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Full Length Research Paper

Breeding Season and Condition Factor of Oreochromis niloticus (Pisces: Cichlidae) in Leke Babogaya, Ethiopia

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The breeding season and condition factor of Oreochromis niloticus were studied in Lake Babogaya. 917 (565 female and 352 male) samples collected over 12 months between September 2005 to August 2006. Fulton condition factor was 2.13. Two factors ANOVA indicated a significant seasonal fluctuation in the condition of both sexes, but not between male and female O.niloticus. Poor body conditions coincided with time of peak breeding activity. The interaction effects of sex and month on Fulton condition factors was not significant. State of gonad maturation and Gonadosomatic index values showed that Oreochromi niloticus in Lake Babogaya breeds all year round with peak activities between April to August and during this time needs to manage the lake to use the resource appropriately.

Key words: *Breeding, Condition, fish, Lake Babogaya, Size composition*

INTRODUCTION

Providing adequate food for a rapidly increasing human population is one of the greatest challenges in the world. The problem is particularly acute in countries like Ethiopia where, besides population explosion, natural and man-made calamities have aggravated the problem. In addition to increasing food production from land agriculture, therefore, it is necessary to sustainably exploit the aquatic ecosystems to contribute towards the effort of food security by virtue of their high productivity. Ethiopia's fish resources could undoubtedly offer one of the solutions to the problem of food shortage in the country. Therefore, it is necessary to sustainably exploit the fish resources.

Ethiopia is endowed with sizable amount of lotic (running) and lentic (stagnant water) environments whose fishery potential has not yet been fully realized (Lemma, 1987). 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 (Tedlla, 1973). From the inland water bodies, crater lakes are well represented in Africa, including Ethiopia (Baxter, 2002). Among these are the Bishoftu crater lakes, which form an extensive series of volcanic explosion craters in the vicinity of Bishoftu and harbour a variety of edible fish species.

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Generally, The potential fish yield of Ethiopian water bodies 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 ecologically and economically most important species of fish, accounting for over 95% of Ethiopia's fishery, are Oreochromis niloticus (Tilapia), Clarias gariepinus (Catfish), Barbus species and *Lates* niloticus (Nile perch), among others (LFDP 1996 in Tadesse, 1998).

The three fish species found in Lake Babogaya are O. niloticus, C. gariepinus and Tilapia zilli. They were introduced in the lake by the Ministry of Agriculture aiming at enhancing the fishery of the lake. From these species O. niloticus the focus of this study. Information on the reproductive biology of O.niloticus has been reported in the country by several authors (Admassu, 1996, 1994; Stewart, 1988; Tadesse, 1997, 1988; Teferi et al., 2001). The species breeds continuously throughout the year in the Ethiopian lakes, but the breeding activity is intensive during the periods from December to March in Lake Ziway (Tadesse, 1988), January to April and July to September in Lake Awassa (Admassu, 1994, 1996) April to August (peaking in June and July) in Lake Tana

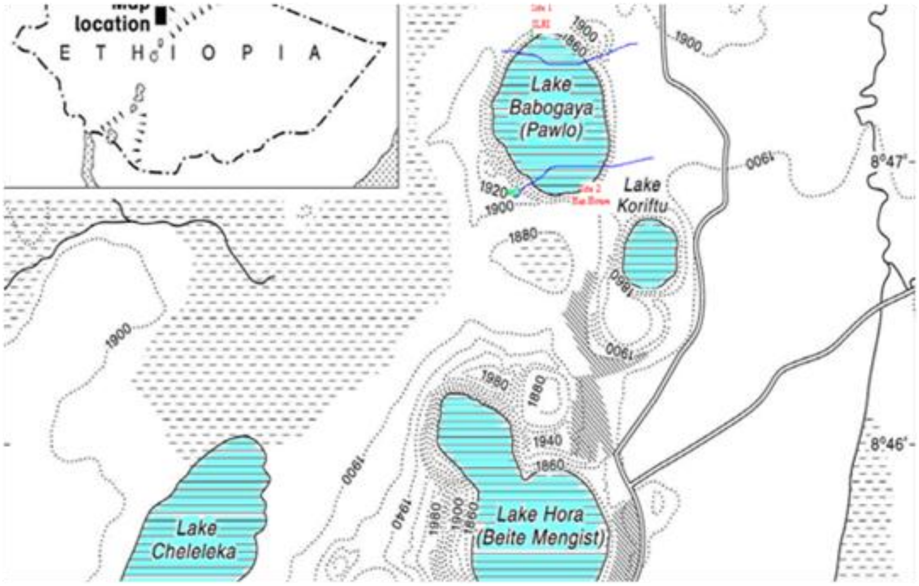

Figure 1: Location of Lake Babogaya in relation to the other Bishoftu Crater Lakes (Lamb 2001).

(Tadesse, 1997) and from March to June in Lake Chamo (Teferi, 1997). Stewart (1988) also reported that the species in Lake Turkana breeds continuously throughout the year but peak breeding occurs during March to July. The peak breeding activity of the fish in Lakes Awassa and Ziway, according to Admassu (1994) and Tadesse (1988) respectively, appear to be correlated with rainfall, peak in phytoplankton biomass and other associated factors Since O. niloticus is fast growing fish it can be cultured to produce large quantity of inexpensive animal protein. In spite of its importance, very little work has been done on the fishery and the resource is exploited without enough knowledge on its reproductive biology (Tadesse, 1999). Therefore, contributing information on the reproductive biology of O. niloticus can provide basic knowledge for the proper management of the resource. However, such basic information is non-existent for Lake Babogaya and this has hindered proper management of the fisheries.

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 O. niloticus in Lake Babogaya in particular. The specific objectives were to assess breeding season and condition factors of O. niloticus in the Lake.

MATERIALS AND METHODS

Study Area

This study took place at Lake Babogaya, a volcanic Crater Lake found in the vicinity of Beshoftu town in East Showa (Fig. 1). The Lake is a small, roughly circular and fairly deep, found at an altitude of 1,870 m and at about 9^0N latitude and 39^0E longitude (Prosser et al., 1968; Wood et al., 1984). Like the other volcanic crater lakes of the area, it is a closed system surrounded by very steep and rocky hills. The vertical distance from the lake's surface to the crater rim is 20 m, and this affords moderate protection from wind (Baxter, 2002) The lake is fed primarily by precipitation falling directly on its surface and run-off from its small catchment area (Prosser et al., 1968), which was formed from volcanic rocks of basalt, rhyolite and tuff (Mohr, 1961). Table 1 describes some morphological, physical and chemical characteristics of the Lake.

Mean monthly minimum air temperature ranged from 7.4 to 13.5^0C, while the maximum mean monthly air temperature varied from 22.8 to 31.5 ^{0}C. Monthly total rainfall varied from 2.1 mm of January 2006 to 239.5 mm of July 2006. Surface water temperature is generally between 22^0C and 24.5^0C, while the bottom temperature is almost constant (19.2^0C-19.4^0C) (Wood et al., 1984). In a recent study, Major (2006) reported that the water temperature and dissolved oxygen ranged from 23^0C to 27^0C and 7 mg l^{-1} to 14 mgl^{-1} respectively.

Field sampling and measurement

Samples of O. niloticus were collected monthly between September 2005 and August 2006 using gill net. Monthly sampling was done at two different sites of the lake. Harmeniawian house (site one), located about 20 m offshore at a depth of 3 to 12 m. ILRI (site two) is 3 to 7 m deep and 10 m away from the shore and have a relatively dense macrophyte around the shore. Gill net (8 and 10 cm stretched mesh size) of 50 m long each mesh size was set parallel to the vegetation. The gear was set in the afternoon (5 PM) and lifted the following morning (7 AM). In addition, fish caught by fishermen were also included in our sample to obtain a wide range of fish size group and increase the sample size. 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, and sex of each specimen was determined by pressing the abdomen and/or dissecting the gonads.

Table1: Morphological, physical and chemical characteristics of Lake Babogaya, Ethiopia.

Parameters	**Values**
Latitude	9^0N and 39^0E[d]
Altitude (m)	1870 [d]
Surface area (Km2)	0.58 [d]
Volume (Km^3)	0.022 [d]
Maximum depth (m)	71 [b]
Mean depth (m)	38 [d]
Conductivity, K_{25} (scm^{-1})	900[c]
Alkalinity (meq l^{-1})	10.2[b]
PH	9.2[b]
Salinity (gl^{-1})	0.9[b]
SiO^{-2} (meq l^{-1})	< .1[b]
Alkalinity (meq l^{-1})	10.80[b]
Na+ (meq l^{-1})	5.50[b]
Cl- (meq l^{-1})	0.90[b]
Sum of cations (meq l^{-1})	11.7[b]
Sum of anions (meq l^{-})	11.4[b]

, [0] Dégrée [b]Major, 2006;[c]Gebre-Mariam, 1994;[d]Prosser *et al*., 1968

Determination of breeding season

The breeding season of O.niloticus was determined from the percentage of fish with mature gonads sampled each month. The maturity stages of the gonads were determined by visual examination using maturity keys. A five-point maturity scale was used for this purpose (Holden & Raitt, 1974) and all examined maturity stages were recorded. Therefore, the breeding season of O. niloticus was determined based on the frequency of fish with ripe gonads and on Gonadosomatic index (GSI). The GSI for each fish was computed as the weight of the gonads as the percentage of the total body, as follows:

GSI = (GW/TW) X 100

Where, GW: Gonad weight in gram

TW: Total weight in gram

Determination of condition factor

Condition factor of the fish was determined by computing Fulton's condition factor as in Bagenal and Tesch (1978), as follows:

FCF = (TW / TL^3) X 100

Where, FCF = Fulton's condition factor

TW = total weight in grams

TL = total length in centimeter

Two ways ANOVA was employed to investigate differences in FCF between sampling months and sexes and to test the sex-by-month interaction (Sokal and Rohlf, 1981).

RESULTS

Size composition of the Sample

A total of 917 (565 female and 352 male) *O. niloticus* A total of 917 (565 female and 352 male) *O. niloticus* individuals were caught during the study. The total length of the fish ranged from 4 to 28 cm and the corresponding total weight ranged between 6 and 680 g for both sexes. As shown in figure 2, the greater proportion of the sampled fish for both sexes ranged in size between 14 and 22 cm. The peak was between 17 and 19 cm for both sexes. This length group alone was about 36% for females and 29% for males. Fish over 23 cm and below 10 cm TL were least represent in the sample (Fig.2).

Breeding Season

Mean gonadosomatic index (GSI) ranged from 0.7 – 3.5 for females and from 0.6 - 2.1 for males. GSI values varied highly significantly between sampling periods for both sexes (ANOVA, P < 0.001). Temporal variation in

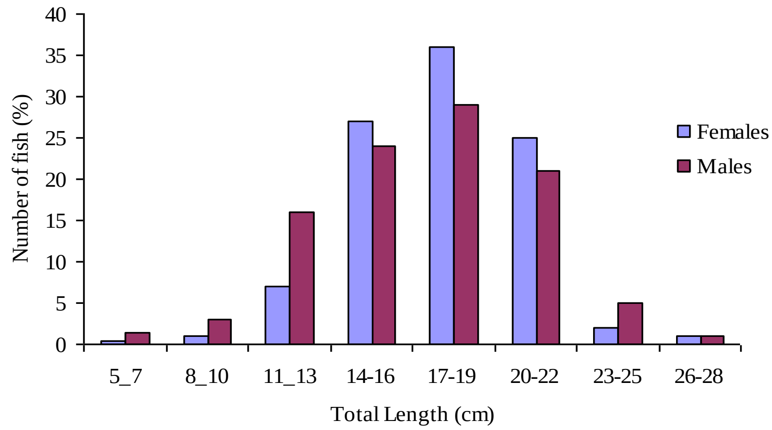

Figure 2. Length-frequency distribution of *O. niloticus* sampled in Lake Babogaya.

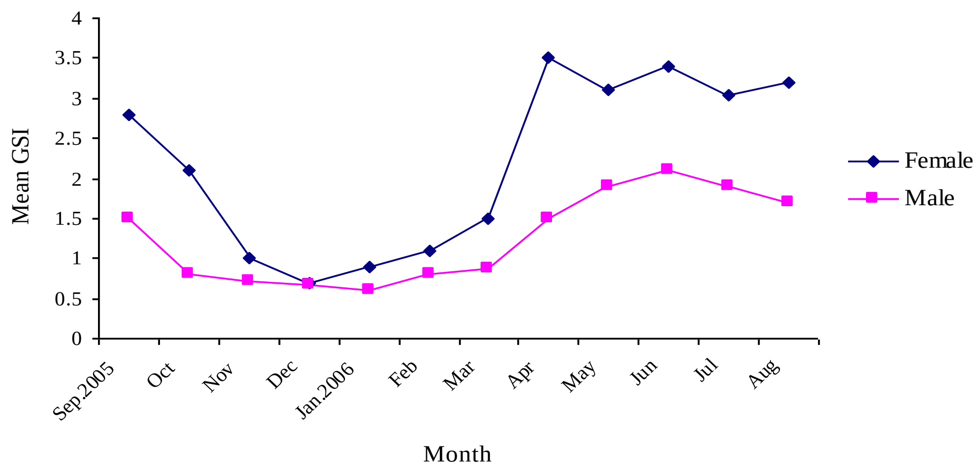

Figure 3. Temporal variation in gonadosomatic index (GSI) of *O. niloticus* from L. Babogaya**.**

GSI was remarkably similar between males and females (Fig. 3). Thus, there was a biannual cycle in which GSI increased from March peaking in April for females, and June for males (Fig. 3). GSI values were lower between October and February. The cycle in GSI was also reflected in monthly variation in the frequency of fish with ripe gonads (Fig. 3 and 4). The frequency was found to be high between April and August including September for both sexes (Fig. 4) which coincides with the periods of peak GSI values. In addition, lowest frequency of ripe fishes was recorded at times of lowest GSI values.

Condition Factor

Mean ± S.E. Fulton's condition factor (FCF) values ranged from 1.97 ± 0.06 in June to 2.39 ± 0.04 in January for females whereas from 1.86 ± 0.01 in July to 2.32 ± 0.04 in December for males. Average FCF (± SE) combined for the sexes were 2.13 ± 0.03; that of females was 2.17 ± 0.02 whereas that of males was 2.11 ± 0.04. FCF varied significantly between sampling months in both sexes (ANOVA, $P < 0.001$). However, sex-by-month interaction was not significant (ANOVA, $P > 0.05$).

DISCUSSION

In O. niloticus, seasonal variation in GSI and the percentage of ripe fish (Fig.3 and 4) were quite apparent and the pattern was more or less similar in both sexes. Indeed, fish with well developed gonads and ripe eggs

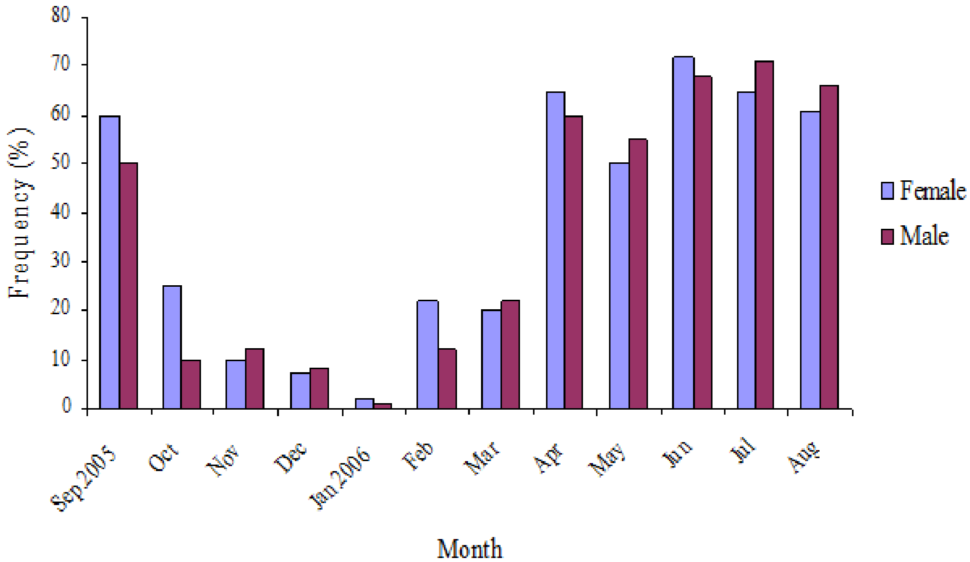

Figure 4. Temporal variation in frequency (%) of ripe female and male *O. niloticus* from Lake Babogay

were noted almost throughout the year. GSI values and percentage of ripe fish indicated that breeding in O. niloticus was year round peaking from April to August. Tadesse (1988) also reported that O. niloticus in Lake Zwai reproduces continuously throughout the year with a high peak of activity between December and March. The presence of individual breeding fish in Lake Babogaya at all time of the year may be partly attributed to the low seasonal fluctuations in temperature. Lowe-McCconnell (1982) also stated that in the tropics seasonal fluctuations in temperature and photoperiod are generally very low and this might be favorable for species to spawn at any time of the year.

The peak breeding activity of *O. niloticus* in L. Babogaya was coincident with the rainy season of the area (Fig 3). The role of rainfall in timing reproduction is well documented (Balarin and Hatton, 1979; Fryer and Iles, 1972; Lowe-McConnell, 1987). Rainfall, through associated biotic and abiotic factors, acts as a cue for tilapia to breed intensively, so that offspring are produced at times of better growth and survival (Lowe-McConnell, 1982). Rainfall might have the same role in the breeding cycle of *O. niloticus* in Lake Babogaya as well. Run off, for instance, could increase nutrients resulting in increased food availability, and improved quality of food (Admassu 1996; Jalabert and Zohar, 1982; Tadesse 1988).

Correlation between rainfall and peak spawning has also been reported for other tilapia populations in Ethiopia (Admassu, 1994, 1996; Tadesse, 1988, 1997; Teferi, 1997) and elsewhere (Fryer and Iles, 1972; Jalabert and Zohar, 1982; Lowe-McConnell, 1982; Stewart, 1988). These authors have variously suggested the above mentioned role of rainfall in *O. niloticus* breeding. Admassu (1996), for instance, reported that peak breeding of the fish in L. Awassa is coincident with rainfall and associated increase in phytoplankton biomass. In addition, the quality of the available food in the lake is believed to be improving during and immediately after the rains (Teferra, 1987). Furthermore; zooplankton biomass is likely to improve following those events. Mengistou and Fernando (1991) also showed an increase in the zooplankton biomass of Lake Awassa during the rainy season.

Condition factor are used to evaluate the well-being or fatness of fish and are based on the hypothesis that heavier fish of a given length are of best condition. The pattern of seasonal variation in Fulton condition factor of both sexes in *O. niloticus* was similar throughout the year. Condition factor of both sexes of *O. niloticus* in Lake Babogaya was significantly different (ANOVA, $P < 0.001$) in the different months. A study done on the related species in Lake Zwai by Tadesse (1988) also showed similar results. Numerous authors (LeCren, 1951; Teferra, 1987; Tadesse, 1988; 1997; 1999) agree that such variation could arise due to seasonal fluctuations in environmental factors, food supply and quality, feeding rate, degree of parasitization and reproductive activity. From the present study it was clear that poor body conditions conceded with peak breeding activity. Tadesse (1988) also reported that for the same species in Lake Zwai. This may indicate that production of sperms in males and eggs in females during breeding season may drain metabolic energy. Also engagement in breeding activity as well as parental care could possibly suppress somatic growth, as the fish devote less time for feeding during the breeding season. In conclusion, in Lake Babogaya *O. niloticus* breeds all year round with a high peak of activity between April and August and poor body conditions coincided with peak breeding months.

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