

GROWTH PATTERNS AND CONDITION FACTORS OF FOUR FISH SPECIES IN LAKE ONA, SOUTHERN NIGERIA

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Abstract

Growth patterns involving evaluation of Length-Weight Relationships (LWR) of four dominant fish species in Lake Ona, Southern Nigeria, were studied. The fish species, *Heterotis niloticus* (Osteoglossidae), *Syndontis nigrita* (Mochokidae), *Citharinus citharus* (Citharinidae) and *Heterobranchus bidorsalis* (Clariidae) were caught from 2001 to 2003, using varied fishing gears. The gears were three bottom-set and three surface-set gill nets of mesh sizes 1.0 cm 3.0 cm and 5.0 cm, with each having a length of 25.0 m and a depth of 3.0 m; cast net with stretched mesh size of 6.4 cm; fish baskets, locally called manly; non-return value traps and a set of long-lines of length 35.0 m while Fish Aggregating Devices (FAD) and fences were equally used to aggregate fishes. The LWR was determined from the formula, $w = aL^b$ with the parameters a and b in that formula estimated through logarithmic transformation in the form of $\text{Log } W = \text{Log } a + b \text{Log } L$. The condition factor (k) was estimated from the relationship, $k = W/100/L^3$. The results obtained from LWR are presented for the four species and the values of the growth exponent “ b ” ranged from 1.92 to 3.04 for *H. bidorsalis*; 2.47 to 3.03 for *H. niloticus* 1.39 to 2.11 for *C. citharus* and 1.01 to 1.97 for *S. nigrita*. Fish species in the lake were generally healthy and in good condition. Overall mean condition factor (k) were 1.21 for *H. bidorsalis*; 1.57 for *H. niloticus*; 2.40 for *C. citharus* and 1.60 for *S. nigrita*.

Keywords: Length-weight relationship, condition factor, growth exponent, isometric-allometric growth patterns, Lake Ona.

Introduction

Length and weight are two basic components in the biology of fish species at individual and population levels. Length-Weight Relationship (LWR) is an important factor in fish ecology and indeed the biological study of fishes (Bagenal, 1978). LWR is of prime importance in parametrizing fish yield equations in stock assessments and management (Nash *et al*, 2006). LWR enables the estimation of biomass from commercial processing data. LWR as an empirical relationship is helpful in studying the natural history of fishes.

The mathematical parameter of LWR of fish furnishes further information on the weight variation of individuals in relation to their length (condition factor, k). This factor estimates the general well-being or relative fatness (plumpness) of the individual and is usually influenced by age, sex, season and maturity (Anyanwu *et al*, 2007).

Lake Ona is a natural freshwater lake in Oshimili South Local Government Area of Delta State in Southern Nigeria. Like other inland water bodies in Nigeria, Lake Ona has been undergoing steady exploitation over the years by artisanal fishermen, whose only objective is to catch fish for commercial purposes. Until quite recently when some researchers (Ekelemu and Zelibe 2006; Olele and Obi, 2006a and 2006b; Olele and

Ekelemu 2008; Olele *et al.*, 2008), conducted research on the lake, there has been a dearth of information on this water body. However, very recently, the present authors have commenced a series of investigation on varied aspects of the water body. The present study aims at providing a scientific background on the LWR of four dominant species in Lake Ona. The species, *Heterotis niloticus*, *Synodontis nigrita*, *Citharinus citharus* and *Heterobranchus bidorsalis* were selected from an earlier work (Ekelemu and Zelibe, 2006).

Materials and Methods

Study area: Lake Ona lies west of River Niger and has its source from Utto spring (Ekelemu, 2006). It is located eight kilometres from Asaba, Nigeria, lying on latitude $6^{\circ}4'1''\text{E}$ and longitude $6^{\circ}15'1''\text{N}$ of the equator (Fig. 1.) The lake has a length of 2,250.01m, an area of 516,1972m² with a volume of 413,804.12m³ (Ekelemu, 2006).

Topography and vegetation: Lake Ona lies in the Asaba-Ogwashi rock formation and has a gentle slope from its banks that permits inflow of surface run-off and organic matter derived from the surrounding vegetation. This load contributes to the allochthonous materials in the lake. The substratum is made up of a deep layer of clay and an ad-mixture of silt and decomposing organic matter. The lake is devoid of thick tree canopy but it is dominated by floating aquatic macrophytes viz *Salvinia nymphaeella*, *Salvinia nymphaea*, *lotus* Linn., present mostly in the back waters. Found floating on the water surface are *Azolla pinnata*, and *Pistia stratiotes*. Fringing the shoreline is a dense population of *Panicum subalbidum*, Kunth, *Paspalum scrobiculatum*, Linn and *Diplazium sammati*, Kahn.

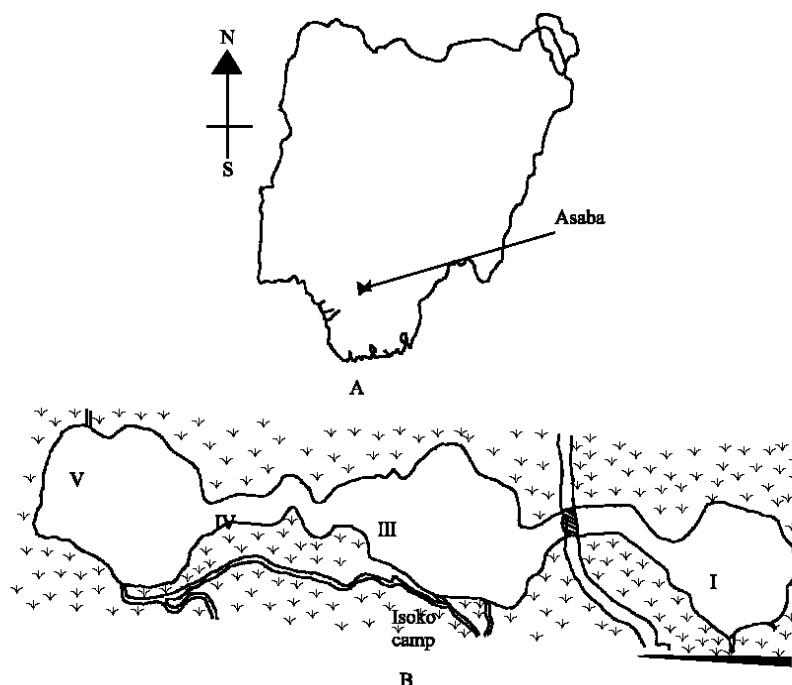


Fig 1: Map of Nigeria, (B) shows details of study stations- I, II, III, IV and V on Lake Ona.

Study stations: In the wet season, Lake Ona appears as a common sheet of water but in the dry season, it is compartmentalized into three distinct sections of Ona-ododo, Ogbu and Obabala, with Ogbu and Ona-ododo being the largest and smallest respectively. Five sites were established in the course of the study and were designated stations I, II, III, IV and V Fig. 1. Stations I, III and V were Ona-ododo, Ogbu and Obabala,

respectively. Station II is the link between stations I and III, while the link between stations III and V is station IV.

Sampling for fish: Fish samples used for the study were collected at fortnightly intervals between August 2001 and July 2003 from the three stations designated I, III and V, which are the main channels of the lake. The sampling period spanned two dry and wet seasons (October – March and April – September respectively). For the purpose of sampling one fisherman and a boatman were engaged for each station. At each station, three bottom-set and three surface-set gill nets of mesh sizes 1.0, 3.0 and 5.0cm were used for sampling. Each net had a length of 25.0 m and a depth of 3.0m. In addition to these nets, one segmented cast net with pockets of stretched mesh size 6.4cm was used at each of the stations.

In view of the large size of the lake, to take care of the bottom dwelling fishes five fish baskets locally called manly and five non-return valve traps were set in each of the stations. There was also a set of long-lines of length 35.0 m which ran along the edges of the fringing vegetation of the three stations. This was to take care of fishes using the vegetation as hiding places. In the dry season months, Fish Aggregating Devices (FAD) and fences. The FADs were twigs cut and heaped in the water for fishes to use as sanctuaries. The FADs and fences were used to aggregate and catch fish by encircling area with net and removing the twigs. The gears used were tended twice on sampling days between 06.00-7.30 and 17.00-18.30hr.

All fish samples caught were washed, packaged in Coleman ice-chests and transported to the laboratory, where they were sorted, counted and all measurements (total length, standard length and weight) were taken and recorded to the nearest 0.1cm and 0.1g, respectively. Fish samples were identified up to the species level according to Reed *et al.* (1967) and Idodo-Umeh (2003).

Data analysis

Total length, body weight and number of fish species caught at the three stations (I, III and V) were used for the following analysis LWR was determined from the formula, $W = aL^b$. The parameters a and b in the formula were estimated through logarithmic transformation in the form, $\text{Log } W = \text{Log } a + b \text{ Log } L$

Where,

- W = Total body weight of fish (g)
- L = Total length of fish (cm)
- b = Growth exponent or regression coefficient
- Log a = Intercept on the Y-axis

The condition factor (k) was estimated from the relationship, $k = W/100.L^b$ after Le Cren (1951). Data collected were subjected to analysis of variance and means separated using the new Duncan Multiple Range Test (NDMRT).

Results

Catch data: A total of 1,394 fishes were caught during the sampling period. However, attention in the present study focused on the four species whose data are summarized in Table 1. The Catch data presented in Table 1 shows that the species and their occurrence by number were:- *Heterobranchus bidorsalis* 17 (1.22 %), *Heterotis niloticus* 75 (5.38 %) *Synodontis nigrita* 288 (20.66 %) and *Citharinus citharus* 308

(22.09). *C. citharus* was therefore the most abundant while *H. bidorsalis* was least abundant, as only 17 specimens were caught.

Analysis of variance showed a significant difference among the monthly number of fish at the three stations of the lake $P < 0.01$. DMRT showed that the monthly number of fish at Station I was significantly different from those of stations III and V, $P < 0.05$.

Table 1: Catch data on four fish species in Lake Ona

Family	Species		Stations			Total Per species
			I	III	V	
Clariidae	<i>Heterobranchus bidorsalis</i>	-	13	4	17	
Osteoglossidae	<i>Heterotis niloticus</i>		26	44	5	75
Mochokidae	<i>Synodontis nigrita</i>		8	103	177	288
Citharinidae	<i>Citharinus citharinus</i>		9	187	112	308
Total per Station			43	347	298	

Meristic data

Presented in Table 2, are range of figures for two basic meristic features taken which were Total Length (TL) in centimetres (cm) and Body Weight (BW) in grams (g). Total length of *H. bidorsalis* ranged from 15.9 cm to 83.9 cm in Lake Ona while the body weight ranged from 23.2 g to 5,003.08 g (Table 2). Total length of *H. niloticus* ranged from 17.6 cm to 59 cm, while the body weight ranged from 46.6 to 1,621.0g Table 2. For *S. nigrita*, TL ranged from 04.5 cm to 18.0 cm while it BW ranged from 05.5 g to 56.3 g in Lake Ona (Table 2). Across Lake Ona, TL for *C. citharus* ranged from 06.0 to 27.0cm while the BW ranged from 05.8 to 581.2 g.

Table 2: Range of total length and body weight of four fish species in Lake Ona

Species	Range of parameters	Station I	Station III	Station V
<i>Heterobranchus bidorsalis</i>	TL (cm)	-	30.6-83.9	15.9-1.1
	BW (g)	-	225.1-5,003.08	23.2-51.3
<i>Heterotis niloticus</i>	TL (cm)	17.6-48.7	17.2-59.3	22.7-56.5
	BW (g)	46.6-1,034.4	52.0-1,621.0	126.1-1,421.5
<i>Synodontis nigrita</i>	TL (cm)	05.8-10.9	04.5-18.0	05.2-16.5
	BW (g)	09.1-16.3	05.8-45.0	05.5-56.3
<i>Citharinus citharus</i>	TL (cm)	08.0-15.2	08.5-27.0	06.0-21.5
	BW (g)	33.0-132.0	15.2-581.2	05.8-125.1

TL = Total Length, BW = Body Weight

Length-Weight Relationship

Presented in Table 3, are the parameters of LWR obtained in this study. The b-values for *H. bidorsalis* in all the stations ranged from 1.92 to 2.98. The b-values for *H. niloticus* for all the stations ranged from 2.47 to 3.03. As the table shows, the b-values for *C. citharus* for all the stations ranged from 1.39 to 2.11 while a range of 1.01 to 1.97 was obtained for *S. nigrita*

Table 3: Length-Weight Relationships and related statistics of four fish species in Lake Ona

Family BW (g)	Species	n	a	b	r	Station	Mean TL (cm)	Mean
Clariidae	<i>H. bidorsalis</i>	00	---	---	---	I	---	---
		13	-1.78	2.93	0.981	III	51.18	
		04	-0.66	1.92	0.688	V	15.68	37.48
Osteoglossidae	<i>H. niloticus</i>	26	-1.94	3.03	0.991	I	22.18	214.35
		44	-1.24	2.62	0.941	III	29.56	497.03
		05	-1.11	2.47	0.940	V	35.33	649.20
Mochokidae	<i>S. nigrita</i>	08	0.18	1.01	0.852	I	8.06	12.44
		103	0.06	1.29	0.867	III	11.14	20.50
		177	0.77	1.97	0.764	V	12.91	21.13
Citharinidae	<i>C. citharus</i>	09	0.30	1.39	0.831	I	12.23	68.04
		187	0.05	1.62	0.804	III	14.03	77.29
		112	0.57	2.11	0.920	V	14.77	77.96

Condition factors of four fish species in Lake Ona

Results of analysis for Condition Factors (k-values) of fish caught are presented in Table 4. From the table, condition factor for *H. bidorsalis*, ranged from 0.90 at Station V to 1.29 at Station III with a mean of 1.21. For *H. niloticus*, k-value ranged from 1.07 (Station V) to 1.70 (Station III) with a mean of 1.57. Condition factor for *S. nigrita* ranged from 1.32 (Station V) to 2.54 (Station I) with a mean of 1.60, while the range obtained for *C. citharus* was 2.01 (Station V) to 3.31 (Station I) with a mean of 2.40. An interesting trend is that for virtually all species, k-value was highest at Station I and least at Station V.

Table 4: Mean condition factor (k) for fish species in Lake Ona

Species	Number	Station I k	Station III k	Station V k	Overall mean k
<i>Heterobranchius bidorsalis</i>	17	---	1.29	0.90	1.21
<i>Heterotis niloticus</i>	75	1.29	1.70	1.07	1.57
<i>Synodontis nigrita</i>	288	2.54	1.57	1.32	1.60
<i>Citharinus citharus</i>	308	3.31	2.70	2.01	2.40

Seasonal variation in mean monthly condition factor (k)

Illustrated in Fig. 2, is the seasonal variation in mean monthly condition factor (k) of the dominant fish species in Lake Ona. *H. niloticus* and *H. bidorsalis* exhibited k-values that were high in the dry season (October – March) and relatively lower in the wet season (April – September). *H. niloticus* had a high k-value of 3.10 in March 2002, which was one of the dry months. The k-value equally dropped in the wet season to a minimum of 1.10 in October 2002, which was the onset of the dry season. *H. bidorsalis* had its highest k-value of 1.86 in January 2002, which was the peak of the dry season. It however, exhibited a minor peak of 1.49 in the wet season in May 2003.

For *S. nigrita* and *C. citharus*, wet season k-values were generally higher than those of the dry season. The maximum values were obtained in the wet season, 3.64 in August 2002 for *S. nigrita* and 4.13 for *C. citharus* in June 2003. Least 'K' values were obtained in the dry season where a value of 1.04 was recorded in October for *S. nigrita* and 0.66 in November 2001 for *C. citharus*.

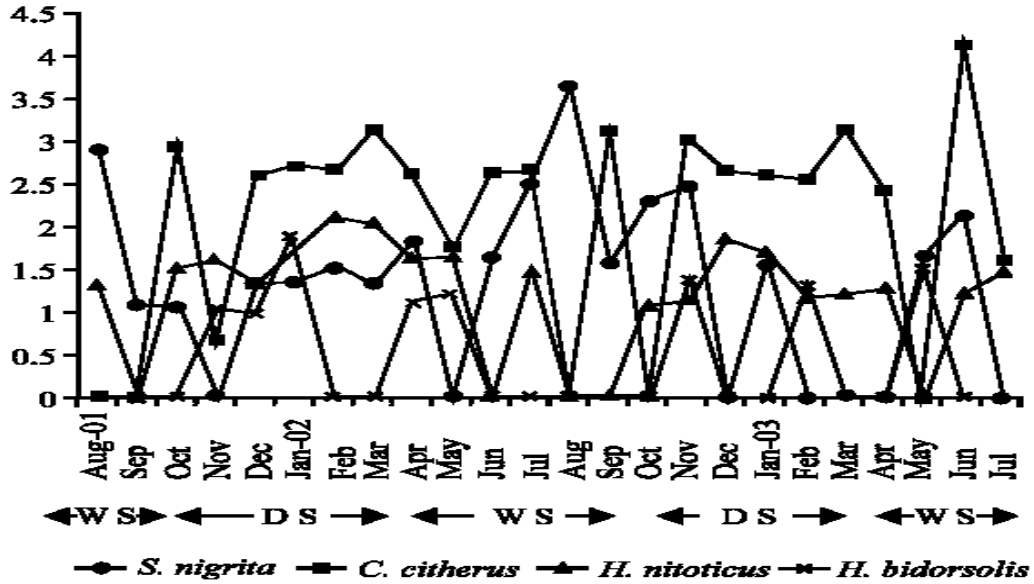


Fig. 2: Monthly K-values of dominant fish species from Lake Ona, Nigeria

Table 5: Summary of Analysis of Variance for observed variation in monthly means of condition factor

	<i>S. nigrita</i>	<i>C. citharus</i>	<i>H. niloticus</i>	<i>H. bidorsalis</i>	<i>p-value</i>
Samples	$\bar{X} \pm SE$	$\bar{X} \pm SE$	$\bar{X} \pm SE$	$\bar{X} \pm SE$	$p < 0.001$
	$1.323^b \pm 0.21$	$2.07^b \pm 0.26$	$1.19^b \pm 0.14$	$1.21^b \pm 0.13$	$p < 0.001$

Presented in Table 5 is the summary of analysis of variance for the observed variations in the condition factor of the fish species. Mean monthly k-values for *H. niloticus* and *S. nigrita* were not significantly different ($p > 0.001$) from each other but were significantly different from *H. bidorsalis* and *C. citharus* ($p < 0.001$).

Discussion

The high values of meristic features obtained, indicate that under natural conditions, fish attain commercial sizes in this little known natural tropical body of fresh water (Lake Ona). The overall growth exponent *b* obtained in this study ranged from 1.01 to 3.03. Growth model in fish generally follows the cube law hence the use of Fulton's Condition Factor or the isometric factor ($k = W/L^b$), attributing to the length-weight exponent, a *b*-value equal to 3 (Gullard, 1987). In "isometric growth pattern" the growth exponent, '*b*' = 3, the body form maintains a constant proportion to length (Weatherly and Gill, 1987). When '*b*' \neq 3 allometric growth pattern which could be negative or positive, is indicated. When '*b*' < 3, negative allometry in growth pattern is indicated. When '*b*' > 3, it is described as positive allometry. With respect to *H. bidorsalis* at Stations III and V where *b*-values obtained were less than the isometric value of 3, this species exhibited a negative allometric growth pattern. This implies that they tend to become thinner as they grow larger. However, at Station I, a different growth pattern was observed for *H. niloticus*. The growth pattern of *H. niloticus* was observed to have followed a positive allometry, as a *b*-value of 3.03 was obtained.

The growth pattern of *H. niloticus* was observed to have followed a similar pattern to that of *H. bidorsalis* with the *b*-values less than the isometric value of 3 at stations III and V. Thus, these species exhibited a negative allometric growth pattern. This implies they tend to become thinner as they grow larger. However, at Station I, a different

growth pattern, positive allometry was observed for *C. citharus*, where a b-value of 3.03 was obtained. It was equally observed that at all stations, *S. nigrita* and *C. citharus* exhibited negative allometric growth patterns with the tendency to become thinner as they grow larger. It would appear that all species exhibited negative allometric growth pattern at stations III and V. Negative allometry in growth pattern was reported for juvenile cichlids, *Chromidotilapia guntheri* and *Hemichromis fasciatus* in Lake Eleiyele, Ibadan Southern Nigeria (Zelibe, 1982), *Clarias gariepinus* (King, 1996a), *Illesha africana* and *Heterobranchus longifilis* from River Idodo, Nigeria (Anibeze, 2000).

Only *H. bidorsalis* and *H. Niloticus* exhibited positive allometry at Station I. Positive allometry in growth pattern had been observed for yet some other juvenile cichlids, *Sarotherodon galileaus* and *Tilapia zilli*, in Lake Eleiyele, Ibadan Southern Nigeria (Zelibe, 1982). In their study, on LWR of five species in Epe Lagoon Nigeria, Fafioye and Oluajo (2005), obtained range of b-values, 2.799 - 3.218 and concluded that this was an indication of near isometric relationship, with 60% of the variation in body weight being accounted for by changes in length. The species in their study were *Clarias gariepinus*, *Illesha africana*, *Chrysichthys nigrodigitatus*, *C. walker* and *Ethmalosa fimbriata*.

Condition factor

It was observed in the present study, that condition factor for all species were of values of 1 and above which indicate that fish species are doing well in the lake. When k is greater than unity, the fish species is healthy. Bagenal (1978), documented that for mature fresh water fish, condition factor ought to be in the range of 2.9 to 4.8. While highest monthly value of k obtained for *H. dorsalis*, was 1.86 in January, a dry month and exhibited a minor peak of 1.49 in the wet season. Anibeze (2000) recorded a monthly index of relative condition factor of 0.19-1.29 for males of a relative *H. longifilis* in Idodo River. Contrary to the trend obtained for *Heterobranchus* species in this study, Anibeze (2000) yet observed increased K-values during the rains. Anibeze (2000) and Anwa-Udondiah and Pepple (2012), attributed increased values of mean monthly condition factor of *H. longifilis*, to availability of food and gonadal development. Result from this study disagree with that of Kumolu-Johnson and Ndimele (2011), who reported positive allometric growth in their study of nine fish species, from a Lagoon in Lagos-Nigeria. They stated 'b' and 'K' values with a range of 2.5 - 3.2 and 0.91 – 8.66 respectively.

Factors known to influence a prevailing condition factor include environmental condition, availability of food, feeding intensity, density or population changes, spawning among others. Apart from Station V where *H. bidorsalis* had a 'K' value of 0.9, the study fish species, all had 'K' values greater than 1, in all the stations where they were present. It therefore implies that the fishes were healthy, in good condition and that the water body was conducive for their culture.

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