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Length-Weight Relationships and Condition Factors of Several Nigerian Fish Species

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Abstract

The length-weight relationship and condition factor of *Sarotherodon galilaeus* and *Oreochromis niloticus* were observed in Strabag Lake, Ibadan, Nigeria. A total number of 365 individuals were caught during the period of study with *Sarotherodon galilaeus* constituting 65.21% of the total catch while *Oreochromis niloticus* made up 34.79% of the catch. The mean weight and mean total length were 56.04 ± 1.019 g and14.64 ± 0.103 cm respectively for *S. galilaeus*;62.86 ± 2.184 g and15.84 ± 0.171 cm respectively for *O. niloticus*. The constants *a* and *b* of the exponential equation $W = [aL]^b$ were determined by transforming it into a log-transformed linear equation $log W = log a + blog L$ using the length and weight data. These parameters were then fitted to the exponential equation. The respective exponential equation for the length-weight relationship was $W = 0.068[L]^{2.5}$ for *S. galilaeus* and $W = 0.034[L]^{2.7}$ for *O. niloticus* which shows that both species exhibited negative allometric growth ($b< 3.0$). The correlation coefficient and condition factor recorded were 0.944 and 6.70 respectively for *S. galilaeus* and 0.911 and 3.49 respectively for *O. niloticus* specimens. The species showed negative allometric growth and were thriving well in the environment. However, *S. galilaeus* individuals were better suited to the environment than *O. niloticus* individuals. *O. niloticus* individuals were thriving better in the dry season than in rainy season. Since fish cannot survive outside water, it is recommended that similar studies be carried out on the lake water to ascertain its water quality parameters status for a comprehensive management of its resources.

Keywords: allometric growth, condition factor, length-weight, *O. niloticus*, *S. galilaeus*, total length

Introduction

Fish plays an important role in the development of a nation, being a cheap source of protein and also contains other essential nutrients required by the body (Sikoki and Otobotekere, 1999). Length-weight relationships of fishes, which are crucial in the fisheries biology and assessments (Garcia *et al.*, 1989; Haimovici and Velasco, 2000), estimate the fish's average weight with a given length category by using the mathematical relation (Beyer, 1987; Thomas *et al.*, 2003). The values are important for estimating the number of fish at a particular time and comparison of fish species populations caught from various places at similar or different times (Thomas *et al.*, 2003). In addition, the length-weight relationship indicates the degrees of stabilization of taxonomic characters in fish species and it is useful in the management and exploitation of fish populations (Pervin and Mortuza, 2008). Notable among the studies on length-weight relationships in fish are the reports of Shenouda *et al.* (1994) for *Chrysichthys* spp. from the Southernmost part of the River Nile (Egypt); Alfred-Ockiya and Njoku (1995) for mullet in New Calabar River; Ahmed and Saha (1996) for carps in Lake Kaptai, Bangladesh; King (1996) for Nigeria fresh water fishes; Diri (2002) for *Tilapia guineensis* in Elechi creek.

The relationship of length-weight estimates condition factor (K) of fish species (Wooton, 1990; Petrakis and Stergiou, 1995; Goncalves *et al.*, 1996; Binohlan and Pauly, 1998; Cherif *et al.*, 2008) and fish biomass through the length frequency (Gayanilo *et al.*, 1997; Tsoumani *et al.*, 2006; Ayoade and Ikulala, 2007; Cherif *et al.*, 2008). Condition factor compares the well-being of a fish and is based on the hypothesis that heavier fish of a given length are in better condition (Bagenal and Tesch, 1978). Condition factor studies take into consideration the health and general well-being of a fish as related to its environment; hence it represents how fairly deep bodied or robust fishes are (Reynold, 1968). It has been used as an index of growth and feeding intensity (Fagade, 1979). Condition factor decreases with increase in length (Bakare, 1970; Fagade 1979) and also influences the reproductive cycle in fish (Welcome, 1979). Condition factors of different species of cichlid fishes have been reported by Siddique (1977) in Lake Naivasha, Kenya; Fagade (1978, 1979, 1983) in the Lagos Lagoon, Nigeria; Dodzie and Wangila (1980) at Sagana Fish Culture Farm near Nairobi, Kenya; and Arawomo (1992) in Opa Reservoir, Ile-Ife, Nigeria. Some condition factors reported for other fish species include Hart (1997), for *Mugil cephalus* in Bonny estuary, Nigeria, Hart and Abowei (2007) used ten fish species from the lower Nun River, Delter, Nigeria, and Abowei and Davies (2009), *Clarotes lateceps* from the fresh water reaches of the lower Nun river, Delter, Nigeria.

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Presently, there are no reports carried out on the fish species of Strabag Lake. Therefore, this study aimed at describing the length-weight relationships and condition factors of *S. galilaeus* and *O. niloticus* which were species caught from the lake during the period of study. The growth parameters and condition factors of the fish species will provide information for management strategy of the species in Strabag Lake, Ibadan, Nigeria.

Materials and Methods

Study area

Strabag Lake is a man-made lake at Adegbayi, Ibadan, Nigeria, located between Latitude 07°22'55.80" N and 07°22'57.96" N and between Longitude 003°58'46.85" E and 003°58'55.06" E at an altitude of 220 m above sea level. Roughly, it assumes the shape of a trapezium with an approximated area of 0.0271 km^2; it has a mean depth of 10 m and was a result of excavation in the early 80's (Fig. 1). Due to long residency time of water, the artificial lake now contains species of fish of unknown history. With the construction of buildings around the lake, the water body has been affected by negative anthropogenic activities.

Fish sampling

Fish samples were collected at different sampling points once a month from November 2013 to October 2014. Gill-net fishing gear, measuring 20 m in length and 3 m in depth with a mesh size of 60.35 mm, was used to sample fish at different points on the lake (Fig. 2). Mesh sizes greater that or less than 60.35 mm were not effective for fish catch because no fish were caught when they were used during the preliminary study. The gill-net was set either parallel or perpendicular to the shore line. The fishes caught from each station were appropriately labelled and transported in ice-chests (for preservation) until they get to the laboratory. In the laboratory, fish species were identified using standard identification keys prepared by Paugy *et al.* (2003) and Adesulu and Sydenham (2007). Morphometric measurements of individual fish in the samples were taken and recorded: total length and standard length were measured with the aid of a meter rule to the nearest 0.1 cm while weight was determined with the aid of an electric weighing machine to the nearest 0.01 g.

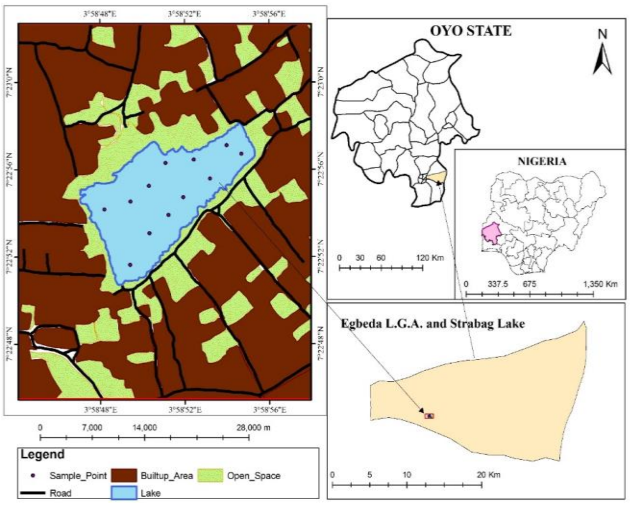

Fig. 1. Map of Nigeria showing Strabag Lake

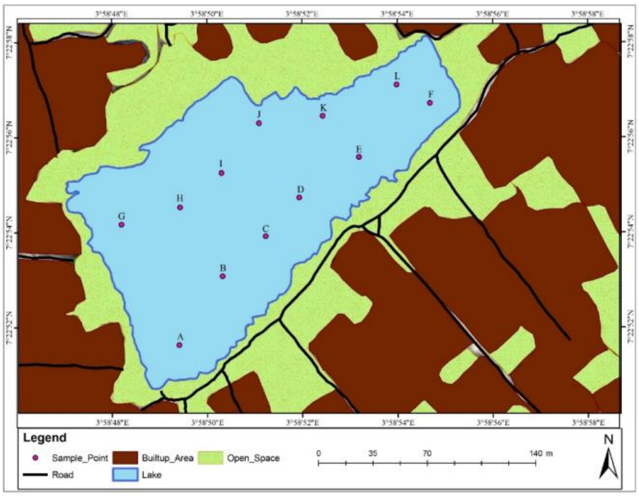

Fig. 2. Map of Strabag Lake showing sampling points

Length-weight relationships (LWR)

The relationship between the length (L) and weight (W) of fish was expressed by the equation: $W = [aL]^b$ (Pauly, 1983), where W = Weight of fish in (g), L = Total Length (TL) of fish in (cm), a = Constant (intercept) and b= The Length exponent (slope). The "a" and "b" values were obtained from a linear regression of the length and weight of fish by using their log-transformed values i.e., $\log W = \log a + b \log L$. The correlation coefficient (r^2), that is the degree of association between the length and weight was computed from the linear regression analysis.

Condition factor (K)

The condition factor was determined by using the equation $K = \frac{100[W]}{[L^b]}$ where K = Condition factor, W = mean weight of the fish (g), L = mean total length of the fish (cm) and b = slope value obtained from the regression line of length-weight equation. The exponent 'b' value, that is equal to 3, was not used to calculate the 'k' value. Bolger and Connolly (1989) claim that it is not a real representation of the length-weight relationship for greater majority of fish species, therefore the 'b' value planned to be used if 'b' was equalled to 3 would be the one obtained from the estimated length-weight relationship equation $W = [aL]^b$ as suggested by Lima-Junior *et al.* (2002).

Results

The measurements of Length and weight in *S. galilaeus* ranged from 10.0 cm to 19.5 cm (mean 14.64 ± 0.103) and 21.75 g to 113.42 g (mean 56.04 ± 1.019) respectively and from 11.8 cm to 22.1 cm (mean 16.63 ± 0.801) and 30.27 g to 167.75 g (mean 62.86 ± 2.184) respectively in *O. niloticus* (Table 1). Table 2 shows the that the size of the two species differed significantly ($P < 0.05$) with *O. niloticus* individuals generally of larger size than those of *S. galilaeus*. The Log-transformed graphs of total length against weight of *S. galilaeus* and *O. niloticus* are shown in Figs. 3 and 4. The two species exhibited negative allometric growth with their $b$values less than 3 in the habitat. The respective exponential equation for the length-weight relationships were $W = 0.068(L)^{2.5}$

for *S. galilaeus* and $W = 0.034(L)^{2.7}$ for *O. niloticus*. The mean condition factor for *S. galilaeus* was 6.70 while it was 3.49 for *O. niloticus*.

The graphical representation of the monthly condition factors for the two species in Strabag Lake is shown in Fig. 4. The maximum and minimum condition factors for *S. galilaeus* ranged between 5.20 and 11.87 during the rainy season months of September and October. However, the maximum and the minimum condition factors (1.26 and 4.45) for *O. niloticus* occurred in the dry and rainy months of March and October respectively. *K* values for the species during the period of study followed approximately the same pattern. *S. galilaeus* had a significantly higher condition factor than *O. niloticus* at $P < 0.05$. as shown by student's T-test (table 3). There was a significant difference in *K* values between the seasons in *O. niloticus* but not in *S. galilaeus* (Table 4).

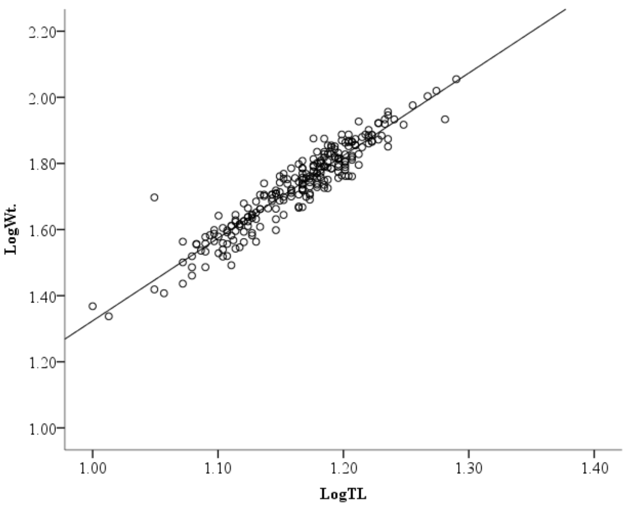

Fig. 3. Length-weight relationship of *Sarotherodon galilaeus* from Strabag Lake

Note: Wt=weight, TL=total length, r=correlation coefficient

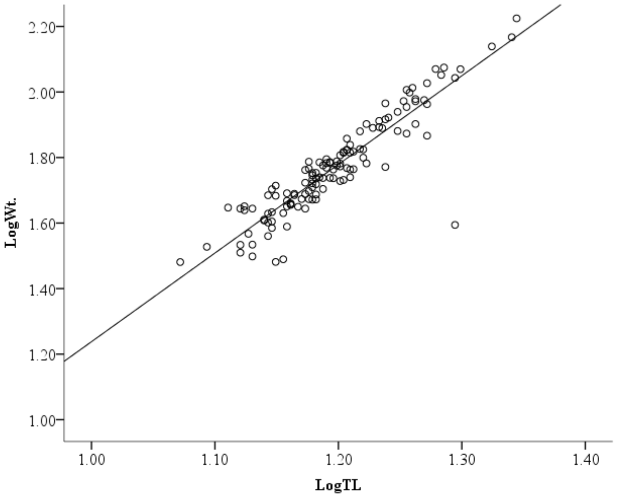

Fig. 4. Length-weight relationship of *Oreochromis niloticus* from Strabag Lake

Note: Wt=weight, TL=total length, r=correlation coefficient

Discussion

Length-weight relationship

The values obtained for the length-weight showed that *S. galilaeus* and *O. niloticus* were negatively allometric in their growth ($b < 3$ for both species). Variations growth patterns have been reported by several authors for different fish species from various water bodies. According to Pervin and Mortuza (2008) "*b*" values usually ranged from 2.5 to 4.0 for many fish species. The above results are in agreement *with* the results of King (1991) who reported allometric growth patterns for *Tilapia* species from Umuoseriche Lake, Nigeria, and Haruna (2006) who also reported a regression coefficient of 2.7 to 3.2 for *S. galilaeus* from Magaga Lake, Kano, Nigeria. Benedict *et al.* (2009) studying sixteen fish families from Cross River inland wetlands, Nigeria, reported a regression coefficient of 2.7 each for *O. niloticus* and *Heterobranchus longifilis*.

The transformed length fitted over weight gave linear growth indicating the three dimensional growth structures of most fish species (Lagler *et al.,* 1977). Values of the length exponent in the length-weight relationship being isometric implies that the fish species did not increase in weight faster than the cube of their total lengths. However, the weight of other fish species increased faster than the cube of their total lengths. Length-weight relationships give information on the condition and growth patterns of fish (Bagenal and Tesch, 1978). The regression co-efficient for isometric growth is '3' and values greater or lesser than '3' indicate allometric growth (Gayando and Pauly, 1997). As the values of "*b*" increases, the size of the fish also increases because the fish usually grows proportionately in all directions. However, the changes in fish weight in general are actually greater than the changes in its length. The body shape of fish tends to change as the length increases. In Strabag Lake, *S. galilaeus* and *O. niloticus* showed a high correlation coefficient of $r = 0.944$ and $r = 0.911$ respectively indicating that the species increased in weight as the length also increased. However, there was no proportional increase in weight as the length increases since the '*b*' values of both species were less than three, i.e., their growth was negatively allometric.

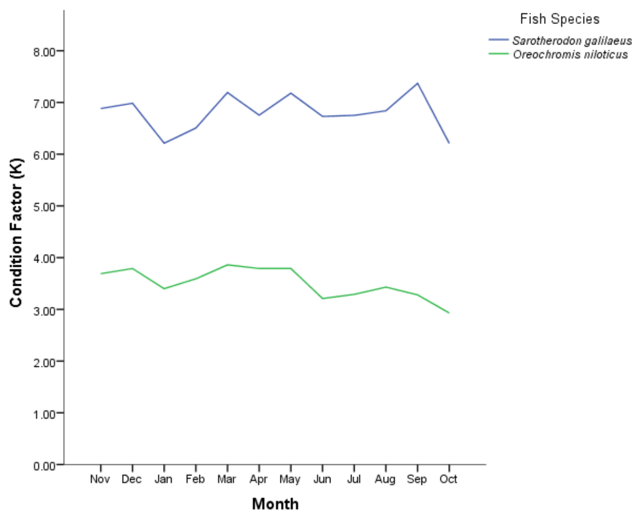

Fig. 5. Mean monthly condition factor between *Sarotherodon galilaeus and Oreochromis* in Strabag Lake

Table 1. Length-weight relationship of *Sarotherodon galilaeus* and *Oreochromis niloticus*

Fish species	n	Weight (g)		Total length (cm)		Exponetial. equation	r	K ± S.E.
		Range (cm)	Mean ± S.E.	Range (cm)	Mean ± S.E.			
S. gallilaeus	238	21.75 - 113.42	56.04 ± 1.019	10.0 - 19.5	14.64 ± 0.103	$W = 0.068[L]^{2.5}$	0.944	6.70±0.044
O. niloticus	127	30.27 - 167.75	62.86 ± 2.184	11.8 - 22.1	16.63 ± 0.801	$W = 0.034[L]^{2.7}$	0.911	3.49±0.038

Note: n = number of samples, r = correlation coefficient, K = condition factor, S.E. = standard error

Table 2. Student's T-test for the total length between *Sarotherodon galilaeus and Oreochromis niloticus*

Parameter	Fish species	n	Range (cm)	Mean ± S.E.	t	df	Sig. (2-tailed)
Total length	*S. galilaelus*	238	10.0 - 19.5	14.64 ± 0.103	-3.320	363	0.001*
	O. niloticus	127	11.8 - 22.1	16.63 ± 0.801			

*. Significant at the 0.05 level (2-tailed).
Note: n = sample size, S.E. = standard error, t = T-test value, df = degree of freedom, Sig. = significance

Table 3. Student's T-test for the condition factors (K) between *Sarotherodon galilaeus and Oreochromis niloticus*

Parameter	Fish species	n	Range (cm)	Mean ± S.E.	t	df	Sig. (2-tailed)
Condition factor	*S. galilaeus*	238	5.20 - 11.87	6.70 ± 0.044	48.531	363	0.000*
	O. niloticus	127	1.26 - 4.45	3.49 ± 0.038			

*. Significant at the 0.05 level (2-tailed).
Note: n = sample size, S.E. = standard error, t = T-test value, df = degree of freedom, Sig. = significance

Table 4. Student's T-test for the condition factors (K) between the seasons

Parameter	Fish species	Season	n	Range (cm)	Mean ± S.E.	t	df	Sig. (2-tailed)
Condition factor	*S. galilaeus*	Dry	105	5.38 - 8.61	6.67 ± 0.059	0.454	236	0.650
	S. galilaeus	Rainy	133	5.20 - 11.87	6.71 ± 0.063			
	O. niloticus	Dry	47	3.00 - 4.15	3.62 ± 0.047	2.557	125	0.012*
	O. niloticus	Rainy	80	1.26 - 4.45	3.42 ± 0.052			

*. Significant at the 0.05 level (2-tailed).
Note: n = sample size, S.E. = standard error, t = T-test value, df = degree of freedom, Sig. = significance

Condition factor (K)

The condition factor (K) of fish species reflects on the physiological state of the fish in relation to its welfare with respect to accumulation of fats (Le Cren, 1951), gonadal development (Angelescu *et al.*, 1958), feeding activity (Bagenal and Tesch, 1978), density and climatic condition. The condition factor of the fish species in Strabag Lake varied from 5.20 to 11.87 with a mean value of 6.70 ± 0.044 for *S. galilaeus* and from 1.26 to 4.45 with mean value of 3.49 ± 0.038 for *O. niloticus*. Both fish species recorded high values of K and this shows that they were in good condition in the studied environment. However, the significant difference ($P < 0.05$) in the mean condition factors of these fishes might be because the studied individuals are different species. This might also be due to the fact that *S. galilaeus* individuals were significantly larger than *O. niloticus* individuals. Fish of smaller sizes tends to have higher condition factor and hence well suited to the environment than fish of larger sizes (Bakare, 1970; Fagade 1979). According to Gayando and Pauly (1997), factors such as size classes, sex, and stages of maturity often affect fish well-being.

Vazzoler (1996) reported that condition factor can vary with gonadal development and time of year, and also among different populations. These temporal and seasonal fluctuations of the condition factor are influenced by endogenous parameters such as nutritional aspects, sex, and the state of gonadal maturation or exogenous parameters (environmental factors) affecting a population (Rodriguez, 1987). In this study, *O. niloticus* recorded high significant *K* value in dry season (3.62 ± 0.047) than the rainy season (3.42 ± 0.052). This might mean a more abundant food for the species during the dry season than during the rainy season. Another explanation is that the rainy season months might be the reproductive months for *O. niloticus* in which the significant decline in condition factor is attributed to the deposition of materials for gonad formation, which may lead to increase in weight and actual spawning which lead to reduction in fish weight respectively (Mgbenka and Eyo, 1992; Vazzoler, 1996).

Conclusions

This study reveals that fish species of Strabag Lake increase in length was not proportional with the of size. The fish species were thriving well in the environment but *S. galilaeus* individuals were better suited to the environment than *O. niloticus* individuals. In addition, *O. niloticus* individuals were thriving better in the dry season than in rainy season.

Since fish cannot survive outside water, it is recommended that similar studies be carried out on the lake water to ascertain its water quality parameters status for a comprehensive management of its resources.

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