



## GROWTH RELATIONSHIPS AND REPRODUCTIVE FEATURES OF *Sarotherodon galilaeus* (Linnaeus, 1758) IN ELEIYELE LAKE SOUTHWESTERN NIGERIA

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### ABSTRACT

Length weight relationship (LWR), condition factor (K) and some reproductive features of *Sarotherodon galilaeus* Linnaeus, 1758 from Eleiyele Lake were investigated from March, 2010 to February 2011. Total length and weight were recorded. Gonad maturation was determined macroscopically, fecundity by gravimetric method and gonadosomatic indices calculated. The LWR had a significant correlation for the sizes, sexes and seasons. Differences were recorded in the growth pattern between size groups and sexes. The species was in good condition in the Eleiyele Lake with K greater than 1. Higher gonadosomatic index recorded between August and December suggests that spawning occurred during this period. Fecundity of *S. galilaeus* ranged from 572 – 4082 for a fish with total length 13.4 – 21.4 cm. The information provided on the growth pattern and reproductive features of this commercially important species (*Sarotherodon galilaeus*, which is little studied in Eleiyele Lake) should enhance effective management of the fisheries and production.

**Keywords:** growth relationship, condition factor, gonad cycle

### INTRODUCTION

Eleiyele reservoir lies north to northwest of Ibadan town, Nigeria at an altitude 125 meters above sea level. It's the main reservoir which supplies water to Ibadan and has an area of 5.46km<sup>2</sup> with a storage capacity of 1550 million gallons (Imevbore, 1965; Nwa, 1979; Bolaji, 2010). Cichlids constitute more than 50% of fish caught annually by the fisherfolks in Eleiyele Lake. Cichlids are dominant in the fish fauna wherever they occur in the aquatic ecosystem (Reed *et al.*, 1967; Ikomi and Jessa, 2003). This might be attributed to cichlids being principally primary consumers or detritivores (Fagade, 1971). They are hardy and have wide tolerance limits to most potentially limiting physico – chemical parameters. They are multiple spawners and exhibit parental care over their young ones (Trewavas, 1982; 1983; Balshine-Earn, 1997). Cichlids are among the commercially important inland fishes of Africa and are suitable for fish culture. Previous work are available on various aspects of the biology of West African cichlids including those of Zelibe *et al.*, (1990) that described the food and feeding inter-relationships of juveniles of cichlids in Eleiyele Lake and Ayoade and Ikulala – Allen (2007) provided information on the length – weight relationship, condition factor and stomach contents of *Hemichromis bimaculatus*, *Sarotherodon melanotheron* and *Chromidotilapia guentheri* in Eleiyele Lake. This work aims at providing information on the length – weight relationship, condition factor, gonadosomatic index and fecundity of *Sarotherodon galilaeus* which is little studied in

the Eleiyele Lake. Knowledge of the growth pattern and fecundity of fish enhance effective management of the fisheries and production.

### MATERIALS AND METHODS

Specimens of *S. galilaeus* caught with gill net of mesh size 50 – 55 mm by fishermen in Eleiyele Lake were collected from March 2010 to February, 2011. In the laboratory each specimen was measured to the nearest centimeters using a fish measuring board and the body weight was determined to the nearest gram using a top loading Mettler balance Model PJ6000. Each specimen was split open, the sex was noted and stages of gonad development were classified according to Nikolsky (1963). The ovaries in stage (IV) were preserved in Gilson's fluid and agitated at intervals. The surrounding connective tissues were removed and the number of eggs in each pair of ovaries was determined by gravimetric method. Egg diameters were measured with graduated micrometer mounted in the eye – piece of a binocular microscope.

### Length – weight relationship

The length-weight relationship (LWR) was estimated by using the equation:  $W_T = a L_T^b$  (Ricker, 1973) where  $W_T$  = total weight (g),  $L_T$  = total length (cm), a = constant, b = growth exponent. A logarithmic transformation was used to make the relationship linear

$$\log W_T = \log a + b \log L_T$$

**Condition factor**

The condition factor was estimated from the relationship

$$K = \frac{100 W_T}{L^b}$$

(Bauchot and Bauchot, 1978)

where K= condition factor,  $W_T$  = total body weight (g),  $L_T$  = total length (cm), b= growth exponent. The b values obtained were compared to 3 (in order to ascertain whether the species grew isometrically) using student's t-test (Sokal and Rohlf, 1987).

**Gonado - somatic index ( $I_G$ )**

Gonad stages I to V were used in estimating  $I_G$  from the relationship

$$I_G = \frac{\text{Gonad weight (g)}}{\text{Total body weight (g)}} \times 100$$

**Fecundity**

The equation describing the relationship between fecundity and body size is given as

$$F = ax^b$$

Where F = fecundity

$$x = L_T / W_T$$

a = intercept

b = slope

**Statistical Analysis**

The regression line was calculated by the method of least regression analysis. Anova and Student's t test were employed to test the level of significance between the size groups and sex respectively. Statistical analysis was carried done with statistical software SPSS.

**RESULTS**

**Length weight relationship (LWR)**

The total weight ( $W_T$ ) and total length ( $L_T$ ) of the specimens obtained during this study varied between 10.13 to 1359.5 g (mean = 148.84 g ± 11.83) and 8.2 – 39 cm (mean: 17.83 cm ± 0.36) respectively. For the female specimens, the  $W_T$  and  $L_T$  recorded was 25.1 – 1359.5 g (mean: 178.6 g ± 0.36) and 10.9 – 39 cm (mean: 18.8 cm ± 0.57) respectively. The male specimens examined had  $W_T$  ranging between 12.7 – 592.5g (mean: 122.8g ± 12.65) and  $L_T$  between 8.6 – 29.7 cm (mean: 17.3 cm ± 0.48). The females were significantly ( $p < 0.05$ ) larger than the males. The estimated coefficients of the LWR for the different size groups, sex, combined and other details of the statistical analyses are summarized in Table 1. Higher b value (3.72) was recorded in the larger size group compared to 2.65 obtained for smaller group. Statistical analysis showed that the b values obtained for the size groups were significantly different from 3 ( $p < 0.05$ ). The b value recorded for the female (3.004) was higher than the male (2.63) and b value of the male was significantly different from 3. The rainy season's b value (2.91) was slightly lower than dry season (2.97). However, statistical analysis revealed both values did not differ significantly from 3. The values obtained for correlation coefficients (r) were greater than 0.90 in all the LWR except in size group 18.9 – 29.8 cm (r = 0.8778).

**Table 1: Length – Weight relationships of *Sarotherodon galilaeus* in the Eleiyele reservoir, Ibadan**

Size groups	$L_T$ (cm)	$W_T$ (g)	n	a	b	r	S.E.(b)	t= $\frac{b-3}{S_b}$
8.6 – 18.8			131	-1.28	2.653	0.906	0.109	-*3.188
18.9 – 29.1			58	-2.703	3.719	0.878	0.271	*2.652
29.2 – 39.4			3	-	-	-	-	-
<b>Season</b>								
Rainy			90	-1.579	2.908	0.976	0.069	-1.333
Dry			103	-1.656	2.967	0.947	0.100	-0.329
<b>Combined Sexes</b>	8.6 – 39	10.13 to 1359.5	193	-1.614	2.935	0.925	0.060	-1.078
<b>Females</b>	10.9 – 39	25.1 – 1359.5	90	-1.693	3.004	0.966	0.086	0.046
<b>Males</b>	8.6 – 29.7	12.7 – 592.5	90	-1.255	2.629	0.921	0.119	-*3.131

\*significantly different from 3 at  $p < 0.05$

**Condition factor**

The combined specimens had mean K value of 2.07 ± 0.03. The mean K increased with size and the highest value of 1.967 was recorded in the largest

size group (Table 2). K value of the different size group was significantly different ( $p < 0.05$ ). The K value of the female specimens was not statistically different from the male. The K value obtained

throughout the sampling period was higher than 1. Monthly fluctuations occurred in the *K* value with the highest (2.40) and lowest (1.66) values recorded in the rainy season months (Fig. 1).

**Gonadosomatic Index (*I<sub>G</sub>*)**

The *I<sub>G</sub>* values ranged between 0.017 and 2.33% (mean: 0.344 ± 0.048%) for the males. The females ranged from 0.06 to 4.46% (mean: 0.78 ± 0.117%). The highest mean *I<sub>G</sub>* (1.708) was obtained in the smallest size group and 18.9 – 29.1cm group recorded the least mean value (0.568 ± 0.109) (Table 3). Monthly variation occurred in mean *I<sub>G</sub>* of this species in Eleiyele Lake with highest mean value of 1.57% ± 0.3609 in November (Fig. 2). Statistical analyses showed significant differences between the *I<sub>G</sub>* of female and male specimens, between size groups and also between months. *I<sub>G</sub>* increased with stages of gonadal maturity for the male and female,

and the mean *I<sub>G</sub>* of the female were always higher than that of the male of the same stage of gonadal development (Table 4).

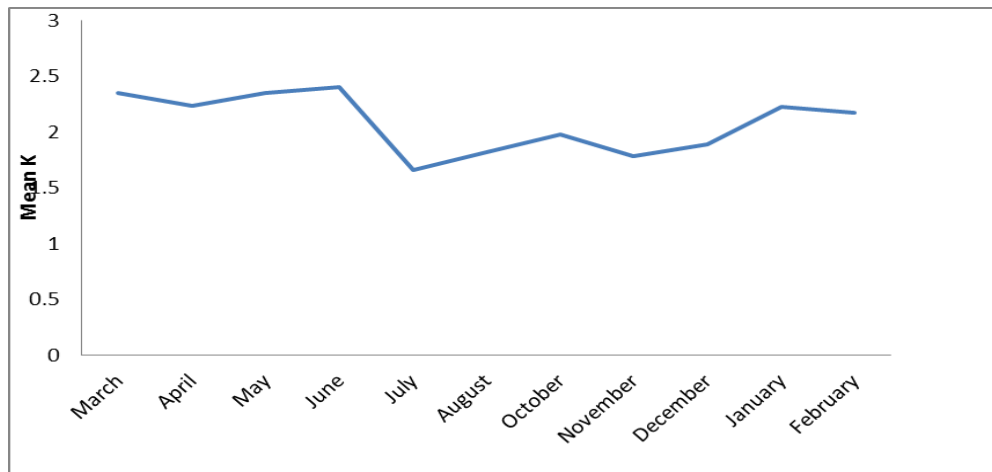
**Gonad Cycle**

Specimens with stage I or II gonads are more abundant and were available throughout the year. Specimens with matured and ripe gonads (stages III and IV) were also encountered throughout the sampling period except in January and February and they were lower in number than specimens I and II. Specimens with running or spent gonads were rarely encountered in the sample. Ripe individuals (stage IV) were obtained more between August and December and few ripe specimens were caught between March and June during the sampling period (Fig.3).

**Table 2: Condition factors of *Sarotherodon galilaeus* in Eleiyele Reservoir**

Parameters	N	Range of K	Mean ± SE	Fstat/t test
<b>Size groups (cm)</b>				
8.6 – 18.8	131	0.05 – 4.64	1.063 ± 0.092	*18.105
18.9 – 29.1	57	0.05 – 3.62	1.926 ± 0.092	
29.2 – 34.4	3	1.35 – 2.67	1.967 ± 0.384	
<b>Sex</b>				
Male	90	0.02 – 3.04	2.035 ± 0.048	0.9656
Female	90	1.35 – 3.3	2.096 ± 0.041	
Combined	193	0.02 – 3.3	2.065 ± 0.03	

\*significantly different at p<0.05

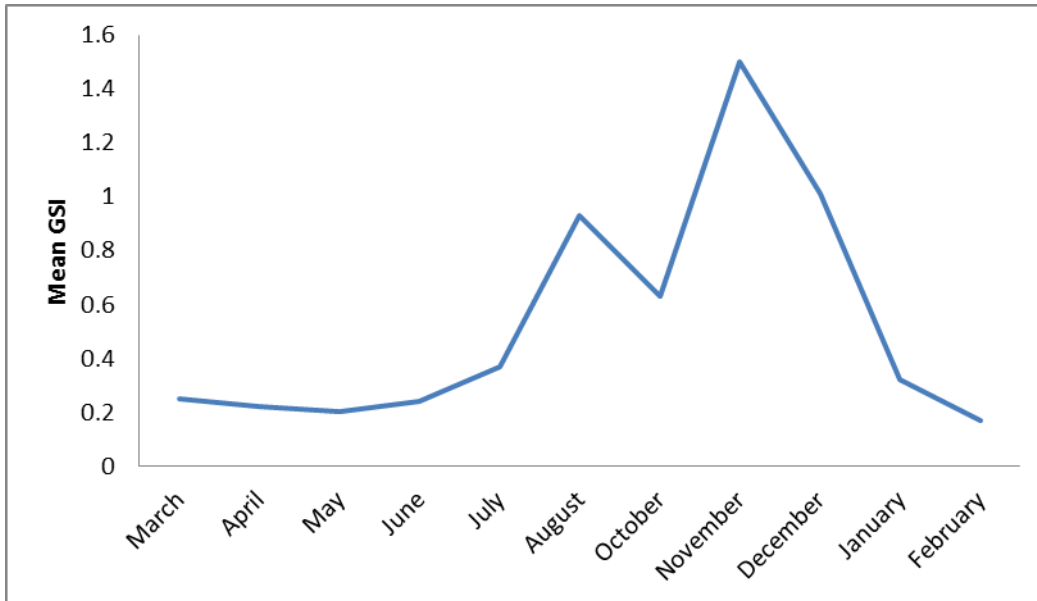


**Fig. 1: Variation in mean condition factor of *Sarotherodon galilaeus* with month in Eleiyele Lake**

**Table 3: Gonadosomatic index of *Sarotherodon galilaeus* in Eleiyele Reservoir, Nigeria**

	N	Range of I <sub>G</sub>	Mean ± SE	t cal	F cal
<b>Size groups (cm)</b>					
8.6 – 18.8	131	0.1 – 4.3	1.708 ± 0.078		*28.73
18.9 – 29.1	58	0.02 – 3.8	0.528 ± 0.109		
29.2 – 39.4	3	0.18 – 2.79	1.26 ± 0.786		
<b>Sex</b>					
Male	90	0.017 – 2.33	0.343 ± 0.048		*3.759
Female	90	0.06 – 4.46	0.780 ± 0.117		
Combined	193	0.017 – 4.46	0.604 ± 0.075		

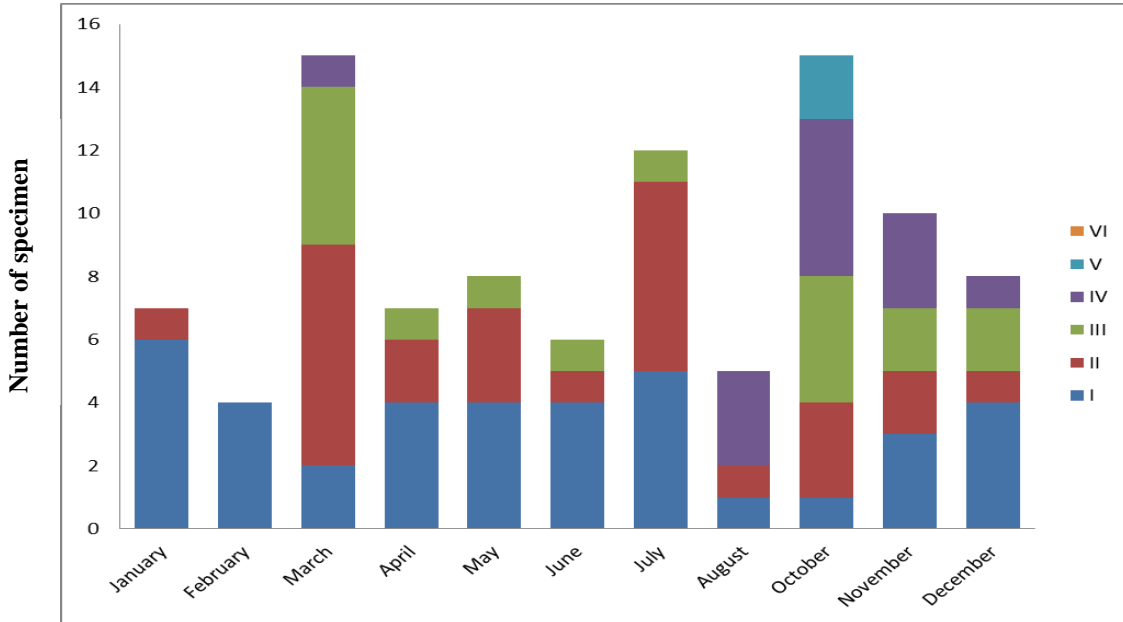
\*significantly different at p<0.05



**Fig. 2: Variation in mean gonadosomatic index of *Sarotherodon galilaeus* with month in Eleiyele Lake**

**Table 4: Variation in gonadosomatic index with the stages of gonad maturity of *Sarotherodon galilaeus* in Eleiyele Reservoir, Nigeria**

Parameters Gonad stage	Male I <sub>G</sub>		Female I <sub>G</sub>	
	Range	Mean ± SE	Range	Mean ± SE
I	0.02 – 0.41	0.19 ± 0.12	0.06 – 0.32	0.24 ± 0.05
II	0.05 – 1.12	0.24 ± 0.26	0.11 – 1.31	0.32 ± 0.28
III	0.07 – 0.62	0.52 ± 0.19	0.27 ± 3.14	0.98 ± 2.1
IV	0.13 – 2.33	0.67 ± 0.39	2.29 ± 4.64	3.31 ± 1.19
V	-	-	1.00	1.00



**Fig. 3: Variation in gonad maturity stages with months in *Sarotherodon galilaeus* from Eleiyele Lake, Southwestern Nigeria**

**Fecundity**

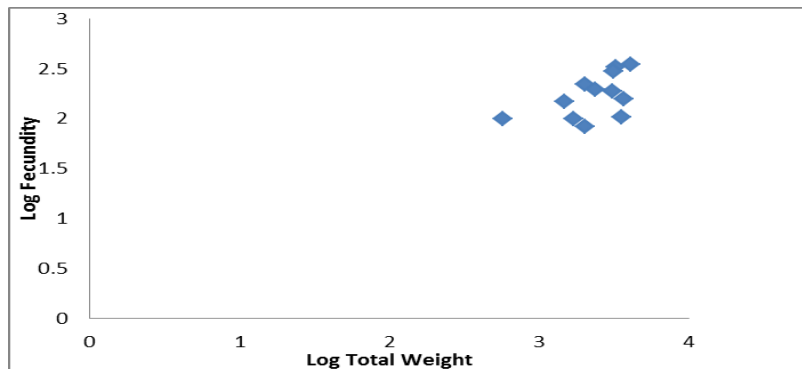
The absolute fecundity varied between 572 ( $L_T$ : 17.3cm); and 4082 ( $L_T$ : 24.5 cm). There was increase in fecundity with increase in length and weight of fish Figures 4 and 5. The highest fecundity was recorded in the heaviest specimen. The

relationships between fecundity (F) and  $L_T$  and  $W_T$  can be represented by the following equations,

$$F = 1.12 L_T^{1.7} \quad (r=0.60, p<0.05, n=12)$$

$$F = 2.04 W_T^{0.59} \quad (r = 0.54, p<0.05, n = 12)$$

The highest correlation coefficient (r) was recorded for the fecundity – body length relationship.



**Fig. 4: Relationship between fecundity and total weight of *Sarotherodon galilaeus* In Eleiyele Lake**

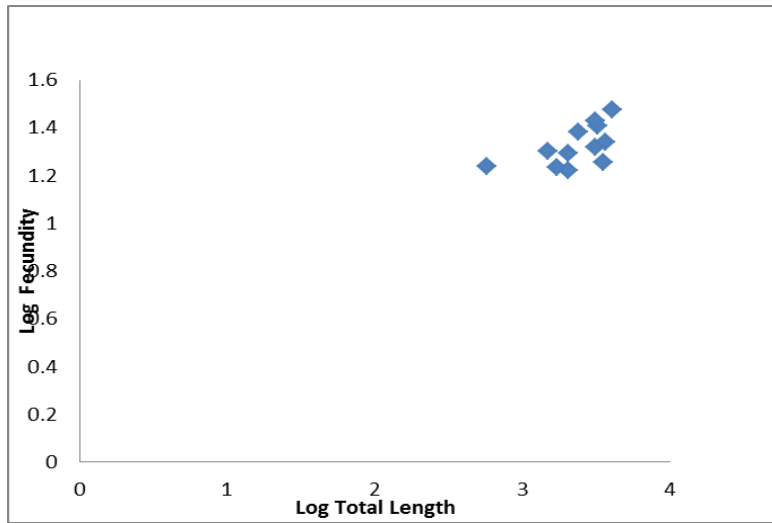


Fig.5: Relationship between fecundity and total length of *Sarotherodon galilaeus* in Eleiyele Lake

## DISCUSSION

The length weight relationship of *S.galilaeus* in the Eleiyele Lake showed significant and positive correlation indicating an increase in weight as the length increases. Statistical analyses of the LWR for size groups of the species revealed that the 8.6 – 18.8 cm group demonstrated negative allometric growth ( $b < 3$ ) and the 18.9 – 29.8 cm showed positive allometric growth ( $b > 3$ ), since  $b$  values were significantly different from 3. This revealed that each size group demonstrated different growth pattern. The recorded  $b$  value for the male which differed significantly from 3 indicated that the male specimens exhibited negative allometric growth. The female showed isometric growth ( $b = 3$ ). The differences recorded in the growth pattern between the size groups and between sexes could be attributed to differences in spawning condition and stomach contents/nutritional condition. This is in line with the observation of Ayoade (2011) who reported that  $b$  value of *Schilbe mystus* in Oyan Lake varies with size and sex. According to Prasad and Anvar Ali, (2007) change in the  $b$  exponent is due to changes in the specific gravity and shape of the body contour. *S.galilaeus* however showed isometric growth for the combined sex. This is contrary to the observation of Olele (2010) who reported that *S.galilaeus* in Onah Lake exhibited negative allometry. This difference in the  $b$  value may be the result of variations in ecology of the geographical locations or due to changes in the environmental conditions (Bagenal and Tesch, 1978)

*S. galilaeus* in Eleiyele Lake is in good condition as suggested by the mean condition factor which was greater than 1. The recorded increase in  $K$  with size group could be attributed to the specimens

in largest size groups being in ripe condition. This is in line with the observation of Meye and Ikomi (2011) who reported increase in  $K$  value with increase in size of *Hemichromis fasciatus*. According to Onimisi and Oniye (2010), the increase in  $K$  with size was attributed to the bigger fish being more efficient in finding food than the juveniles. The monthly variation in  $K$  value may be as a result of differences in availability of food with season and reproductive conditions of the specimens. The higher  $K$  value recorded for the females than the males, and combined sexes indicates that the females showed more plumpness and this is reflected in the significant difference obtained between the weight of the female and male specimens. Zoarder *et al.* (2012) made similar observation for *Chela cachius* in the old Brahmaputra River.

The higher gonadosomatic index ( $I_G$ ) recorded for the female specimen than male is an indication that the female put in more energy in the production of gonadal material. This observation is supported by Fagade *et al.* (1984), who reported that while gravid testis of *S. galilaeus* can constitute on the average 2% of the body weight, gravid ovary form averagely more than 4.6% of the body weight. The higher mean  $I_G$  computed for the smallest size group could be attributed to development of gonad not being age /size dependent but due to genetic make – up and response of the individuals to environmental factors to achieve feeding success (Olele, 2010). November being the period when highest  $I_G$  was recorded coincided with the period (August – December) when ripe individuals were encountered. This suggests that spawning occurred during this period. According to Fagade *et al.* (1984) spawning and spent individuals

of *S. galilaeus* in IITA Lake, Ibadan was obtained in the period May – June and October – December.

The absolute fecundity 572 (17.3 cm) – 4082 (24.5 cm) recorded for *S. galilaeus* during this study is in line with the observation of Fagade *et al.* (1984) who recorded 578 (13.4cm) to 3960 eggs (24.1 cm) for *S. galilaeus* in IITA Lake. A fecundity of 1, 452 (total length = 28.4cm) in the upper Ogun River; 604 eggs (total length = 15.6cm and weight 115 g) to 2173 eggs (total length 31.0 cm and a weight of 578 g) in Opa reservoir; 915 eggs (standard length; 15.5 cm) to 2220 eggs (standard length; 21.5 cm) in the Kigera reservoir were obtained by Adebisi (1987), Fawole and Arawomo (2000), Issa *et al.*, 2005 respectively for *S. galilaeus*. This variation in fecundity may be due to differential abundance of food (Fagade *et al.*, 1984) and differences in environmental factors, which was shown to have direct effects on the fecundity of *Tilapia* species in Kigera reservoir (Issa *et al.*, 2005). The highest number of eggs recorded in the heaviest specimen is in conformity with results obtained by Annune and Bako (1998) for *Oreochromis niloticus* in Kubanni reservoir.

## CONCLUSION

Information is provided by this study on the length weight relationship, condition factor, gonadosomatic index and fecundity of *Sarotherodon galilaeus* in the Eleiyele Lake. These results should enhance effective management and conservation of this commercially important species.

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