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Some Aspects of Growth and Reproduction in the Nile Perch (*Lates niloticus*, Linne 1762) From River Rima, North-western Nigeria

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ABSTRACT

Some aspects of growth and reproduction of the Nile perch (Lates niloticus) from River Rima, North-western Nigeria were studied. These included length-weight and length-length relationships, condition factor, and morphology of the gonads, gonad maturation stages, and gonadosomatic index (GSI). A total of 55 samples were collected from the river from July to December, 2011, using gill nets and baited set lines. Total length (TL) of the samples ranged from 13.50cm to 35.00cm with a mean of 27.66±4.64SD while their total weight ranged from 25.30g to 493.10g with a mean of 290.43±101.33SD. The b value of the total length-total weight relationship for the overall samples (b = 3.090), females (b =3.175) and samples <25cmTL (b=3.812) indicated positive allometric growth pattern, while males had the b value of 2.920 and samples ≥25cmTL (b=2.193) exhibited negative allometry. Mean relative condition factor of all the samples was 0.96±0.79SE. It was highest in November (Kn = 1.01±0.25SE) and lowest in July (0.85±0.14SE). It was slightly higher in males (0.99±0.13SE) than in females (0.93±0.0.06SE). Smaller samples <25cmTL were in better condition (Kn = 0.98 ± 0.54SE) than larger ones (Kn = 0.95±0.12SE) in samples ≥25cm TL). Only immature (I) gonad maturation stage was observed in both sexes. Mean GSI for males and females were 0.706±0.6179SD and 2.751±4.54465SD, respectively. The r values of the relationship between GSI and total length in females and males were 0.702 and 0.225, respectively, indicating that GSI increased with an increase in the body length, but this is more in the females than in males.

Keywords: *Lates niloticus*, Length-weight relationship, Condition factor, Gonad maturation stages, Gonadosomatic index, River Rima.

INTRODUCTION

Lates niloticus, commonly known as the Nile or Niger Perch is the only species of the Family Centropomidae found in northern Nigeria (Reed *et al*., 1967). It is widespread in most parts of Africa, being native to the rivers Congo, Nile, Senegal, Niger and Lakes Chad, Volta, Turkana and other river basins (Pringle, 2005). It is one of the largest freshwater fishes, reaching a maximum length of nearly two meters

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(more than six feet) and weighing up to 200kg (Greenwood *et al*., 1966). The females are generally larger than males (Loubenbi, 1974). The Nile perch becomes sexually mature when it is around 3 years of age and can live for up to 16 years, with each individual capable of spawning numerous times and producing an abundance of off-springs (Hopson, 1972). The species also spawn most of the year (Reed *et al*., 1967). The female Nile Perch commences spawning when it has grown up to 50-80cm and can produce up to 16 million eggs at a time (Mackenzie and Cotterell, 2001). The species do not guard eggs or raise fry (Asila and Ogari, 1988).

Knowledge of length-weight relationship has numerous practical applications in fisheries biology. It is required for the estimation of individual fish weight from length, with the weight being added up to obtain total biomass or standing stock (Benedito-Cecilio *et al*., 1997). In fisheries science, the condition factor is a term used to compare the "condition of fatness or well being of the fish. It is based on the hypothesis that the heavier the fish of a particular length, the better their physiological condition (Bagenal, 1978). Condition factor is also a useful index for monitoring of feeding intensity, age and growth rates in fish (Oniye *et al*., 2006).

Knowledge of the gonad maturation stages of fishes is also required for many purposes and these include determination of stocks that are mature and the size or age at first maturity (Bagenal,1978).

Gonadosomatic index is a good indicator of reproductive activity used in determining fish reproductive cycle stages. It is a tool for measuring the sexual maturity of animals in correlation to ovary and testes development (Rhodes and Sadovy, 2002)

Studies on the biology and ecology of *L. niloticus* from various places have been reported by many workers and these include Okedi (1971), Acere (1985), Kitchel and Schindler (1997), Balogun (2000), and Dadebo *et al.* (2005). This study is aimed at providing baseline data on some aspects of growth and reproduction of *L. niloticus* in River Rima which has not been documented before. The data obtained can be used to enhance research on management and conservation of the species in river Rima and in other water bodies with similar eco-climatic conditions.

MATERIALS AND METHODS

Study area

The fish samples were collected from River Rima in Sokoto, north-western Nigeria. Sokoto lies between longitudes $4^{o}8'$E and $6^{o}5'$E, and latitudes 12^{o}N and $13^{o}58'$N (Mamman, 2000). The climate of Sokoto is tropical continental, with much of the rains between June and September, while the long dry season is from October to May (Ita *et al*., 1982).

River Rima flows in a south-western direction over 100km and joins the major River Sokoto to form the Sokoto-Rima river system. It is a seasonal river, usually over-flowing its banks during the rainy season in August and September, and up to October at times (Mock, 1963).

Fish samples

Samples were collected from the River on a weekly basis from July to December, 2011. Samples were obtained with the assistance of fishermen at several sites along the River Rima, namely, Kwalkwalawa, Bakin gulbi and Maginawa (Figure 1).

The fishing gears used were gill nets, seine nets and baited set lines. The samples were examined fresh in the laboratory immediately after collection and where the samples could not be studied on the day of procurement; they were stored in a freezer to preserve quality until the next day.

On each sample, measurements of total length, standard length, head length and girth were taken by using a metric ruler (in cm). Total weight and gutted weight (in g) were measured using top loading balance. The sex of the samples was identified by the presence of external genital papilla in larger male samples which is absent in the females and for testes or ovaries after the dissection in the smaller specimens. Gonads were detached and weighed (g). Length (cm) of each gonad lobe was measured. As the testes and ovaries appear to be very thin, their widths could not be measured.

Gonad maturation stages

According to Kesteven (1960), gonad maturation stages are determined by visual examination of the gonads and assigned as immature, maturing, mature, running, and spent (only immature stage was found in this study). Similarly, fecundity and egg size could not be determined because all the samples were immature.

Statistical analysis

Length –length relationships

Linear regression analysis was used to compute the equations for the relationships between the length-length and weight-weight parameters. This is represented by the equation: Y = a = bX Steel and Torrie (1980), Where: Y = fish gutted weight (g), or standard length, fork length, head length or girth (cm); X = fish total weight or total length (cm); a = constant and b = exponent.

Length-weight relationships

The relationship between the length (L) and weight (W) was calculated by a logarithmically transformed equation of length-weight relationship to give a linear one as: $\text{LogW} = \text{Log}_a + {}_b\text{Log L}$ (Bagenal and Tesch, 1978). Where: W = weight of fish (g); L = length of fish (cm); a = constant; b = exponent. The values of 'a' and 'b' are estimated by least squares regression analysis (Zar, 1984).

Length-weight relationships

Table 2 presents the results of length-weight relationship obtained for the TL and TW There was very high correlation and significant ($p<0.01$) relationship between all the length and weight parameters.

Condition factor

For calculating relative condition factor or Kn (Weatherly and Rogers, 1978), the equation used was: $Kn=100W/L^b$, Where: Kn = relative condition factor; W= weight of fish (g); L =length of fish (cm); b = coefficient obtained from LWR. Analyses for the length-weight relationships and relative condition factor were carried out based on sex and two size classes (<25cm TL and ≥25cm TL), using SPSS software version 16.

Gonadosomatic index

Gonadosomatic index was expressed according to Gabr *et al.,* (1998) as: GSI = Gonad weight/Body weight x100. Data collected were analyzed using descriptive statistics (means, standard deviation and percentage). Statistical comparisons of data between the sexes and the 2 size classes were determined using analysis of variance (ANOVA) according to Steel and Torrie (1980).

RESULTS

Growth Studies

Size distribution of samples

A total of 55 samples of *L. niloticus* were used for this study. Nine samples were <25cmTL and 46 samples ≥25cmTL in size. There were 27 males and 28 females. Total length of all the samples ranged from 13.50cm to 35.00cm with mean 27.66±4.64SD and their total weight was from 25.30g to 493.10g with a mean 290.43±101.33SD. The minimum, maximum, mean and standard error of all the other body dimensions such as standard length (SL), head length (HL), girth (GTH) and gutted weight (GW) are presented in Table 1.

Table 1: Size distribution of *L. niloticus* from River Rima (N=55)

Parameters	Min	Max	Mean	SE
SL (cm)	13.50	35.00	27.680	4.67
TL(cm	11.00	29.00	23.38	4.14
HL (cm)	3.50	10.00	7.12	1.50
GL(cm)	3.00	9.20	7.12	1.39
TL(cm)	25.30	493.10	290.75	100.27
GDL	23.10	482.50	265.73	96.70

Table 2: Total length-total weight relationship of *L. niloticus* from River Rima.

Parameters	No. Sampled	R	b	SE of b	Test of b
All Samples	55	0.98	3.09	0.09	*S
Sex					
Male	27	0.97	02.92	0.14	*S
Female	28	0.98	3.18	0.12	*S
Class size					
<25cm	09	0.99	3.66	0.17	*S
≤ 25cm	46	0.97	032.76	0.27	*S

Equation: LogTW=a +bLogTL; *S =Significant` (P<0.05).

The b value obtained for all samples was 3.090, indicating positive allometric growth pattern. The b value for males (2.920) indicates negative allometry and in the case of females (3.175), it shows positive allometry. The smaller samples (3.655) exhibited positive allometry and the larger samples (2.027) negative allometric growth pattern. Exactly the same growth patterns were obtained in the TL-GW relationship based on all variables of this study, that is, sex and 2 size classes as shown in Table 3.

Table 3: Total length-gutted weight relationship of *L. niloticus* from River Rima

Parameters	No. sampled	r	b	SE of b	Test of b
All Samples	55	0.97	3.16	0.105	*S
Male	27	0.98	2.99	0.138	*S
Female	28	0.98	3.26	0.138	*S
<25cm	09	0.99	3.81	0.142	*S
≤ 25cm	49	0.72	3.19	0.330	*S

Equation: LogTW=a +bLogTL; *S =Significant` (P<0.05).

Table 4 shows the values of the SL-TW relationship. Growth patterns for all samples were negatively allometric. Likewise for the two sexes and in the larger samples, but in the case of smaller samples, their growth patterns were positive allometry. For the SL-GW relationship (Table 5), growth pattern of all samples, males and larger samples were negatively allometric. In females and the smaller samples, growth patterns were positively allometric.

Table 4: Total length-total weight relationship of *L. niloticus* from River Rima

Parameters	No. sampled	r	b	SE of b	Test of b
All Samples	55	0.98	2.898	0.090	*S
Male	27	0.97	2.805	0.147	*S
Female	28	0.98	2.933	0.118	*S
<25cm	09	0.98	3.506	0.276	*S
≤ 25cm	49	0.82	2.048	0.219	*S

Equation: LogTW=a +bLogSL; *S =Significant` (P<0.05).

Table 5: Standard length-Gutted weight relationship of *L. niloticus* from River Rima

Parameters	No. sampled	R	b	SE of b	Test of b
All Samples	55	0.98	2.898	0.090	*S
Male	26	0.97	2.805	0.147	*S
Female	28	0.98	2.93	0.118	*S
<25cm	09	0.98	0.219	0.276	*S
≤ 25cm	46	0.82	2.048	0.219	*S

Equation: LogTW=a +bLogSL; *S =Significant` (P<0.05).

Length-length relationships

Table 6 presents the regression equation for the TL-SL, TL-HL, TL-GTH and TW-GW relationships. All the b values between the length-length parameters indicate negative allometric growth pattern as they are <1, indicating that growth in total length is faster than in all the other length parameters. For the TW-GW relationship, the b value was almost 1, which is isometry, suggesting exact increase in total weight with increase in gutted weight. There was also very high correlation in all the relationships. All the equations were highly significant (p≤0.01).

Table 6: Length-length and weight-weight Relationships of *L. niloticus* from river Rima (N=55)

Relationship	B	SE of b	r
SL = a+b TL	0.87	0.03	0.98
HL = a+b TL	0.28	0.02	0.88
GTH = a+b TL	0.26	0.02	0.87
GW= a+bTW	0.94	0.02	0.99

Condition factor

The mean condition factor for all samples was 0.96±0.79SD, indicating that the samples were in good condition as indicated by the Kn value of almost 1. Males (0.99+0.13SE) were in better condition than females (0.93+0.06SE) and the smaller samples (0.98+0.54SE) were in better condition than the larger ones (0.95+0.12SE) as shown in Table 7. Based on monthly observations of this study, condition factor of the samples of *L. niloticus* from R. Rima was higher in December (1.13 ± 0.27SE) and lower in July (0.85 ± 0.14SE) as shown in Table 8.

Table 7: Condition factor of *L. niloticus* from River Rima in relation to sex and 2 size classes

Parameters	No. of Samples	Kn±SE	Test of b
All Samples	55	0.96±0.79	*S
Male	27	0.99±0.13	*S
Female	28	0.93±0.06	*S
<25 25cm	09	0.98±0.54	*S
≥25cm	46	0.95±0.12	*S

Kn =Mean condition factor; SE=Standard Error; *S=Significant

Table 8: Mean monthly variations in condition factor of *L. niloticus* from River Rima

Month	No. of Sample	Range of Kn	Mean Kn±SE
July	18	0.84 - 0.93	0.85 ± 0.14
August	-	-	-
September	-	-	-
October	15	0.74 - 0.96	0.92 ± 0.25
November	12	1.08 - 1.26	1.01 ± 0.25
December	10	0.99 - 1.16	1.13 ± 0.27

Kn= Condition factor; SE=Standard Error

Reproduction Studies

Morphology of the gonads

All gonads of the samples were immature. The ovaries were small, elongated, paired and pale brown in colour. The testes were thread-like structures, milky in colour and appearing single not paired. Table 9 presents the mean gonad sizes based on sex and the 2 size classes. Testes were longer than ovaries but the ovaries were heavier. Gonads were longer and heavier in larger samples as shown by the mean values of gonad length (GL) and gonad weight (GW).

Table 9: Gonad dimensions of *L. niloticus* from River Rima

Parameter	No. of Samples	Mean GL (cm)	SD	Mean GW (g)	SD
All sample	55	10.764	5.1944	2.473	2.498
Female	28	9.554	5.1759	2.650	2.761
Male	27	12.019	5.0007	2.289	2.311
0-25	9	9.444	5.1944	10.233	74.038
26-50cm	46	11.022	5.1424	29.8111	60.785

Gonadosomatic Index (GSI)

Table 10 presents the mean GSI values for all the samples (1.747±5.388SD) and also based on sex and the 2 size classes. The mean GSI in females (2.751±7.454SD) was significantly higher (p≤0.05) than that of males (0.706±0.620SD). Smaller samples (6.836±12.572SD) had significantly (p≤0.05) higher GSI value than larger ones (0.751±0.738SD).

Table 11 present the regression equation for the relationship between GSI and TL based on sex and the 2 size classes. There was higher correlation in the GSI-TL relationship in females (r=0.702) than in males (r=0.225), while higher correlation existed between GSI and TL in the smaller samples (r=0.523) than in the larger ones (r=0.037). In all the cases, the equations were significant (p≤0.05).

Table 10: Mean GSI values based on sex and 2 size classes of *L. niloticus* from River Rima

Parameter	No. of samples	Mean	SD
All samples	55	1.747	5.388
Female	28	2.751	7.454
Male	27	0.706	0.620
<25cmTL	09	6.836	12.572
≥25cmTL	46	0.751	0.738

Table 11: GSI –TL relationship for *L. niloticus* from River Rima

Parameter	a	b	SE of b	r
All samples	18.959	-0.622	0.134	0.537
Males	-0.227	0.038	0.029	0.225
Female	30.594	-1.016	0.202	0.702
<25cmTL	33.387	-1.403	0.865	0.523
≥25cmTL	1.163	-0.014	0.057	0.037

DISCUSSION

Samples used in this study ranged in size from 13.50cm to 35.00cm with mean 27.66±4.64SD and their total weight was from 25.30g to 493.10g with a mean 290.43±101.33SD. Based on the findings of various authors (Greenwood *et al.*, 1966; Reed *et al.*, 1967; Hopson, 1972; Holden and Reed, 1972; Loubenbi, 1974; Olaosebikan and Raji, 1998 and Snoeks, 2005), this size of the samples fall below the average size of reaching maturity, which according to all these authors was 50 to 80cm total length. Hence, all the gonads were found to be immature.

The positive allometric growth pattern for females and smaller samples with b values >3 in this study suggested that they were fatter or wider in appearance than the males and samples ≥25cmTL appeared slimmer and thus longer as their growth pattern indicated negative allometry (b<3). The high b value of positive allometry of almost four (3.655) which was found through all the length and weight is further confirmation that small samples of *L. niloticus* in River Rima appear to be more robust, and as the species grow bigger, they tend to look longer and slimmer. This is in accordance with the report of Bagenal and Tesch (1978) that fish generally pass through several stages of growth in life each with its different length-weight relationship. The variation in the growth pattern in the two sexes may probably be due to sexual dimorphism as is found in many catfishes (Linder, 2009).

The isometric growth pattern with b values of almost one in the length-length and weight-weight relationships suggests that as the total length increases, all the length parameters also increase and increase in total weight will result to increase in gutted weight as reported by Broadhurst *et al*. (2006).

Better condition in the month of December than in the month of July in this study may be due to better feeding conditions in the former than in the latter, as there was more availability of food materials after the rain. Better condition in the males than in the females may probably be due to the fact that males have better foraging activities and conservation of stored food energy than females. This is similar to the report of Mgbenka and Eyo (1992) on *Clarias gariepinus* in Anambra River Basin, Nigeria. On the other hand, the smaller samples (<25cm) were in better condition than the larger samples (≥25cm). Fish are known to change their food preference with age (Welcomme, 1979) and variations in food habits with size in this study may have resulted in the better condition of the smaller samples than in the larger ones.

The gonadosomatic index value obtained in this study showed that GSI for the females were higher than those of the males. Similar findings of higher GSI in females than in males were reported by Fawole and Arawomo (2000), Offem *et al.* (2008) and Shinkafi *et al.* (2011). Shinkafi and Ipinjolu (2012) associated this to the heavier weight of ovaries in comparison to the testes. Higher GSI value in the smaller samples than in the larger ones may be due to immaturity of the gonads and that even though the larger samples had better somatic growth, there is not much difference in gonadal growth between them and the smaller samples. Same may also be the case in the higher r value in the GSI-TL relationship in the smaller samples compared to the larger ones.

This study has provided baseline information on some aspects of growth and reproduction of *L. niloticus* in River Rima. Biological data on this species in the river has not been documented anywhere before. Therefore this study is expected to be used as a basis for further studies on this important giant of freshwater (*L. niloticus)* for its management and conservation in

River Rima and other water bodies with similar eco-climatic conditions.

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