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Sex ratio and fecundity of *Chrysichthys nigrodigitatus* (Family - Claroteidae) from Asejire Lake, Nigeria

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Abstract

Sex ratio and fecundity of Chrysichthys nigrodigitatus from Asejire Lake were examined. The length-weight relationship showed that weight was curvilinearly related to standard length. The logarithm transformation of weight against standard length gave a straight-line graph represented by the following equation:

$$Log\ W = -0.66 + 2.13\ Log\ sl$$
$$r^2 = 0.854;\ (p<0.001)\ n = 209$$

Males were generally more with a male : female ratio of 1:0.18. The average fish weight was 88.97g (16.28 cm standard length). Sexual maturity was attained at an average size of 45.0g (14.0 cm standard length). Relative fecundity was dependent on body weight and standard length ($P < 0.05$ and $P < 0.01$ respectively). Chrysichthys nigrodigitatus expended between 0.75% - 27.30% of body weight in egg production. The condition factor values showed that a female specimen of equal length with a male specimen is heavier. Six gonad maturity stages were identified, ovary and gonad weights increased with stage of maturity.

Key words: *Chrysichthys nigrodigitatus*; body weight; standard length; condition factor; gonads.

Introduction

Nigeria is blessed with a vast expanse of inland fresh water an estimate of over 12,000,000 hectares (Ita, *et al.* 1985; Ita, 1993), which is about 12.4% of it's surface area (94,185,000 hectares) (Olaosebikan and Raji, 1998). These water bodies including the lakes, rivers, streams, etc constitute sources of fish supply from inland fisheries. Fishing in the inland waters are carried out with simple fishing gears such as bamboo traps, cast nets, drag nets with the aid of dug out canoes. Since most of the water bodies in Nigeria are still traditionally farmed and ponds are under managed, thus giving rise to the shortage in fish supply. Therefore it is expedient to expand and develop fresh water fish as a renewable natural resource before most of the fisheries go into extinction. Globally fish contributes about 18% but in developing countries (Nigeria inclusive), fish provides as much as half the animal protein required and it is mainly got from the small-scale fisheries (FAO, 2002) of which Chrysichthys is one.

A main problem of aquaculture in Nigeria is the inadequate or insufficient supply of fry and fingerlings. This could be attributed to low level research and knowledge as it pertains to culturing and breeding of fresh and brackish water species. *Chrysichthys*, silver catfish, occurs in most of the major rivers of Africa

(Boulenger, 1909, 1911 and 1915). Jayaram (1966) reviewed the taxonomy of the Bagridae family and recognised 36 of the species of the genus *Chrysichthys*. He stated that they have a total length of 370 mm in West Africa.

Chrysichthys are more prominent in low brackish water areas and in major rivers of Nigeria, particularly the lagoon where it is mainly captured. In lake Asejire, *Chrysichthys* spp. are among the dominant fishes of commercial catches (Aransiola, 1989). This study therefore, seeks to determine the relationship if any between body weight and fecundity and also investigate if there is any relationship between sex and length of *C. nigrodigitatus* (Lacepede) in Asejire lake, Nigeria.

Materials and Methods

Samples of *C. nigrodigitatus* were collected over a period of ten months i.e April to January in conjunction with the fishermen fishing on the lake who set the bamboo traps for the breeders and the set nets are weed to collect other specimens. Some breeders were also collected in the nets but most were caught with bamboo traps. Those caught in bamboo traps and nets were merged together for accurate records since gravid females were essential to the study.

Sexes were determined according to Ajayi (1972). Females were recognised by reddish round inflammation around the genital aperture which is round shaped with distended abdomen due to the presence of ovaries when cut open. The males were determined by the oval shape of the genital aperture, slightly sticky skin and presence of testes when opened with flat abdomen. The mouth of the male is broader with larger heads.

The total, forked and standard lengths were measured using a measuring board and sometimes a ruler to the nearest centimetres. The total length (absolute length) was measured from the most interior extremity to the end of the tail fin. The standard length was measured from the most anterior extremity to the hidden base of the tail fin rays, which is identified by the fin when the tail is bent sharply side ways. The forked length is from most anterior extremity to the point where the tail is forked. Each specimen was weighed using a top-loading balance to the nearest grammes. The gonads of each fish was removed and weighed to the nearest gram. This was determined by using Gilson's fluid to preserve and harden the eggs, which were then counted by volumetric sub-sampling after Fagade and Adebisi (1979). The volume of a portion of the sub-sample is taken, the number of eggs in that volume is counted and is extrapolated to the total volume of the original ovary from which the sub-sample was taken. The relative fecundity was calculated as number of eggs per unit weight of fish, i.e;

$$\text{Relative Fecundity} = \frac{\text{number of eggs}}{\text{weight of fish}}$$

The gonado-somatic index (GSI) of the fish was determined using the following formula;

$$\text{GSI} = \frac{\text{weight of gonad}}{\text{weight of fish}} \times 100$$

Condition factor was used to compare the condition or fatness of the fish. According to Bagenal and Tesch (1978), condition factor could be used to compare differences related to sex, season or place. It was calculated using the Fulton's coefficient formula;

$$K = \frac{100W}{l^3}$$

where, l = standard length(cm)
W = Body weight(g)

Correlation and regression were used to determine the type of relationship that exist between total length, standard length and body weight of fish. It was also used to determine the type of relationship between the reproductive parameters.

Results

The temperature readings varied from 27.5 – 31.2^{0}C. indicating a fairly high temperatures. The highest temperatures were recorded in November and the lowest temperatures recorded were in the month of June. The pH did not vary much from neutral between 6.8 – 7.6. The values were relatively constant with a mean value of 6.86. The water conductivity value ranged between 140 ohms and 155 ohms, which was low. The mean salinity was 1.06 with a range of 0.75 – 1.30‰; the lowest values were during the rainy season months of May – July.

The length – weight relationship of *C. nigrodigitatus* is presented in Table 1 and Figure 1 on scattered diagrams. Both parameters were highly significant (P<0.001).

Table 1: *Linear Regression for Predicting Weight of Chrysichthys nigrodigitatus using Standard Length*

Dependent variable	Prediction Equation (Y = a + bx)	n	r	r^2	SE	Sign.
Weight, Y	–267.49 + 23.36 sl	32	0.96	0.92	25.49	***
Log Weight, Y	–1.05 + 2.25 log sl	32	0.93	0.87	0.08	***
Weight, Y	–220.96 + 18.81 sl	177	0.84	0.70	32.32	***
Log Weight, Y	–0.62 + 2.09 log sl	177	0.85	0.71	0.08	***
Weight, Y	–229.83 + 19.59 sl	209	0.86	0.73	33.02	***
Log Weight, Y	–0.66 + 2.13 log sl	209	0.85	0.73	0.08	***

sl – standard length ***P < 0.001

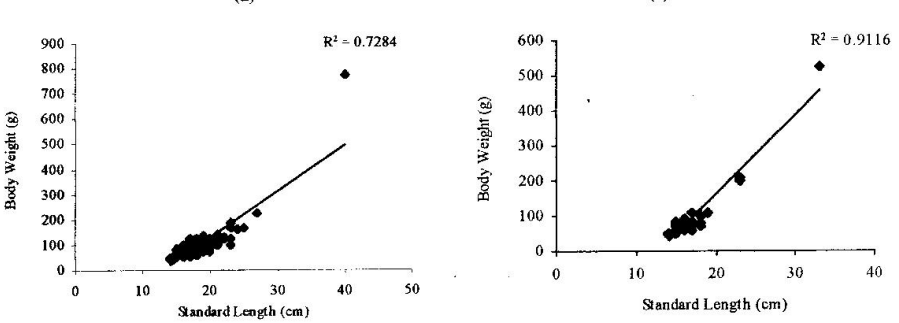

Figure 1: Body Weight – Standard Length relationship in male (a) female (b) *C. nigrodigitatus*

The following prediction equation described the relationship between length and body weight of a fish:

$$Y = a + bx$$

where, Y = body weight (g)
x = standard length (cm)
a + b are constants.

The regression equations representing the least square line of the relationship are:
females Y = –267.49 + 23.36x
males Y = –220.96 + 18.81x
The logarithmic transformation of both parameters were plotted to obtain a straight line:

Log W = Log a + b log 1 (Bagenal and Tesch, 1978)

Thus the following equations were obtained:

females Log W = −1.046 + 2.50 log sl
r^2 = 0.930; P<0.001 n = 32

males Log W = −0.62 + 2.09 log sl
r^2 = 0.710; P<0.001 n = 177

The relationship between condition factor and body weight was plotted on scattered diagrams (Figure 2). The mean condition factor (k) of female fish indicated that they were relatively heavier than their male counterparts. During the study period 209 *C. nigrodigitatus* – 32 females and 177 males giving a male:female ratio of 1:0.18. In *C. nigrodigitatus* the ratio of males to females was higher in the month of January.

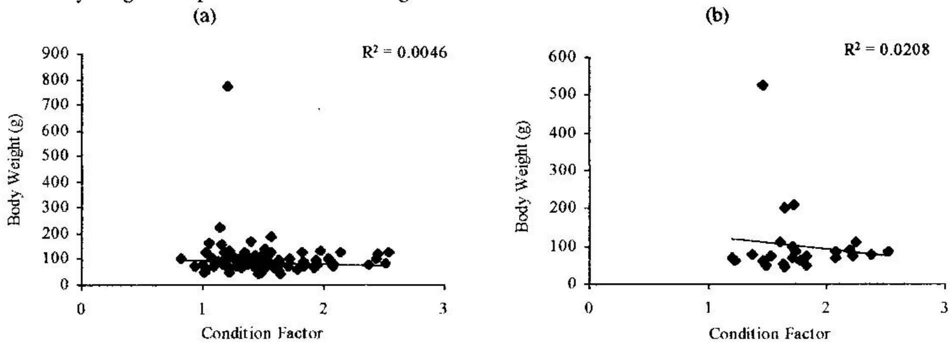

Figure 2: Body Weight - Condition Factor in male (a) and female (b) *C. nigrodigitatus*

The statistical relationship between the various gonadal and somatic parameters are shown in Table 2. The fecundity ranged from 466 eggs in *C. nigrodigitatus* which weighed 45.0g with a standard length of 14.0 cm to 16,490 eggs in a fish that weighed 525.0g having a standard length of 31.0 cm.

Table 2: *Linear Regression for Predicting Gonadal and Somatic Parameters of Chrysichthys nigrodigitatus using weight and length.*

Dependent variable	Prediction equation (Y=a+bx)	n	r	r^2	SE	Sign.
Gonad weight, Y	-58.88+4.50a	32	0.91	0.83	7.21	****
Gonado-Somatic index, Y	-6.50+1.01a	32	0.43	0.17	7.48	ns
Gonad weight, Y	-6.25+0.18b	32	0.90	0.81	7.66	****
Gonado-Somatic index, Y	5.82+0.03b	32	0.37	0.14	7.72	ns
Gonad weight, Y	0.22+0.03a	177	0.39	0.16	0.19	****
Gonado-Somatic index, Y	0.51-0.01a	177	0.07	0.01	0.28	ns
Gonad weight, Y	0.19-0.001b	177	0.32	0.10	0.20	****
Gonado-Somatic index, Y	0.41-0.00b	177	0.14	0.02	0.28	ns
Gonad weight, Y	-13.66+0.96a	209	0.34	0.12	7.40	**
Gonado-Somatic index, Y	[illegible]	[illegible]	0.07	0.005	4.50	ns
Gonad weight, Y	[illegible]	[illegible]	0.44	0.19	[illegible]	[illegible]
Gonado-Somatic index, Y	[illegible]	209	0.27	0.07	[illegible]	[illegible]

[illegible]

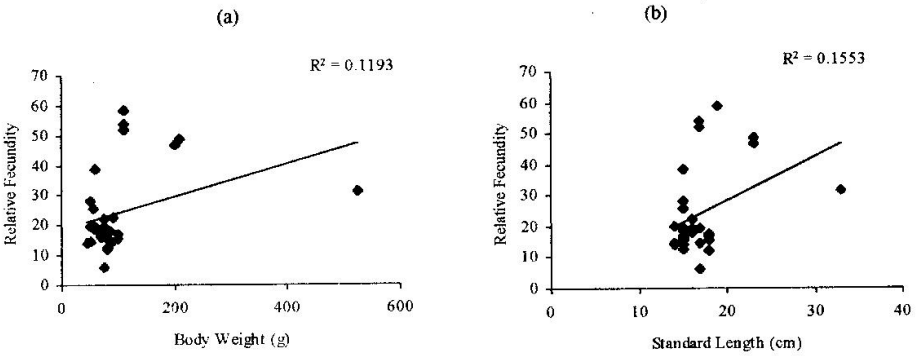

Figure 3: Relative Fecundity - Body Weight (a) and Standard Length (b) Relationship

Fecundity was plotted against body weight (Figure 3(a)) to give a scattered diagram with correlation coefficient (r^2) of 0.122 showing non-significant values. The standard length and fecundity relationship (Figure 3(b)), also gave non-significant correlation coefficient (r^2) value of 0.170. Indicating that fecundity is neither dependent on body weight nor length and there is no relationship between them. They were represented by the following equations (weight and standard length):

where, Y = Fecundity (number of eggs)
x = body weight (g) or standard length (cm)

Body weight $Y = 17.15 + 0.04x$
$r^2 = 0.122$ ($P>0.001$ n = 32)
Standard length $Y = 2.52 + 1.19x$
$r^2 = 0.170$ ($P>0.001$ n = 32)

The gonad-body weight relationship were plotted on scattered diagrams (Figures 4) and are represented by the equations:

where, Y = Gonad weight (g)
x = Body weight (g)
females $Y = -6.25 + 0.18x$
$r^2 = 0.812$ ($P<0.001$ n = 32)
males $Y = 0.19 + 0.001x$
$r^2 = 0.102$ ($P<0.001$ n = 177)

The result indicates that gonad weight increases the body weight of the specimen, that is the specimens could have the same length but different weights due to the weight of the gonads. The length of the specimens also increased with gonad weight.

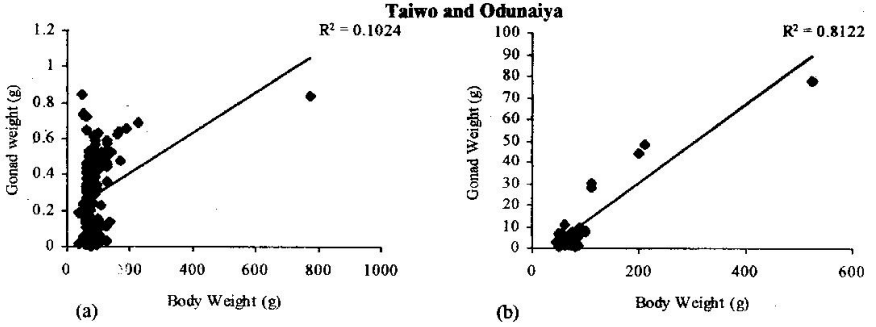

Figure 4: Gonad Weight - Body Weight Relationship in male (a) & female (b) *C. nigrodigitatus*

Discussion

The results indicate that the length of fish increased with body weight. The value of the exponent, regression coefficient, b, was calculated for both males and females separately and pooled as shown in the results. The value (2.13) obtained was below three for an ideal fish, but are still within the range of 2 and 4. Therefore, these results show a positive allometric growth, i.e, fish become heavier with increase in length. These values were in agreement with the value of 2.77 gotten by Odedeyi (1987) but, contrary to Aransiola's (1989) value of 1.32 for females and 0.842 for males at Asejire Lake. This indicates that the condition of *C. nigrodigitatus* at Asejire Lake has increased over time due to under fishing at the time of the study. This could be attributed to the fishers being discouraged because of the small size of the fishes. The calculated regression coefficient, for the total and standard length relationship showed that the value for the female (1.19) *C. nigrodigitatus* was lower than that of the male (1.55) which is in disagreement with Aransiola's (1989) male value of 1.15. The r^2 values indicates a high level of significance, signifying that standard length increases with total length. The rate of increase is explained by the exponent, b, which shows that the rate of increase of standard length to total length is slightly higher.

Condition factor (k) was used to compare the condition or fatness of fish based on the hypothesis that the heavier fish of a particular length are in better condition. There was variation between the mean condition factor (k) of the male (1.939) and the female (2.339). The higher values of the females showed that female specimens having equal length with a male specimens is heavier. These values are in agreement with Aransiola's (1989) result of 2.13 for males and 2.48 for females. Gonad development could be responsible for the difference in condition as it relates to fish length. The average size per fish recorded in this study are smaller than those recorded for the same species in Kainji Lake where the fish grows to larger sizes (Ajayi, 1972; Olaosebikan and Raji, 1998) and the Lagos lagoon (Ezenwa, 1981; Ezenwa and Ayinla, 1994).

There was a predominance of males (177) to females (32) that is 1:0.18. Aransiola (1989) also observed this in Lake Asejire with a male – female ratio of 1:0.56 and 1.0.795 respectively. He attributed it to the probability of more males being caught. However, this could be true for those fish caught with set nets, the males might be faster swimmers so they are more susceptible to the net. The study revealed a predominance of females in the bamboo traps (they go into the bamboo to spawn) and fish caught with cast net though mainly male which is probably the reason for the high male values. Another reason for this predominance of males could be that

more males were hatched and developed to adult stage and a high female mortality before maturity. It was also noted that more mature females were purchased in agreement with Aransiola (1989) who collected matured females in May. Spent specimens were observed mainly at the peak of the dry season, December and January.

The maturity size of a fish is dependent on a number of factors among which are the fish life span and the maximum size the fish can attain during its life. A low asymptotic length tends to give rise to a very small size at maturity and vice versa (Berverton and Holt, 1993). The life span of a fish is also directly related to its minimum size at maturity (De-Silva, 1973). Therefore, the relatively small size of *C. nigrodigitatus* at maturity in Asejire Lake might probably be indicative of a short life span and low asymptotic length. However, this might not be true for other water bodies, such as river Ogun, Benue and Niger where larger maturity sizes have been recorded. Low maturity sizes could also be attributed to overfishing or poor conditions in the lake. Though the later condition might not be true because this study showed that the condition of the fish in the lake was fine and the lake seemed to be underfished as at the time of this study.

A change in the environment could be responsible for this early maturation, i.e. a change in the environment of this population from a riverine to a lacustrine condition. In the riverine population fishes are able to migrate down the river into the lagoons and migrate up river to breed, but the lacustrine population experience no such migration. Also intensive predation or food shortage could lead to early maturity. From this it could be concluded that the high fishing intensity taking place on the lake and a change in environment, from riverine to lacustrine might be responsible for the early maturity of the gonads.

The gonado-somatic index (ovary weight expressed as a percentage of body weight) varies from 0.75 to 27.73 with a mean of 9.23 for *C. nigrodigitatus*. This means that between 0.75% and 27.73% of the weight of *C. nigrodigitatus* was expended in the production of eggs. Aransiola (1989) put gonado-somatic index of *C. nigrodigitatus* that they examined in Asejire lake at between 0.02-25.71 with a mean of 5.65. The correlation between gonad and body weight in both species is positive and significant (r^2 = 0.81, 0.21, $p<0.001$) which indicates that the gonad weight of the fish is proportional to its somatic weight. This is in agreement of the findings of Laleye *et al.* (1995)

The fecundity of *C. nigrodigitatus* (466 eggs with body weight 45.0g to 16,490 eggs and body weight 525.0g) in this study was found to be less than that recorded by Aransiola (1989) recorded 2,837 eggs (body weight 42.6g, 11.6 cm standard length) to 23,310 eggs (body weight 350.0g, standard length 25.5 cm). Fagade and Adebisi (1979) in their study found 189 eggs in each of the paired ovaries of a 13.0 cm total length to 2,884 eggs in a 25.2 cm total length specimens from Asejire lake. Ikusemiju (1976) reported 896 to 4,168 eggs from *C. walkeri* with total length between 13.3 to 24.5 cm. This study revealed that fecundity varied with body weight among fishes of the same body weight.

Conclusion

The sex ratio of *Chrysichthys nigrodigitatus* revealed a high male to female ratio 1:0.18 which is probably an indication that the lake contains more males than females. The exponential value, b, for length - weight relationship in male *C. nigrodigitatus* is 2.09 and 2.50 in females. Therefore, *C. nigrodigitatus* has an allometric growth, that is, growth increases with equal increase in body weight. The females are in a better condition than their males, with a condition factor of 2.34 *C. nigrodigitatus*. The female *C. nigrodigitatus* were found to be in best condition, therefore, they used the water nutrients better than their males. It was proved from the study that spawning takes place all year round as gravid

fish were purchased throughout the period of study, which corresponds with the rainy seasons, probably because food are more abundant during this season. Size does not actually affect maturity, gravid 20g fish were observed. *C. nigrodigitatus* exhibits the six stages of gonad development like any typical tropical fish species. It was also found that fecundity in *C. nigrodigitatus* was relatively high compared to that of *C. walkeri* which was carried out by the author at about the same time. Fecundity was found to be related to increases in somatic growth; a 20g *C. nigrodigitatus* had 466 eggs, 525g had 16,490 eggs. The gonado-somatic index revealed that though *C. nigrodigitatus* had a high condition factor, it spent less of its body weight 9.23% for egg production. Fishermen could be advised not to harvest fish caught in bamboo traps as they are mainly gravid fishes and they should be allowed to spawn and grow thereby increasing fish available for harvest.

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