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Research Article

Length -weight relationship, sex ratio, length at maturity and condition factor of African catfish *Clarias gariepinus* in lake Babogaya, Ethiopia

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Abstract

Length weight relationship, sex ratio, size at maturity and condition of Clarias gariepinus in Lake Babogaya were studied at Lake Babogaya located in the vicinity of Bishoftu town at about 45 Km East of Addis Ababa. Samples of C.gariepinus were collected monthly during September (2005) through to August (2006) using hook - and - line method and gillnets of various mesh sizes. The relationship between total length (25 to 102 cm) and total weight (165 to 7000 g) was curvilinear and represented as $TW = 0.0156\ TL^{2.934}$, $R^2 = 0.942$, $P < 0.05$. Sex ratio was not significantly different from 1:1 except in samples taken in April and July, and in length groups between 25 and 54 cm total length (TL) in the total sample. In all these cases, there was a preponderance of females over males. In the total sample, for instance, females were about 1.26 more numerous than males. The 50% sexual maturity length (L_{50}) was estimated at 50 cm TL for females and 56 cm TL for males. Fulton condition factor (mean ± SE) was 0.66 ± 0.04 for females, 0.63± 0.03 for males and 0.64 ± 0.01 combined for both sexes.

Keywords: Lake Babogaya, C. gariepinus, length weight relation, sex ratio, size at maturity and condition factor, Ethiopia.

Introduction

The inland water body of the county is estimated at about 7,400 km^2 of lake area and about 7000 km total length of rivers (Shibru Tedlla, 1973). From the inland water bodies, crater lakes are well represented in Africa, including Ethiopia (Baxter, 2002). The crater lakes in Ethiopia may provide admirable opportunities for comparative biological studies owing to the considerable variations in their morphometric, physical and chemical features. Among these are the Bishoftu crater lakes, which form an extensive series of volcanic explosion craters in the vicinity of the town and harbour a variety of fish species.

Generally, The potential fish yield of these water bodies of the country is roughly between 30,000 and 40,000 metric tones per year for the main water bodies alone, and so far only 20% of this is being utilized (FAO, 1995). The three fish species found in Lake Babogaya are *O.niloticus, C.gariepinus* and *Tilapia zilli*. They are introduced in the lake by the MOA aiming at enhancing the fishery of the lake.

From these species *C.gariepinus* is a case in point to this study. *C.gariepinus*, a member of the group, is a broadly distributed in Ethiopia (Trewavas, 1983). It is found in almost all lakes and rivers of Ethiopia (Shibru Tedla, 1973). Therefore, it is one of the most important species in the fisheries of Ethiopia.

In spite of its important of the fish, very little work has been done on the fishery and the resource is exploited without enough knowledge on the biology of the fish (Zenebe Tadesse, 1999). Therefore, knowing the information on length-weight relationship, sex ratio, size at maturity and condition factor provide basic knowledge for the proper management of the resource. However, such knowledge is not available for the species in Lake Babogaya and this has hindered proper management of the fishery. Therefore, the major objective of the present study was to generate basic biological information that could help to make proper exploitation and management strategies on the Ethiopian fishery in general and *C.gariepinus* in Lake Babogaya in particular. The specific objectives were to assess study sex ratio, size at maturity, Length-weight relationship and condition of the fish of *C. gariepinus* in Lake Babogaya.

Materials and Methods

Study area Lake Babogaya

Lake Babogaya is one of the volcanic crater lakes found in the vicinity of Bishoftu town at about 45 Km East of Addis Ababa. The lake is found at an altitude of 1870 m and at about 9^0N latitude and 39^0E longitude (Prosser *et al.*, 1968; Wood, *et al*., 1984). The phytoplankton community is dominated by blue-green algae, particularly *Microcystis aeruginosa* (Kutz.) (Wood and Talling, 1988), while the zooplankton is composed of copepods (*Afrocyclops gibsoni, Lovenula africana*), rotifers (*Asplancha sieboldi*, Brachionus *calyciflorus* and *Hexarthra jenkinae*) and cladocera (Yeshimebet Major, 2006). The fish community found in Lake Babogaya is composed of *O.niloticus*, *C.gariepinus* and *Tilapia zilli*. From these, *C.gariepinus* is the most dominant species next to *O.niloticus*. Mean monthly minimum air temperature ranged from 11.2 to 13.5^0C, while the maximum mean monthly air temperature varied from 21.6 to 31.5 ^{0}C. Monthly total rainfall varied from 2.1 mm (January 2006) to 239.5 mm (July 2006). Surface water temperature of the lake is reported to be mostly between 22^0C and 24.5^0C while the bottom temperature was almost constant (19.2^0C-19.4^0C) (Wood, *et al.*, 1976 and 1984). In a recent study (Yeshemebet Major, 2006), the water temperature and dissolved oxygen of the lake range from 23^0C to 27^0C and 7 mg l^{-1} to 14 mgl^{-1}, respectively.

Field Sampling and measurement

Samples of *C.gariepinus* were collected monthly between September 2005 and August 2006 using hook - and - line and gill nets from two sites. Site one (Harmeniawian House) is located about 20 m offshore at a depth of 4 to 12 m. Site two (ILRI) is 2 to 7 m deep and 10 m close to the shore; where there is a relatively dense macrophyte vegetation. Pieces of tilapia were used as bait for the hooks and the two gears were set parallel to the shoreline in the afternoon (05:00 pm) and lifted in the following morning (7.00 am). In addition, samples of fish caught by fishermen were also included to obtain a wide range of fish size and to increase sample size. Then immediately after capture, total length (TL) and total weight (TW) of each specimen were measured to the nearest 0.1 cm and 0.1g, respectively. Each specimen was then dissected and its sex determined by inspecting the gonads. A five-point maturity scale was used for this purpose (Holden & Raitt, 1974).

Estimation of sex - ratio and length at maturity

The number of female and male *C.gariepinus* caught was recorded for each sampling occasion. Sex-ratio (female: male) was then calculated for each month, for different length classes and for the total sample. Chi-square test was employed to test if sex ratio varied from one - to - one in monthly samples, in various size classes and in the total sample as in Demeke Admassu (1994).

The average length at first maturity (L_{50}) has been defined as the length at which 50 % of the

individuals in a given length classes reach maturity (Willoughby and Tweddel, 1978). Thus, after classifying data by length class, the percentages of male and female *C. gariepinus* with mature gonads were plotted against length to estimate L_{50} (Tweddle and Turner, 1977).

Length - Weight relationship and Condition factor

Length-weight relationship of *C.gariepinus* was calculated using least squares regression analysis (Le Cren, 1951; Bagenal and Tesch, 1978).

$$TW = a \times TL^b,$$

Where, TW = Total weight in grams
TL = Total length in centimeters
a and b = intercept and slope of the equation, respectively

The condition or well being of each fish was determined by computing Fulton condition factor (Bagenal and Tesch, 1978). The condition factor of individual fish was calculated and then monthly mean values were determined for each sex separately. Fulton condition factor was calculated as:

$$FCF = TW / TL^3 \times 100$$

Where, FCF = Fulton condition factor
TW = Total weight in grams
TL = Total length in centimeters

Significance of length-weight relationships and of differences in condition factors of *C.gariepinus* between sexes, sampling periods, and sex by month interaction was tested using ANOVA (Sokal and Rohlf, 1981).

Results

Size composition of the sample

A total of 948 (528 female and 420 male) *C. gariepinus* individuals were caught during the study .The total length of the fish ranged from 25 to 102 cm for females and from 25 to 95 cm for males. The corresponding total weight ranged between 170 and 7000 grams for females and 165 to 5550 grams for males.

As shown in Figure 1, the greater proportion of the sampled female fish ranged in size between 35 and 54 cm, whereas more males were caught between size classes 35 and 64 cm, the peak being between 45 and 54 cm for females and 35 to 44 cm for males. This length group alone was about 30% for females and 24% for males in the total sample. Fish over 85 cm and below 35 cm TL were least represented in the sample (Fig.1).

Sex ratio and length at maturity

Sex ratio results are presented in Tables 1 and 2 The ratio was not significantly different from 1:1 for all sampling months, except in April and July when there was preponderance of females over males (Table. 1). Sex ratio of *C. gariepinus* was also similar to 1:1 for length classes above 54 cm (Table 2). However, females significantly outnumbered males in length classes ranging from 25cm to 54 cm (Table 2). In addition, the overall sex ratio (1.26:1) was also significantly different from 1:1 showing a preponderance of the females (Table 1 and 2).

The smallest sexually mature fish that was caught in this study was a female fish of 30 cm TL and a male fish of 32 cm TL. The 50% maturity length (L_{50}) was estimated to be 50 cm TL for females (Fig. 2a) and 56 cm TL for males (Fig. 2b). On the average, females appeared to attain sexual maturity at a relatively smaller size than males.

Length - Weight relationship and condition factor

The Length-weight relationship of *C. gariepinus* in Lake Babogaya was curvilinear and statistically highly significant ($P<0.05$). The equations separated by sex were as follows.

Males: $TW = 0.0174 \times TL^{2.9029}$, $R^2 = 0.9673$, n = 420
Females: $TW = 0.0143 \times TL^{2.9525}$, $R^2 = 0.955$, n = 528

Table 1. Monthly number of females and males and sex ratio of *C. gariepinus* in Lake Babogaya (* means significant at 5% level).

Month	Female	Male	Sex-ratio	X^2
Sep. 2005	25	27	0.93:1	0.077
Oct.	29	25	1.16:1	0.296
Nov.	40	35	1.14:1	0.333
Dec.	29	26	1.12:1	0.164
Jan. 2006	39	34	1.14:1	0.342
Feb.	46	39	1.18:1	0.576
Mar.	52	47	1.11:1	0.253
Apr.	64	42	1.52:1	4.566*
May.	35	33	1.06:1	0.59
Jun.	63	48	1.31:1	2.027
Jul.	59	34	1.74:1	6.72*
Aug.	47	30	1.57:1	3.753
Total	528	420	1.26: 1	12.304*

Table 2. Number of female and male and sex ratio of *C. gariepinus* in various size classes in Lake Babogaya (* means significant at 5% level)

Size class in cm	Females	Males	Ratio (F: M)	Chi-sq
25-34	40	22	1.82:1	5.226*
35-44	152	111	1.29:1	6.392*
45-54	157	102	1.44:1	11.68*
55-64	79	81	0.98:1	0.025
65-74	51	53	0.81:1	0.038
75-84	25	30	0.64:1	0.455
85-94	19	18	1.06:1	0.027
95-104	5	3	1.67:1	
Total	528	420	1.26:1	12.304*

Figure 1. Length-frequency distribution of *C.gariepinus* from Lake Babogaya

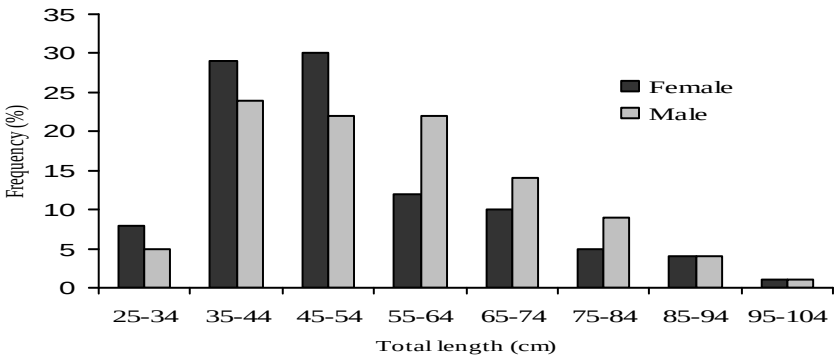


Figure 2. The proportion in different length groups of mature females (a) and males (b) *C. gariepinus* from Lake Babogaya

(a) (b)

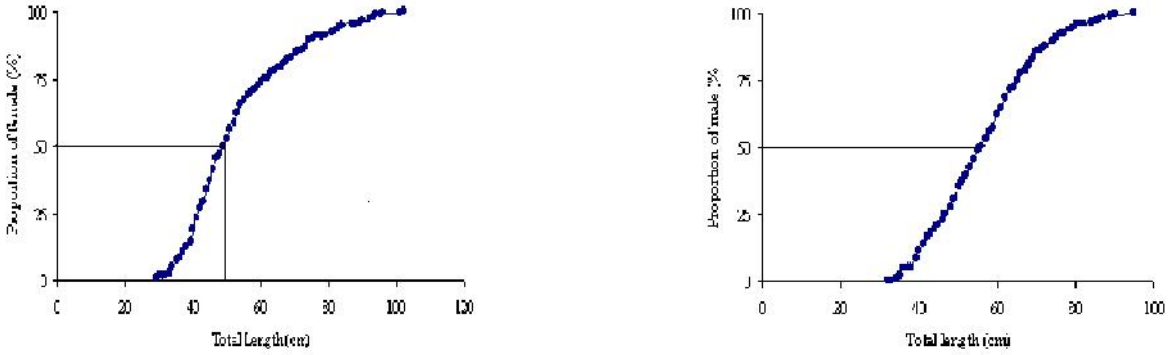


Figure 3. Length-weight relationship of *C. gariepinus* in Lake Babogaya

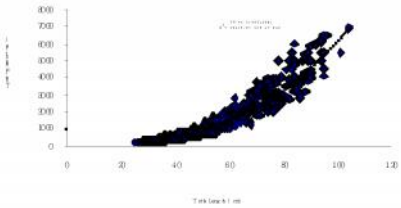
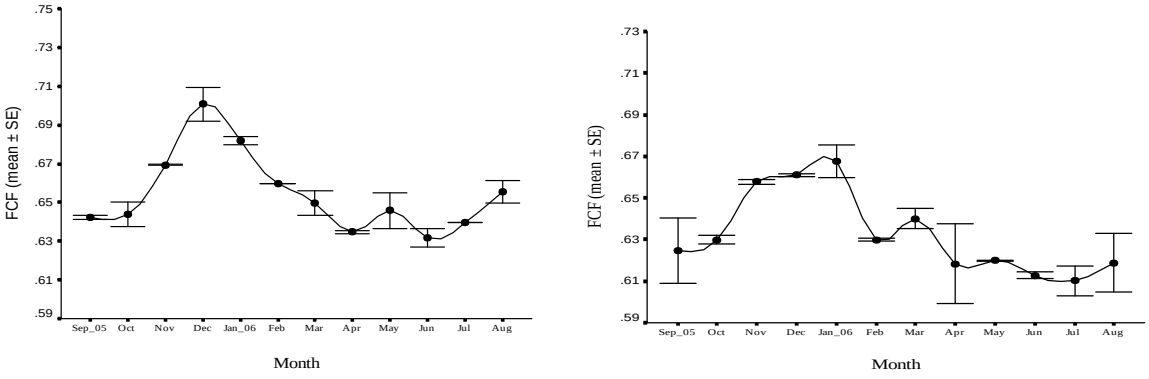


Figure 4. Monthly Fulton condition factor (mean ± SE) of female (a) and male (b) *C.gariepinus* from Lake Babogaya

a. b.



Comparison of the above two equations showed no significant difference between the sexes (ANOVA, P>0.05). Therefore, an equation combined for sexes was fitted and shown in Figure 3. The equation was for fish ranging in length from 25 to 102 cm, and in total weight from 165 to 7000 g. The slope (b=2.93) was close to the theoretical value of 3.

Monthly Fulton condition factor (FCF) values (mean ± SE) of *C. gariepinus* ranged from 0.63 ± 0.05 (in June) to 0.70 ± 0.09 (in December) for females (Fig. 4 a), and from 0.61± 0.04 (in July) to 0.67 ± 0.05 (in January) for males (Fig. 4 b). Mean FCF (± SE) was found to be 0.66 ± 0.04 for the females and 0.63 ± 0.03 for the males. The overall mean FCF was 0.64 ± 0.01.

FCF varied significantly between sampling months and between sexes (ANOVA, P<0.05). Generally, the females had higher FCF values than the males. However, sex by month interaction was insignificant (ANOVA, P>0.05) suggesting that temporal variation in FCF was similar for both sexes (Fig. 4). Thus, FCF of both sexes was high during November (2005) to January (2006), but low during the rest of the months (Fig. 4)

Discussion

The largest *C. gariepinus* caught in the present study was 102 cm (TL) which was comparable to the largest size recorded for the species from Lake Langeno (104 cm; Leul Teka, 2001) but smaller than that from Lake Zwai (117 cm; Daba Tugie and Meseret Taye, 2004). There were a curvilinear relationship between total length and total weight of the fish in the lake (Fig.3). The value of b (2.93) was close to the theoretical value (b = 3), indicating isometric growth. The finding is in agreement with the principle of fish growth (Bagenel and Tesch, 1978), and comparable to the value of b calculated for the same species in L. Langeno (2.9) (Leul Teka, 2001) and L. Zwai (2.84) (Daba Tugie and Meseret Taye, 2004), but slightly lower than that in L. Awassa (3.04) (Elias Dadebo, 1988).

Condition factors, which are used to compare the well-being or fatness of fish, are based on the hypothesis that the heavier fish of a given length are in better condition. Mean FCF in the present study was 0.66 for females and 0.63 for males. The overall mean FCF for the population was 0.64. According to Leul Teka (2001) the corresponding values for the L. Langeno population were 0.63 for females, 0.58 for males and 0.61 for the population in general. The corresponding values for the L. Awassa population were 0.70 for females, 0.69 for males, and 0.70 for the population (Elias Dadebo, 1988). Thus, *C.gariepinus* in Lake Babogaya show a relatively better well-being than that in L. Langeno, but lower than that in L. Awassa.

Additional evidence can also be obtained by using length-weight equations fitted in the present study and that by Elias Dadebo (1988) and Leul Teka (2001). Considering a 30 cm fish length, *C. gariepinus* would be 190 g in L. Awassa, 169.3 g. in L. Langeno, and 185 g in L. Babogaya. In addition, for a 90 cm total length, *C. gariepinus* would weigh 5400 g in Awassa, 4200 g in Langeno and 4700 g in Babogaya. Generally, *C. gariepinus* in Lake Babogaya would be heavier than a similar sized fish in L. Langeno but lighter than that in Lake Awassa. Hence, it can be concluded that the L.Babogaya *C. gariepinus* population grows relatively faster than that in L. Langano and slower than that in L. Awassa. The reason for this difference may be related to the difference in productivity between the lakes, which in turn determines food quantity and quality. This shows that quantity and quality of the food of *C. gariepinus* may be better in Babogaya than in Langeno, whereas that in Awassa may be better than that in Babogaya. However, a detailed study is required to confirm this conclusion. .

Results of FCF of *C. gariepinus* in L. Babogaya suggest that females are in relatively better condition than males. Our finding agrees with sex-based difference in FCF reported for *C. gariepinus* of L. Awassa (Elias Dadebo, 1988) and Langeno (Leul Teka, 2001). It is also common to find populations whose female members grow superiorly and have better condition than the males (Fryer and Iles, 1972).

Conclusions and Recommendations

This study is the first of its kind to be conducted on *C. gariepinus* of L Babogaya. Therefore, further detailed studies are required on other aspects (growth, mortality, etc) of the fish, as well as on the limnology of the lake in general and the biology of the other fish species in particular. However, some conclusions and recommendations can be made based on the findings of the present study.

- It was found out that the smallest sexually mature *C.gariepinus* was 30 cm TL for female and 32 cm TL for male, whereas the L_{50} was 50 cm for females and 56 cm for males. Thus, *C.gariepinus* smaller than about 50 cm should be protected for the stock to sufficiently replace itself and for sustained exploitation. Prior to the start of this study there was very little fishing on Babogaya. However, fishing by the local population has intensified afterwards probably learning from the present study about fish abundance and fishing gears. In any case large numbers of small sized fish were being exploited (personal observations). While development of the fishery is possible, proper management actions are required to protect the immature fish. Therefore, gear size and type must be recommended for the fish in the lake.

- The sex ratio, fecundity, length weight relation and condition of *C. gariepinus* in Babogaya were comparable to those of the species in some other Ethiopian Lakes (Awassa, Langeno and Zwai). This suggests that the L. Babogaya *C. gariepinus* population may have general characteristics (growth and mortality) similar to the populations in the other lakes. This in turn may suggest the possibility of developing the fishery on L. Babogaya as is currently the case on the other lakes (eg. Zwai, Langeno).

- Prior to this, however, in addition to the studies mentioned above, stock assessment study is strongly recommended to estimate optimum fishing level and sustainable yield.

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