THE LENGTH-WEIGHT RELATIONSHIP OF *Schilbe mystus* (LINNE, 1766) FROM TWO MAN-MADE LAKES IN SOUTH-WESTERN NIGERIA

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Abstract

The length-weight relationship (LWR) and condition factor of *Schilbe mystus* from Asejire and Oyan Lakes were investigated. The *b*-values, 3.3845 and 3.2402 for the relationship of body weight to body length for this species in Oyan and Asejire Lakes respectively indicated that it exhibited positive allometric growth. Comparison of the LWR of the specimens revealed that growth rate differs between the sexes, size groups and locations ($p < 0.01$). Out of the 4 size groups (with 5 cm interval) used for comparison of growth rates in the species, the largest size group (24.6-29.5 cm) had lowest condition factor. The mean condition factors of the fish in both lakes were above average.

Keywords: *Schilbe mystus*, lakes, length-weight relationship.

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Introduction

A fish stock assessment gives valuable insight into levels of exploitation of fish stock, population structure and population growth response to environmental changes and pragmatic fisheries management. One of the important factors for fish stock assessment is length-weight relationship which is an important piece of information in fisheries biology which may not be available when needed (King, 1996).

In fish, size is generally more biologically relevant than age, mainly because several ecological and physiological factors are more size-dependent than age-dependent. Consequently, variability in size has important implications for diverse aspects of fisheries science and population dynamics. Also, the relationship between length and weight of fish are important in fisheries biology because they allow estimation of average weight of the fish of a given length group (Beyer, 1987); and can also be used to determine the condition factor (*K*) in order to express the condition of fish in numerical terms (Wooton,1992).

The length-weight relationship of fish species have been studied in Nigeria by various workers (King, 1996; Taiwo and Aransiola, 2001; Fafioye and Oluajo, 2005; Ayoade and Ikulala 2007; Lawson, 2010; Adeyemi, 2011; Ayoade, 2011). This work reports the length-weight relationship (LWR) and condition factor of *S. mystus* (a siluroid catfish of commercial importance) from two different habitats, thus allowing comparison and revealing effects of environment which is studied for the first time.

Materials and methods

Study areas

Oyan and Asejire Lakes are located in south-western Nigeria (Figure 1) and there is a horizontal distance of about 100 km between them. Asejire Lake is a man-made lake constructed on River Osun in 1972. River Osun is one of the series of West African rivers which do not drain into Niger system but discharge into coastal lagoons and creeks bordering the Atlantic Ocean. The lake is Y-shaped with two unequal arms of the Y. From the data supplied by the Oyo State Water Corporation, the catchment area above the dam is 7,800 km^2 and the impounded area is 2,342 hectares. The dam has a normal pool elevation (water level) of 150 m and maximum flood elevation of 152.4 m. The lake has an approximate gross storage of 7,403 million liters.

Oyan Lake (Figure 1) is constructed on Oyan River

and it started to fill with the closing of the gates of the dam on the 30th of October 1984 and took 2½ months to fill. The average annual flow at the dam site is estimated at 1,770 million m^3 and the dam provides a normal level reservoir capacity of 270 million m^3. The climate of Oyan Lake is influenced by the NE-SW movement of a zone of surface discontinuity between maritime (Atlantic) air masses and dry continental (Sahara) air masses. Climatic, vegetation and some physico-chemical features of the study-areas are illustrated on Table 1.

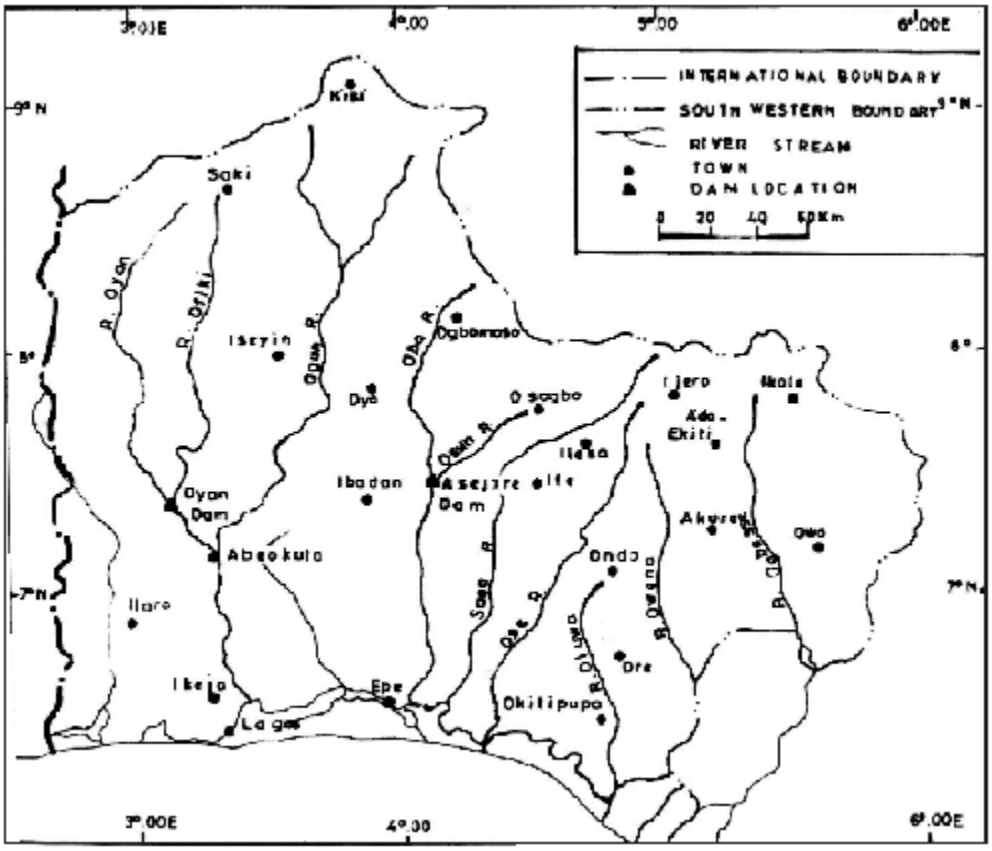

Figure 1: Map of south-western Nigeria showing drainage system and location of Asejire and Oyan Lakes.

Table 1: Features of Oyan and Asejire Lakes.

Features	Oyan Lake	Asejire Lake
Location	20 km North-west of Abeokuta	30 km East of Ibadan
Latitude	07°5′ and 07°26′N	07°21′N
Longitude	03°6 ? and 3°16′ E	04°7′E
Elevation	0 and 150 m above sea level	137 m
Geology	Precambrian metamorphic and plutonic rocks	Precambrian metamorphic rocks
Vegetation	Forest savanna mosaic	
Climate	Dry season: November to April	
Dry season: November to April		
Rainy season: May to October		
Maximum length (km)	27 km	–
Maximum width (km)	6	–
Maximum depth (km)	63	19
*Mean air temperature (°C)	24.3 ± 1.34	27 ± 2.03
*Mean rainfall (mm)	102.6	14.7
*Mean humidity (%)	77.4	79
*Mean dissolved oxygen (mg/l)	7.1 ± 0.96	6.88 ± 1.33
*Mean pH	7.37 ± 0.43	7.21 ± 0.19
*Mean surface water temperature (°C)	29.9 ± 2.34	28.5 ± 1.91

Source: Elliot (1986) and Olurin (1994); *Ayoade *et al* (2006).

Length-weight relationship

Two thousand, four hundred and thirty specimens of *S. mystus* were obtained from landing sites of Oyan and Asejire Lakes from July 2000 to December 2001 from fishermen who caught the fish with gill nets of mesh sizes 50-55 mm and were transported in an ice chest from field to the laboratory.

For the remaining fish not used in racial studies the total and standard lengths of each fish were measured to the nearest tenth of a centimeter using a measuring board. Also, each fish was weighed to the nearest grams using a top loading mettler balance. The regression of body weight on body length was computed from the relationship, $W = aL^b$ where W= total weight in grams, L = total length in cm, a = a constant, b = an exponent usually between 2 and 4 (Bagenal and Tesch, 1978). A logarithmic transformation of the relationship was done as: Log W = log a + b log L. z-transformation (Bailey, 1995), was used to determine whether there is likely to be a real difference in the degree of association (r) of each relationship for the two lakes. Comparison of the regression coefficients obtained for male and female, different size groups, and lake were made by calculation using the formula

$$d = \frac{b_1 - b_2}{\frac{s_1^2}{\Sigma_1(x-\bar{x}_1)^2} + \frac{s_2^2}{\Sigma_2(x-\bar{x}_2)^2}}$$

Where suffices 1 and 2 refer to the two samples, b is regression coefficient, $\Sigma(x-x)^2$ is sum of squares about the mean, s is variance (Bailey, 1995). The calculated values were compared to those on statistical table at 5% probability level.

The slopes of length-weight regressions were compared to 3 using student's t-test (Sokal and Rohlf 1987) to determine whether species grew isometrically.

Condition factor

Fulton's condition factor was calculated from $K = 100\ W/L^b$ (Pauly,1983), where W and L are the total weight in grams and total length in cm of the specimens respectively and b is the regression coefficient computed from body weight and total length relationship. The values of K were used in assessing the condition of fish in relation to sex, size, and season.

Results

Length-Weight Relationship (LWR)

1,050 specimens obtained from Oyan Lake ranged in total length from 9.5-26 cm and total weight from 3.4-158.9 g. The estimated coefficients of the LWR for the different size groups, sex, combined (Oyan) and other details of the statistical analyses are summarized in Table 2. The values obtained for correlation coefficient (r) were greater than 0.80 in all the LWR except in size group 19.6-24.5cm (r= 0.0364). This indicated high degree of positive correlation between the variables and these were highly significant (p<0.01). z-transformation test showed that there was real difference in degree of association (r) (p<0.2%) between the length and weight of male and female *S. mystus* in this lake. Also there was significant difference in the degree of association of length and weight of 19.6-24.5 cm size group and the other size groups.

The slopes (b-values) of the LWR of *S. mystus* in Oyan Lake ranged from 1.1234 (19.6-24.5cm)-3.9807 (14.6-19.5 cm) for the different size groups. Thus, the larger size group had lower b-value. Statistical analysis showed that b-value of 9.6-14.5 cm was not significantly different (p>0.01) from 3, while b-value for remaining sizes were significantly different (p<0.01) from 3. The b-value obtained for the male (3.5459) was found to be slightly higher compared to female (3.3095). Statistical analysis for comparison of b-values revealed that of female was not significantly different (p>0.05) from that of male, while b-value of 19.6-24.5 cm size group was significantly different (p<0.05) from that of the smaller size groups (Table 2).

The 890 specimens examined from the Asejire Lake had total lengths ranging from 9.5-25.5 cm, and total weight 4.8-161.4 g. All LWRs (size groups, sex, and combined (lake) were highly significant (p<0.01) with r-values greater than 0.70 (Table 2). However, statistical analysis showed that r-value for LWR of male was significantly different (p<0.2%) from female, while there is no difference in degree of association between length and weight of *S. mystus* of different size groups. The r-value obtained for LWR of *S. mystus* in Oyan Lake (combined) was also significantly different (p<0.2%) from the same species in Asejire Lake.

The regression coefficient (b) of LWR varied from 2.7110 (19.6-25.5 cm) to 3.6304 (9.6-14.5 cm). Thus, b-value was lower in larger size group as occurred in samples from Oyan Lake. However, the b-values for all the size groups were not significantly different from 3 (Table 2).The b-value of female (3.3521) was slightly higher than that of male (3.0657) and was significantly different (p<0.01) from 3, while that of male was not. For combined (Asejire Lake), the estimated regression coefficient (3.2402) was significantly different (p<0.01) from 3. Statistical analyses revealed that slope of the regression line (b) of the male differed significantly (p<0.05) from that of the female, and that of smaller size specimens from larger size groups. The b-value obtained for specimens from Asejire Lake (combined) was also significantly different (p<0.05) from that of Oyan Lake (Table 2).

Table 2: Estimated parameters of the log length-log weight relationships for size groups and sex of *S.mystus* in Oyan and Asejire Lakes from July 2000 to December 2001.

	Oyan Lake						Asejire Lake					
Size groups (cm)	*n*	*A*	*b*	*r*	S.E(b)	t=b-3/S_b	*n*	*a*	*B*	*r*	S.E(b)	*t* = *b* – 3/S_b
9.6 -14.5	84	-2.928	3.6642^{e}	.8085**^{g}	0.2945	2.2509*	497	-2.8688	3.6304^{A}	0.7856**^{I}	0.5054	1.2473*
14.6-19.5	780	-3.352	3.9807^{e}	0.8147**^{g}	0.1548	6.3353**	8					
19.6-24.5	182	0.3665	1.1234^{f}	0.0364*^{h}	0.5358	-3.5024**	379	-1.7227	2.7110^{B}	.7562**^{I}	.4514	-0.6401*
24.6-29.5	3	-	-	-	-	-	6	-	-	-	-	-
Sex												
Male	40	-2.7476	3.5459^{d}	0.9127**^{A}	0.1066	5.1210**	320	-2.2180	3.0657^{C}	0.7873**^{D}	0.1347	0.4878*
Female	960	-2.5002	3.3095^{d}	0.8507**^{B}	0.1265	2.4466*	550	-2.5676	3.3521^{D}	0.8398**^{E}	0.0894	3.9385**
Combined	1540	-2.5398	3.3845^{I}	.8604**^{C}	0.1277	3.0101**	860	-2.4244	3.2402^{G}	.8382**^{F}	0.0761	3.1564**

*- not significant at $p< 0.01$; **- significant at $p< 0.01$; n = sample size.
a and b: parameters of the relationship. SE (b) = standard error of the slope b. r = Correlation coefficient.
Different alphabets on b and r-values indicates significant difference at $p< 0.05$ and $p<0.002$ respectively.

Condition factor

In Oyan Lake, the mean *K*-value of the female specimens was higher (1.23 ± 0.08) than male (1.12 ± 0.12) but not significantly different ($p>0.05$) (Table 3). There is gradual increase in mean *K*-value with increase in size. However, the value dropped at the largest size group and *K*-value of the different size group was significantly different ($p<0.05$).

The mean *K*-value of the male specimens was slightly higher than that of female specimens in Asejire Lake but showed no significant difference ($p>0.05$). Also, similar to Oyan Lake, the mean *K*-value increased with size and dropped at the largest size group. The *K*-values of the size groups differed significantly ($p<0.05$) (Table 3). For the combined (lakes), mean *K*-value of samples from Oyan Lake was higher than that of Asejire Lake but not significantly different ($p>0.05$). Monthly variation in mean *K*-values for *S.mystus* in both study sites showed that higher condition factors were observed in November 2000-March 2001, while *K*-values dropped between April-October 2001 (Figure 2). Generally, the condition factor exhibited alternating peaks and lows in the two lakes. When it was low in Asejire Lake, it was high in Oyan Lake and *vice versa.*

Discussion

The correct interpretation of the parameters resulting from the LWR of fish species is useful in the study of fisheries biology and management (Weatherly and Gills, 1987). Statistical analyses of the LWR for size groups in Oyan Lake showed that 9.6-14.5 cm group exhibited isometric growth since *b*-value was not significantly

Table 3: Variation in condition factor (*K*) with sex and size groups in Oyan and Asejire Lakes.

	Oyan Lake					Asejire Lake				
Sex	N	Range of *k*	Mean *k*± *SE*	*t*-calculated	*F*-value	*n*	Range of *k*	Mean *k*	*t*-calculated	*F*-value
Male	90	0.16-2.03	1.12 ± 0.12	-2.5704	-	320	0.07-1.98	1.21 ± 0.07	1.3141**	-
Female	960	0.13-3.29	1.23 ± 0.08			550	0.05- 2.06	1.17 ± 0.07		
Size Groups										
9.6-14.5 cm	84	0.16-3.29	1.06 ± 0.16	-	9.2512*	497	0.17-2.06	1.04 ± 0.05	-	
14.6-19.5 cm	780	0.13-2.79	1.20 ± 0.07			8	0.05- 1.98	1.18 ± 0.06		
19.6-24.5 cm	182	0.13-1.79	1.31 ± 0.09			379	0.13-1.75	1.35 ± 0.08		15.0526*
24.6-29.5 cm	3	0.5-1.51	1.1± 0.28			6	0.17-0.77	0.47 ± 0.18		
Combined (Oyan)	1039	0.13-3.29	1.21 ± 0.09	-1.5533**						
Combined (Asejire)	890	0.05-2.06	1.18 ± 0.07							

n is sample size, *SE* – standard error,*-significant , **- not significant.

different from 3, size group 14.6-19.5 cm showed positive allometric growth (b>3), while 19.6-24.5 cm size group was observed to show negative allometric growth (b< 3), thus different growth pattern was demonstrated by each size group. For Asejire Lake, the three size groups exhibited isometric growth with *b*-values not significantly different from 3. In Oyan Lake, male exhibited positive allometric growth, while female showed isometric growth and this is *vice versa* for specimens in Asejire Lake. Statistical analyses showed *b*-value is significantly different from 3 for the combined (lake), this indicates this species exhibited positive allometric growth in both lakes. In this study most of the LWR does not follow the cube law ($W = aL^3$), and this is because fishes do change shape as they grow. Elliot (1986) and King (1996) also reported that growth was allometric for this species in Asejire Lake and Ikpa River respectively. Olatunde (1979) observed that male *S. mystus* had *b*-value close to 3, indicating isometric growth, while female demonstrated positive allometric growth. Fafioye and Oluajo (2005) recorded that values of *b* for *Chrysichthys walkeri* (3.114), *C. nigrodigitatus* (3.042) and *E. fimbriata* (3.210) in Epe Lagoon showed positive allometric or approximate allometric growth. Montuza and Rahman (2006) also showed values of regression coefficient for male (2.941), female (3.008) and combined sexes (2.984) of the freshwater fish *Rhinomugil corsula* to be close to 3.0 and therefore, *R. corsula* did not follow the cube law.

Result of comparison of *b*-values showed that LWR of the larger size group (19.6-24.4 cm) differs significantly from smaller size groups in Oyan Lake while LWR of male is not significantly different from female. However, in Asejire Lake, LWR of different size groups are not significantly different, while male is significantly different from female. For the combined (lake), LWR of this species is shown to be significantly different from that of Oyan Lake. Thus, this present study shows that LWR varies with sex, size and location. These variations may be brought about by changes in growth pattern with different stages of development (sex, size) and differences in environmental condition. According to Vasnetsov (1953), during their development, fish are known to pass through stages in their life history which are defined by different LWRs. Bagenal and Tesch (1978) reported maturity, sex, season and time of day as some of the reasons for differences in LWR. According to Lagler *et al* (1977), social factors and environmental factors interact together to produce growth pattern in a fish. The biotic factors include composition or influence of number on available food, nest sites and feeding behaviour, while environmental factors are the physical and chemical variables prevailing in the fish habitat. Lawson (2010) also reported that *b* and *r* values were higher in females than males or unsex. However, their variances were not significantly different in Lagos lagoon, Nigeria.

The mean condition factors obtained for *S. mystus* in both lakes were greater than 1. This suggests that the fish is above average condition in both lakes (Wade, 1992) and thus both environments are suitable for this species. The observed decrease in mean *K*-value in the largest size group (19.6-24.5 cm) and during the rainy season, which is the spawning season of this species as reported by Ayoade (2009), suggests depletion of reserves in *S. mystus* for reproduction. Condition factor has also been closely linked with reproductive cycle in *C. nigrodigitatus* (Aboaba, 1993). The significant difference (p<0.005) in mean *K*-values of the different size group might be due to changing rate of growth with age or size. The general inverse relationship observed in mean *K*-value with months for this species in the two lakes might be due to the differences in environmental factor and food availability in the two habitats.

In conclusion, the results showed that LWR of the two populations of *S. mystus* studied revealed differences between sex, size groups and location. The conditions of *S. mystus* in both lakes being above average, indicates that the condition of these two fresh water bodies are favourable for this species.

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