturity for *Tilapia. guineensis* in Asejire Lake (A) female, (B) male

3.4 Gonadosomatic Index (GSI)

The mean gonadosomatic index of female was 1.33 ± 0.07 and for male, 0.411 ± 0.02. Temporal changes occurred in the GSI of female and male leading to several peaks to occur; with two major peaks in August and December (Figure 3)

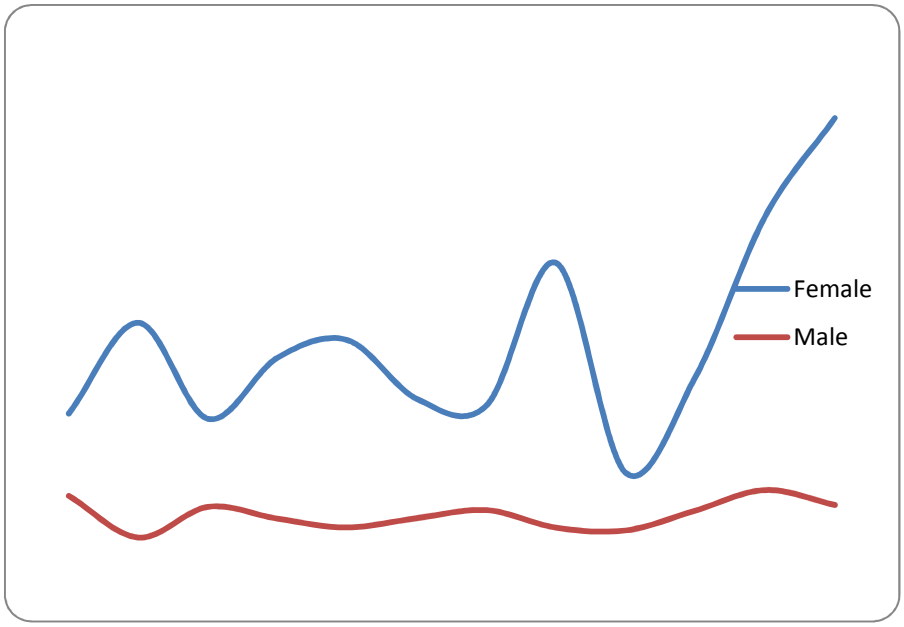


Figure 3: Monthly Variation in Mean Gonadosomatic Index (GSI) of Female and Male *Tilapia guineensis* in Asejire Lake

3.5 Fecundity

Absolute fecundity of the species in Asejire Lake ranged from 3418 eggs (Fish TL: 18.9cm; TWT: 156.2g) to 9852 eggs (Fish TL: 29.7cm; TWT: 575.3g). The mean absolute fecundity was 6509.89 ± 1548.6 eggs. The regression equations illustrating the relationship between fecundity and total length; fecundity and total weight are: $\text{Log F} = 0.6396\,\text{Log TL} + 2.9626; \text{r} = 0.181; \text{n} = 56$

$$\text{Log F} = 2277\,\text{Log W} + 3.2896; \text{r} = 0.2069; \text{n} = 56$$

4. Discussion

4.1 Length Weight relationship

In *T. guineensis* of Asejire Lake, the b-values of 2.9025, 2.8199 and 2.8566 recorded for male, female and combined sexes respectively show negative allometric growth indicating that as the total length is increasing, the weight is not increasing proportionally. This agrees with Niyonkuru and Laleye (2012) who obtained b value of 2.97 for *T. guineensis* in Lake Nokoué. These values were lower than b (3.4) reported for *T. guineensis* in Lagos Lagoon by Fagade (1979). On the contrary Soyinka *et al*. (2013) obtained b value of 0.729 for the species in Lagos Lagoon. Negative allometric growth could be attributed to maturity stages and seasonality (Weatherly and Gill, 1987); food availability (Momsen, 1998), sample size and length range (Ecoutin and Albaret, 2003) and overfishing (Jamabo *et al.*, 2009).

4.2 Condition Factor

The condition factor value of *T. guineensis* (1.039 – 3.589; 2.023 ± 0.01) during the months of study showed that the fish was in good conditions since it was greater than one and were comparable with those documented by Bagenal and Tesch (1978) for mature fresh water fish body weight. Soyinka *et al*. (2013) got higher K (3.64) for *T. guineensis* in Lagos Lagoon. Decrease in condition factor with increase in length was also reported by Fagade, 1979. This may be attributed to the adults spending a part of their energy in reproduction that probably decrease their condition. This is contrary to Onimisi and Oniye (2010) who reported smaller specimens of *Auchenoglanis occidentalis* in Zaria reservoir had the lowest condition factor. The temporal changes in condition factor could be attributed to the deposition of materials for gonad formation, which led to increase in weight and actual spawning which led to reduction in fish weight respectively (Fawole , 2002) .

4.3 Gonad Maturity Stages

Differences in the proportion of individuals with different stages of ovarian and testicular development suggest that breeding intensity is not the same for all months (King and Etim, 2004). The all-year round presence of ripe female spawners in Asejire Lake is in accordance with Babiker and Ibrahim (1979) who reported that female *Tilapia nilotica* breed more than once in a season. Gomez-Marquez *et al.* (2003) also mentioned that Tilapia species breed continuously throughout the year with increased breeding activity during periods of intense

sunshine or rainfall

4.4 Length at first maturity (L_{50})

Length at first maturity (L_{50}) has a great importance in the determination of optimum mesh size (Mehanna, 2007). The estimated lengths for female and male *T. guineensis* in this study, 17.3cm and 16.9cm respectively are bigger than the lengths at first maturity of 8.7cm and 9.9cm for male and female respectively reported by Fagade (1979) for *T. guineensis* of Lagos Lagoon. Larger size at maturity for the species in the Asejire Lake could be due to the lentic condition of the waterbody which is relatively more stable than lagoon. According to Welcomme (1990), maturation tends to be relatively more rapid in river fish species than in lakes as river systems are in most cases unstable and fish therefore respond to unfavourable circumstances by accelerating maturation; also Charlesworth and Leon, 1976 stated that tilapias living in stressful environments often exhibit earlier maturation in life and protracted reproductive periods as a means of maximizing reproductive success. Balirwa (1998) reported that the length at first maturity of Nile tilapia in the littoral habitats of Lake Victoria was a total length of 24cm for both sexes and in Lake Kyoga and it was total lengths 23cm and 36 cm for males and females respectively. Differences in first length of maturity is a function of the size and may also be due to the abundance and seasonal availability of food, temperature, photoperiod and other environmental factors and different localities (Shaloof and Salama, 2008).

4.5 Gonadosomatic Index

The GSI values obtained are in agreement with gonado-somatic indices of 0.03 and 1.67 with a mean of 0.39 ± 0.02 in the male fish while the female fish had a mean gonado-somatic index of 1.34 ± 0.01 with values between 0.12 and 4.06 reported by Komolafe and Arawomo (2007) for *Oreochromis niloticus* in Opa reservoir. The higher value of gonado-somatic index in female than male could be attributed to the amount of energy invested in gamete production by males which is probably less than that invested by females (Pajuelo and Lorenzo 2000). The observed temporal changes in the GSI with alternate peaks between the months suggest a cycle of parental care, ovarian maturation and spawning. Anene and Okorie (2008) also recorded the GSI of female *Tilapia mariae* peaks in alternate months throughout the year

4.6 Fecundity

The result of fecundity studies obtained in this study (3418 – 9852 eggs; 6509.98 ± 1548.6 eggs) is within the range (1035 – 11170 eggs) reported by Fagade (1978) and above 451 – 2150 eggs reported by Etim *et al.*,1989. Keremah and Ndah (2013) recorded mean fecundity of 1,269 eggs per female spawner of *T.guineensis* under laboratory condition. Bagenal and Braum (1978) opined that fecundity of fish varies widely among the same species, size and age. Variation in fecundity may also be due to differential abundance of food.

Conclusion

The growth pattern of *Tilapia guineensis* in Asejire Lake was negative allometric growth indicating as the total length was increasing; the weight was not increasing proportionally. The all-year round presence of ripe spawners in Asejire Lake and multiple peaks observed in the gonadosomatic index signify the species is a multiple spawner.

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