LENGTH-WEIGHT RELATIONSHIP AND DIET OF *Gymnarchus niloticus* IN A TROPICAL MAN-MADE LAKE, SOUTHWESTERN NIGERIA

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ABSTRACT
The trunk fish, Gymnarchus niloticus (Family Gymnarchidae) is endemic to Africa. This study reports the length – weight relationship (LWR) and food habit of 108 specimens of G. niloticus in Eleiyele Lake, Ibadan Nigeria were investigated. The LWR of the species showed positive correlation (r > 0.67). The regression exponent (b < 3) for the combined specimens showed negative allometric growth pattern. Variations were recorded in the b value with months and size groups. The mean condition factor (K) was 0.231 ± 0.01. Significant variation occurred in K with size groups and the smallest size group recorded the highest value (0.225 ± 0.01). Diet evaluated with the Index of Relative Importance (IRI) showed that G. niloticus primarily consumed fish (94.9%).
Keywords: growth relationships, nutrition, condition, growth pattern

INTRODUCTION

Gymnarchus niloticus is endemic to Africa, belongs to Family Gymnarchidae and the genus is monospecific. It is an electric generating fish known to emit continuous electric signals from its tail. It has been shown to be able to use the electrical mechanism in the location of objects such as its prey (Holden & Reed 1972). The electric organ of this species has been the subject of considerable study. The species is commercially important, flesh it's oily with a strong flavor which is greatly relished in most African countries (Sagua 1982, Holden & Reed 1972). It is a culturable species and cultured with cichlids to prevent stunting. Previous studies on this species in Nigeria on its food habits were part of general study of non-cichlid/piscivorous fishes (Imevbore & Bakare 1980 in Kainji Lake, Adeyemi *et al*., 2009 in Gbedikere Lake) except Sagua (1982) who made observations on feeding habits and reproductive biology of the species in Lake Chad. Individual species can be quite plastic in fulfilling their food requirements, exploiting different resources in different environments. The knowledge of the intricate feeding habits of individual species provides information on the ecological roles and requirements of that species within its habitat, thus facilitating well-informed, environmentally-based fishery management for that species and ecosystem of which it is a part (Earl et *al*., 2010).

Due to paucity of information on the biology of this species in Nigeria, this study reports on the length-weight relationship and diet composition of *G. niloticus* in Eleiyele Lake.

MATERIALS AND METHODS

Study Area

Eleiyele Lake was formed by damming River Ona purposely for the supply of water to Ibadan and it's environ in 1939. Eleiyele dam is located on latitude 7° 261′ N and longitude 3° 521′ E with an altitude of 125 m above sea level. The mean annual rainfall is 1262.3 mm and it is flood controlled with a maximum depth of 12 m during the floods. The total catchment area is 323.75 hectares, with an impoundment area of 546 hectares and a total storage capacity of 740 million litres of water (Imevbore 1967). The area lies in the rainforest belt and conditions are tropical. The fish fauna of the lake comprise of 16 species belonging to 10 families. Nine families including Gymnarchidae were represented by one species.

Sampling and Laboratory Procedure

Gymnarchus niloticus (n =108) caught with gill nets (mesh sizes 50 – 55mm) were collected from fishermen at the landing site in Eleiyele Lake from March to September 2009. The total and standard lengths were taken with measuring board to the nearest 0.1cm.Measurement of body weight of individual fish was determined to the nearest 0.1g with an electric balance after keeping the surface of body free from water and other particles.

The relationship between length and weight is described by the equation: $W = aL^b$, (Ricker, 1973)
where W = total weight of fish (g), L = total length of fish (cm), a = constant, b = growth exponent. A logarithmic transformation was used to make the relationship linear.

$$\text{Log } W = \text{log}a + b \text{ log } L$$

The condition factor (K) was calculated using the formula

$$K = \frac{100W}{L^3}$$ (Bauchot and Bauchot, 1978)

Where K = condition factor, W = total body weight (g), L = total length (cm).

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)

The specimens were cut open on the ventral side and stomachs were removed and kept in 4% formalin. Then the gutted weight (weight of the fish without intestine) was taken. An index of fullness (total mass of gut contents as percentage of total mass of each specimen was estimated. (Arnauld & Hureau 1966). The contents of each stomach were emptied into a petri-dish and identified. Food items not digested (prey) were separated and measured. The stomach contents were analysed using the frequency of occurrence, numerical and gravimetric methods (Bagenal 1978).

The Index of Relative Importance (IRI) for each food type was calculated and IRI values was expressed as percent of the total IRI for the sample (Pinkas *et al*., 1971; Cortés, 1997). The body lengths of the fish prey were measured. The relative prey length was computed as the percentage ratio of the total length of prey to the total length of its predator (Adebisi 1980). The prey length – predator length relationship was represented by the equation:

$Y = a + bx$

Where Y = prey length in cm, a = intercept, b = slope and x = predator length.

The specimens examined were divided into three size groups in order to establish if there were changes in Length – Weight relationship and condition factor in relation to size.

Statistical analyses applied to the data are mean, standard deviation, correlation coefficient, t-test and ANOVA.

RESULTS

Length Weight Relationship (LWR)

The results of the length weight analyses are presented in Table 1. All LWRs were highly significant ($P < 0.05$) with r values greater than 0.6 except for the smallest and largest size groups (0.46371 and 0.20023 respectively). The slopes of the LWR (b) ranged from 1.317 (33-49.9 cm) to 3.349 (50-66.9 cm) for the size groups; and 2.022 for combined. The least b value was obtained in June (1.228) and highest in March (3.238). The regression coefficient (b) of the largest size group (67 - 83.9 cm), the unsexed/immature specimens and the month of September are not significantly different from 3.

Table 1: **Length Weight relationships of *Gymnarchus niloticus* in Eleiyele Lake**

Parameters	N	a	b	r	b – 3/SE(b)
MONTHS					
March	9	-3.05	3.238	0.99	-15.137*
April	28	-1.28	2.204	0.91	- 13.343*
May	38	-1.58	2.378	0.95	-20.691*
June	19	0.29	1.228	0.876	- 17.109*
July	5	-2.22	2.723	0.951	-3.154*
August	11	-2.52	2.915	0.967	-8.788*
September	5	-2.49	2.879	0.896	-0.763
SIZE GROUPS/CM					
33 – 49.9	59	0.16	1.317	0.464	-7.683*
50 – 66.9	40	-3.30	3.349	0.895	-7.723*
67 – 83.9	9	-0.57	1.787	0.200	0.879
Combined	108	-0.99	2.022	0.820	-19.877*
SEX					
Female	32	-2.57	2.948	0.974	-12.966*
Male	36	-2.32	2.808	0.923	-6.021*
Immature/ unsexed	40	-3.18	3.267	0.672	-0.266

* - Significantly different from 3.

Condition factor

The mean condition factor of *G. niloticus* during study period was 0.231 ± 0.01. It varied between 0.192 ± 0.01 (50 - 66.9 cm) and 0.255 ± 0.01(33 - 49.9 cm) for the size groups, thus higher K was recorded for smaller specimens and there is significant difference between K for the size groups (Table 2). Monthly variation in mean K is shown in Table 2. Highest mean K was recorded in April (0.248 ± 0.01) and least mean K in July (0.197 ± 0.02) and September (0.196 ± 0.01) with no significant difference in K between months. The mean K of the female specimens (0.208 ± 0.01) showed no significant difference from the male (0.225 ± 0.013).

Fullness of Gut

Out of 108 specimens of *G. niloticus* examined, 84 (74.8%) had food in their gut. Monthly variation occurred in the fullness index (IF) with decrease from June and there was no significant difference in IF between months. Highest IF was recorded in the smallest

size group and there was significant difference in IF between size groups (Table 3). The IF of female specimens (1.69 ± 0.302) was higher than male specimens (0.98 ± 0.237).

Table 2: Variations in condition factor of *Gymnarchus niloticus* in Eleiyele Lake, Southwestern Nigeria

Parameters	N	Range	Mean ± S.D	F test/t test
MONTH				
March	9	0.20 - 0.259	0.232 ± 0.01	
April	28	0.18 - 0.51	0.248 ± 0.01	
May	38	0.15 - 0.45	0.233 ± 0.01	
June	19	0.16 – 0.51	0.245 ± 0.02	
July	5	0.15 – 0.255	0.197 ± 0.02	1.102816
August	11	0.18 – 0.257	0.218 ± 0.01	
September	5	0.16 – 0.238	0.196 ± 0.01	
SIZE/CM				
33 – 49.9	59	0.178 – 0.51	0.255 ± 0.01	
50 – 66.9	40	0.019 – 0.26	0.192 ± 0.01	
67 – 83.9	9	0.15 – 0.244	0.20 ± 0.01	11.2816*
COMBINED	108	0.15 – 0.51	0.231 ± 0.01	
SEX				
Female	35	0.05 – 0.25	0.208 ± 0.01	
Male	31	0.16 – 0.36	0.225 ± 0.01	-0.90428
Immature	42	0.1 – 0.26	0.209 0.01	

*- Significantly different p > 0.05

Table 3: Variations in the index of fullness of *Gymnarchus niloticus* in Eleiyele Lake, Southwestern Nigeria

Parameters	Range	Mean	Standard Error	F-test
MONTH				
March	0 – 4.37	1.7822	0.4261	
April	0 – 3.87	2.2171	0.1735	
May	0 – 12.9	2.4984	0.4359	1.5534
June	0 – 2.89	1.8453	0.1390	
July	0 – 2.17	0.9	0.4126	
August	0 – 2.51	1.1172	0.2868	
September	0.85 – 2.44	1.62	0.3480	
SIZE/CM				
33 – 49.9	0 – 4.37	2.0118	0.1287	6.1376*
50 – 66.9	0 – 3.05	1.4175	0.1307	
67 – 83.9	0 – 2.37	1.3167	0.2148	
SEX				
Female	0 – 4.37	1.6867	0.3023	3.3292
Male	0 – 2.51	0.9793	0.2367	

*- Significantly different p > 0

Qualitative Assessment of Gut content

Dietary constituents of stomach of *G. niloticus* examined were partly digested fish, fish materials (fish fins & scales), insects, copepods, pieces of vegetation, snail shell, and sand particles.

The Table 4 shows that food from fish dominates the diet and formed 46.05%, 48.05% and 89.2% by numerical abundance, frequency of occurrence and weight methods respectively. Juveniles of *Tilapia zillii*, *Hepsetus odoe* and *Clarias gariepinus* were encountered in the stomach.

These were followed by insect food items 22.20% by number, 19.48% by occurrence and 8.49% by weight. Pieces of vegetation encountered in the diet formed 29.88% by number, 7.14% by occurrence and 0.53% by weight. Sand grains occurred in 21.43% of stomachs examined and formed 0.41% by weight. The % IRI showed the primary food of *G. niloticus* to be fish and was almost completely piscivorous (% IRI = 94.88) (Fig.1).

Table 4: **The total number (%), frequency of occurrence (%) and weight of food items in the stomach of *Gymnarchus niloticus* from Eleiyele Lake**

Food items	Number	%	Frequency	%	Weight	%
Pisces						
Tilapia spp	17	3.53	17	11.04	29.6	40.49
Hepsetus odoe	1	0.21	1	0.65	6.1	8.35
Clarias gariepinus	12	2.49	12	7.79	19.2	26.27
Partly digested fish	18	3.73	13	8.44	8.5	11.63
Fish scales, bones	174	36.09	31	20.13	1.8	2.46
Total	222	46.05	74	48.05	65.2	89.2
Mollusca						
Snail shell	5	1.04	3	1.95	0.3	0.41
Crustacea						
Copepods	4	0.83	3	1.95	0.7	0.96
Insecta						
Damsel fly	20	4.15	13	8.44	5.1	6.98
Insect larva/pupae	15	3.11	9	5.84	0.7	0.96
Insect appendages	72	14.94	8	5.2	0.4	0.55
Total	111	22.20	33	19.48	6.9	8.49
Pieces of vegetation	144	29.88	11	7.14	0.4	0.53
Sand grain	-	-	33	21.43	0.3	0.41

Total fish examined = 108 Number with food = 84
Number with empty stomach = 14

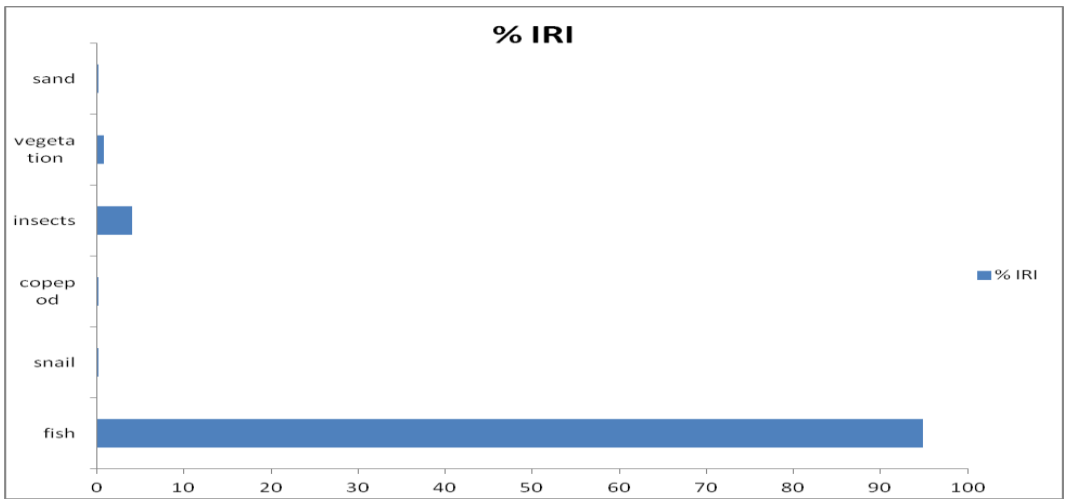

Fig. 1: Percentage of index of relative importance of food items of *Gymnarchus niloticus* in Eleiyele Lake

Prey/ Predator size relationship

The prey length tends to increase with the body length of *G.niloticus* as shown in Fig. 2 (Y = -0.9506 + 0.0859x, r = 0.8145). The relationship between the relative prey length and this fish length showed less correlation (Y = 4.3255 + 0.0467x, r = 0.3351) Fig. 3.

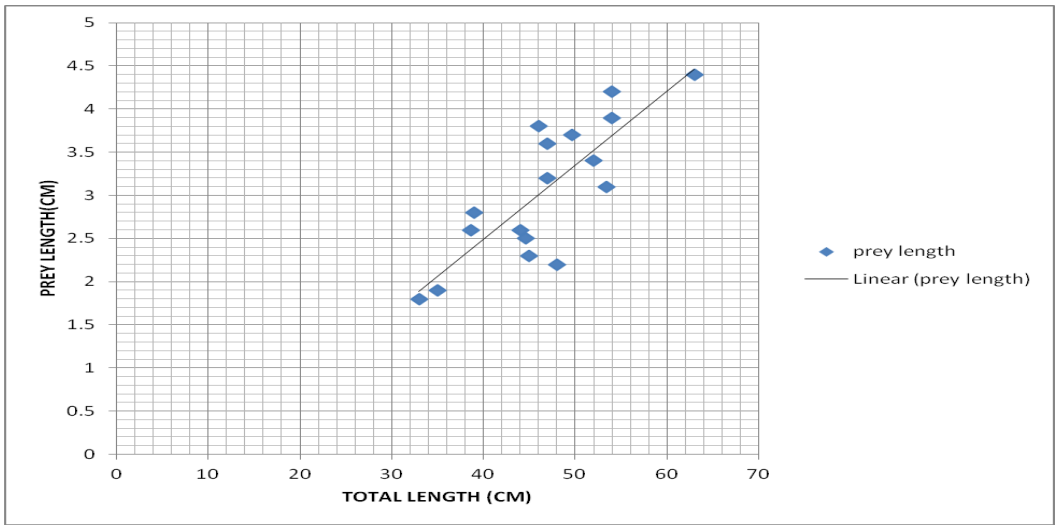

Fig. 2: Variation in length of prey with total length of *Gymnarchus niloticus* in Eleiyele Lake

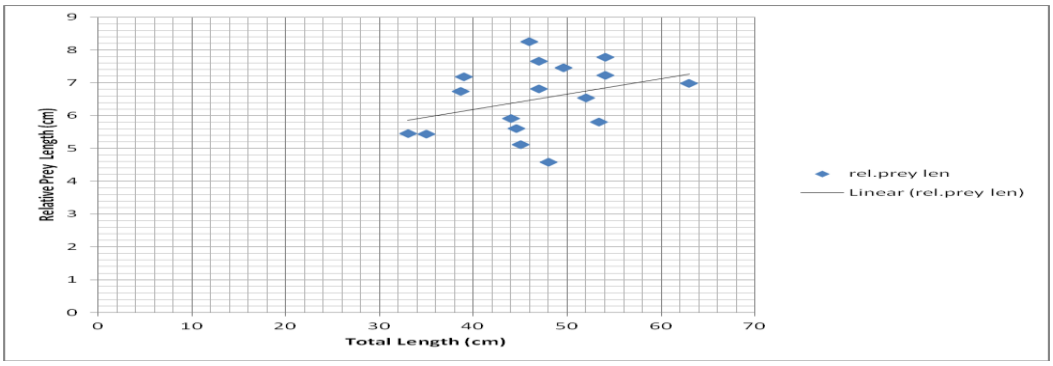

Fig. 3: Variation in relative prey length with total length of *Gymnarchus niloticus* in Eleiyele Lake

DISCUSSION

The high correlation coefficient values obtained indicates that the fish body length increased with increase in body weight.

The growth exponential values, "b" of *G. niloticus* (combined) (2.0222) showed that the growth pattern exhibited by the species was negative allometric (since b < 3). This indicates that as the fish grows it becomes lighter for its length. Negative allometry was also reported by Lawson & Aguda (2010), they recorded 2.40 for *Elops lacerta* in Ologe Lagoon. Ogbe *et al.* (2008) reported 1.1196 and 1.5362 for *Hydrocynus forskalii* and *Alestes nurse* respectively. However, the "b" value hence the growth pattern showed variation between the months (March = 3.238, positive allometry; April to August, 1.2277 – 2.915, negative allometry and September, isometric since b value did not differ significantly from 3) and size groups (33 – 49.9 cm = 1.3171, negative allometry; 50 – 66.9 cm = 3.3487, positive allometry and 67 – 83.9 cm, isometric since b value did not differ significantly 3). These variations in growth pattern shows that this species passed through stages in its life history which were defined by different length – weight relationship (Vanetson 1953). This agreed with Ayoade (2011), who reported that different growth pattern was demonstrated by the size groups of *Schilbe mystus* in Asejire Lake. Juvenile and adult stages of a fish may exhibit differences in the length – weight relationships owing to the changes in the body form with

size, feeding habits and factors related to reproduction (Khan *et al*., 2012).

The low K obtained for *G. niloticus* in the Eleiyele Lake indicated the fish were light for their length and was a reflection of the growth pattern. Significant difference in K between the size groups with higher value in the smallest size group could be due to this group feeding more than larger size groups as indicated by the higher fullness index. This is contrary to Onimisi & Oniye (2010), they reported that the juveniles of *Auchenoglanis occidentalis* in Zaria Reservoir had the lowest condition factor (0.93), the sub – adults had a moderate K (1.01) and the bigger fish (adults) were in better condition (1.28). The lower mean K values (0.197 ± 0.02 – 0.218 ± 0.01) recorded between July and September could be due to lower feeding intensity recorded during these months. The spawning period of this species was reported by Sagua (1982) to be between August and November in Lake Chad and this could also have contributed to the reduced K values obtained during this period.

Food can be obtained by the species in the lake as suggested by the lower percentage of empty stomach. Sagua (1982) also reported higher % of stomach with food for *G. niloticus* (78%) in Lake Chad. The stomach content analysis of *G .niloticus* in the Eleiyele Lake showed that it fed mainly on fish, thus it's a piscivore. Previous studies on the species by Sagua (1982) in Lake Chad and Adeyemi *et al*. (2009) in Gbedikere Lake agreed with this result. The sand grain and plant encountered in the stomach could be as a result of accidental ingestion while devouring its prey (Wooton 1990). Small fish specimens grows highest in the first year of their life and the higher stomach fullness index recorded for this group could be associated to their increased energetic needs (Vassilopoulou & Ondrias 1999). The correlation coefficient (r) of the total length of *G. niloticus* - standard length prey plot showed that there was significant correlation between these variables. Contrary to this, Sagua (1982) observed no direct positive relationship between standard length of *G. niloticus* and standard length of prey. The recorded percentage of the length of the prey to predator was similar to that reported by Sagua (1982) for *G. niloticus* (6.25 – 14.0) in the Lake Chad.

This study has contributed to the understanding of the biology of *G. niloticus* (a commercial species) and this should enhance its effective management and increased production.

CONCLUSION

The low K value obtained for *G. niloticus* in this study is a reflection of the growth pattern (negative allometry). Variations occurred in the growth pattern and condition factor of this species with size groups. Information provided should enhance the effective management and culturing of the species.

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