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Reproductive biology of *Oreochromis niloticus* in Lake Beseka, Ethiopia

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Reproductive biology of *Oreochromis niloticus* in Beseka was studied. Samples of *O. niloticus* were collected monthly during September 2010 to August 2011 using different centimeter mesh sizes of gillnets. The relationship between total length and total weight was curvilinear and sex ratio was different throughout the sampling periods. The 50% sexual maturity length (L_{50}) was estimated at 14 cm TL for females and 17 cm TL for males. Estimated fecundity was linearly related with total length and total weight of the fish. Absolute fecundity was estimated in number and range from 125 to 251 with a mean of 161 ± 2.5. The frequency of ripe gonads suggested that *O. niloticus* in Lake Beseka breeds throughout the year and intensive breeding coincided with the rainy seasons.

Key words: Breeding season, length-weight, *Oreochromis niloticus*, sex ratio, fecundity, Lake Beseka.

INTRODUCTION

A cheap source of protein is urgently required to support an ever increasing human population. Fishery resources definitely can offer one of the solutions to the problem of food shortage in a country like Ethiopia. Moreover, the Nile tilapia (*Oreochromis niloticus*) is the most preferred fish species in Ethiopia for human consumption and the demand has increased rapidly over the last few years.

Therefore, information on the breeding and fecundity of *O. niloticus* can provide basic knowledge for the proper management of the resource. However, such knowledge is not recently available for the species in the lake 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 ensure proper exploitation and management strategies on the Ethiopian fishery in general and *O. niloticus* in the lake in particular. The specific objectives were to assess breeding season and fecundity of *O. niloticus* in Lake Beseka in Ethiopia.

MATERIALS AND METHODS

Field sampling and measurement

Samples of *O. niloticus* were collected using gill nets monthly between September 2010 and August 2011 from different sites. The gear were set parallel to the shoreline in the afternoon (5:00 pm) and lifted in the following morning (7.00 am). Immediately after capture, total length (TL) and total weight (TW) of each specimen were measured to the nearest 0.1 cm and 0.1 g, respectively. The ripe ovaries were split longitudinally and turned inside out, to ensure the penetration of the preservative before they were stored in labeled jars. Finally, ripe ovaries were preserved in Gilson's fluid to estimate fecundity (Bagenal and Tesch, 1978). Preserved samples were then transported for further laboratory analysis.

Estimation of sex - ratio and length at maturity

The number of female and male *O. niloticus* caught was recorded for each sampling occasion. Sex-ratio (female : male) was then calculated for each month and total sample. The average length at

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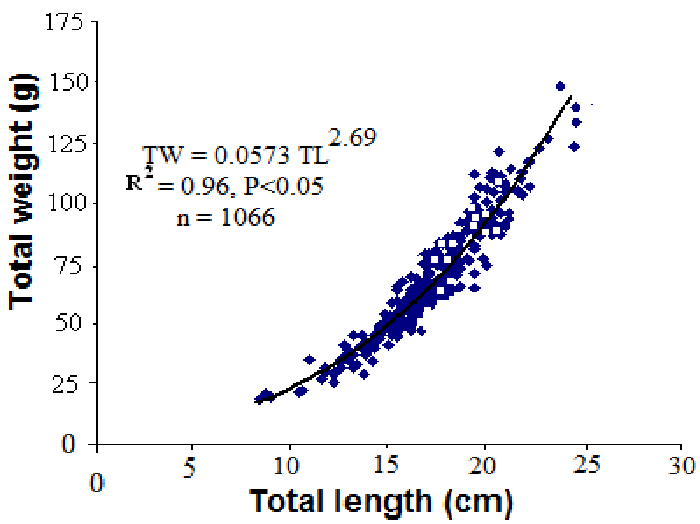

Figure 1. Length-weight relationship of *O.noloticus* in Lake Beseka.

Table 1. Number of females and males fish sampled in Lake Beseka.

Month	F	M	F:M
Sep. 2010	94	21	1:0.22
Oct	65	17	1:0.26
Nov.	57	22	1:0.39
Dec.	42	13	1:0.31
Jan. 1011	14	9	1:0.64
Feb.	17	11	1:0.06
Mar.	33	18	1:0.55
Apr.	45	22	1:0.49
May	66	29	1:0.44
Jun.	76	37	1:0.49
Jul.	120	44	1:0.37
Aug.	164	30	1:0.18
Total	793	273	1:0.34

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 *O. niloticus* with mature gonads were plotted against length to estimate L_{50} (Tweddle and Turner, 1977).

Determination of breeding season and fecundity estimation

The breeding season of *O. niloticus* was determined from monthly frequency of fish with ripe gonads. The ovaries were split longitudinally and turned inside out, to ensure the penetration of the preservative before they were stored in labeled jars (Bagenal and Tesch, 1978). Finally, ripe ovaries were preserved in Gilson's fluid to estimate fecundity (Simpson, 1959). The fecundity of ripe gonads preserved in Gilson's fluid was estimated gravimetrically. To estimate fecundity, the preservative was replaced with water, and the eggs were washed repeatedly, and decanting the supernatant.

Estimated fecundity was then obtained by weighing the entire eggs, and two sub-samples were taken and counted, each of which were all similarly, dried. The eggs were visually counted and weighed using a sensitive balance (ACB plus-3000g). The total number (N) was computed using the following ratio:

$$N/n = W/w$$

Where, N = unknown total number of eggs; n = number counted in sub sample (1000); W = weight of all eggs (g); w = weight of the sub sample (g)

Least squares regression was then used to find the relationship between fecundity and total length, total weight and gonad weight (Admassu, 1994).

RESULTS

Length-weight relationship of the fish

The length-weight relationship of *O. niloticus* in Lake Beseka was curvilinear and statistically highly significant (P<0.05) (Figure 1). The equations separated by sex were as follows:

Males: $TW = 0.0124 \times TL^{2.61}$, $R^2 = 0.631$, n = 273
Females: $TW = 0.0141 \times TL^{2.73}$, $R^2 = 0.709$, n = 793

Therefore, an equation combined for both sexes was fitted and shown in Figure 1. The equation was for fish ranging in length from 8 to 25 cm, and in total weight from 18 to 149 g. The slope (b = 2.69) was close to the theoretical value of 3.

Sex ratio and Length at maturity

Sex ratio results are presented in Table 1. The ratio was different for all sampling months and total sample. Females numerically outnumbered males in all sampling periods.

The smallest sexually mature fish that was caught in this study was a female fish of 6 cm TL and a male fish of 7 cm TL. The 50% maturity length (L_{50}) was estimated to be 14 cm TL for females (Figure 2) and 17 cm TL for males (Figure 2). On the average, females appeared to attain sexual maturity at a relatively smaller size than males.

Breeding season

The frequency of temporal variation between ripe males and females was similar. The frequency was found to be high from September (2010), March to April and August (2011) (Figure 3). The lowest frequency of ripe fishes was recorded at time between October and February,

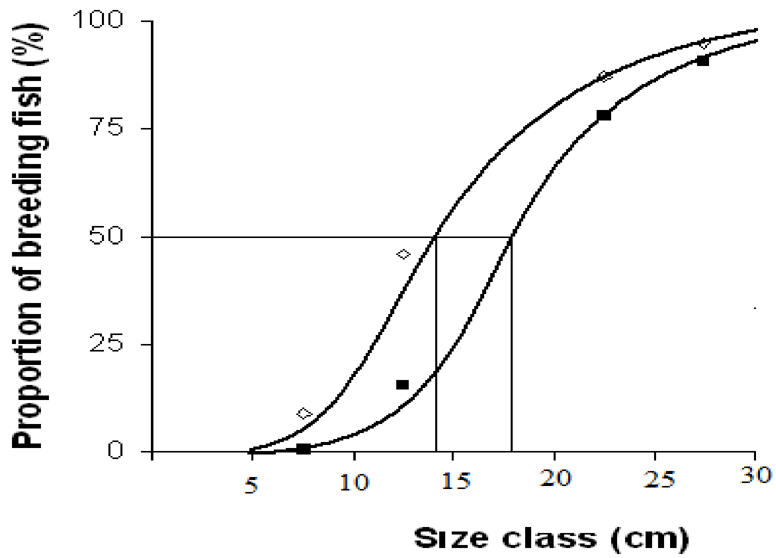

Figure 2. The proportion of size at L_{50} maturity of males (•) and females (◊) in Lake Beseka.

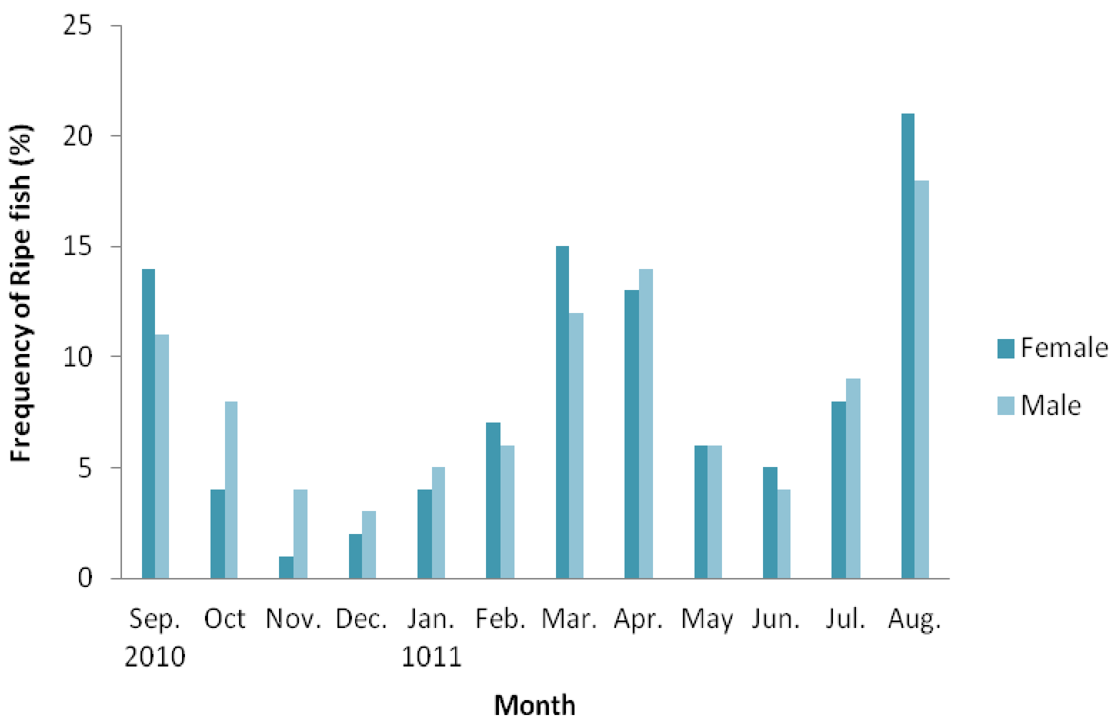

Figure 3. Temporal variation in frequency (%) of ripe female and male *O. noloticus* in Lake Beseka.

and May to July.

Fecundity estimation

A total of 37 ripe female were used for fecundity estimation. Their total length and total weight ranged from 12 to 25 cm and 26 to 149 g, respectively. The number of eggs per individual ranged from 125-351 with a mean of 261 ± 2.5. Fecundity was linearly related to total length and total weight (Figures 4 and 5).

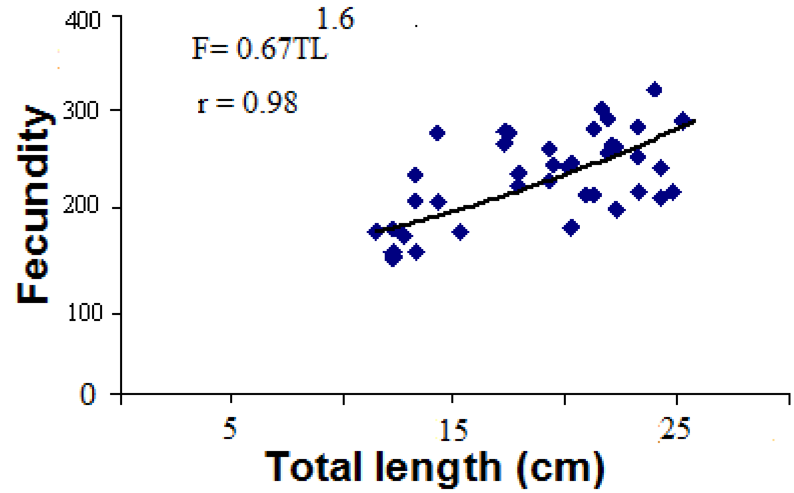

Figure 4. Relationship between fecundity and total length of *O. niloticus* in Lake Beseka.

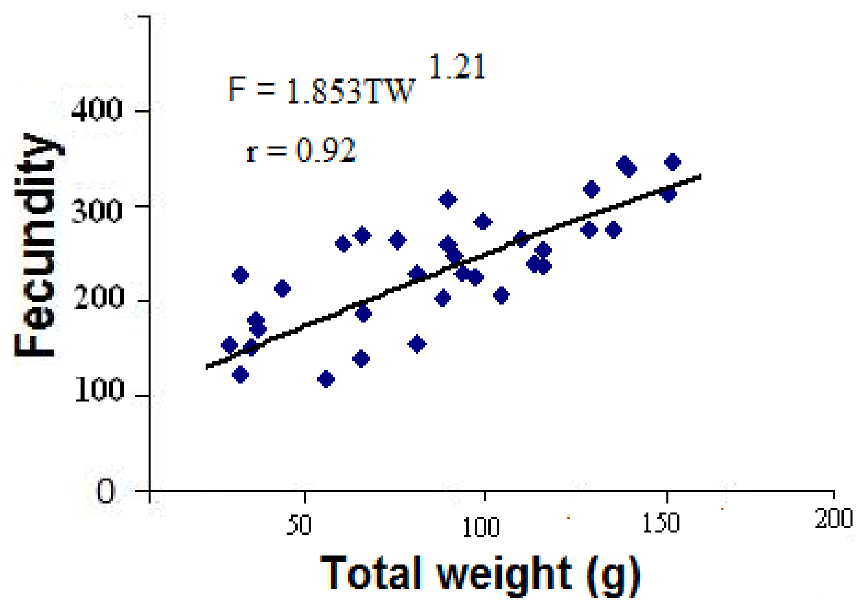

Figure 5. Relationship between fecundity and total weight of *O. niloticus* in Lake Beseka.

DISCUSSION

The largest fish caught in the present study was 25 cm (TL) which was smaller than Lake Babogaya (28 cm) (Lemma, 2012). There were a curvilinear relationship between total length and total weight of the fish in the lake (Figure 1). The value of b (2.69) was close to the theoretical value (b = 3), indicating isometric growth. These finding are in agreement with the principle of fish growth (Bagenel and Tesch, 1978). The study showed that an unbalanced sex ratio existed for samples taken throughout the sampling period. The unbalanced sex ratio found in the present study is difficult to explain. Probably, it could be attributed to behavioral differences between the sexes, which might have made females more vulnerable and passive to fishing gears such as gill nets. The preponderance of females has been attributed to sexual segregation during spawning, activity differences, gear type and fishing site (Admassu, 1994). Hence, further study is required to see if the same factors could be responsible for sex ratio results for *O. niloticus* in the current study.

The size of 50% sexual maturity of the fish in this study was smaller than values estimated for the same species in Lake Awassa and Zwai. Length of maturity in many fish species depends on demographic conditions, and is determined by genes and the environment (Fryer and Iles, 1972; Lowe-McConnell, 1987). Generally, fish in poor condition mature at smaller size than those in good condition (Lowe-McConnell, 1958, 1959, 1987).

Intensive breeding activity of the fish in Lake Babogaya was coincident with the rainy season. Thus, rainfall and associated factors like temperature may act as cues for spawning by the fish so that offspring are produced at a time of better growth and survival. The role of rainfall in fish spawning is well documented (Fryer and Iles, 1972; Balarin and Hatton, 1979; Lowe-McConnell, 1982). Runoff, for instance, results in increased nutrient concentrations which in turn result in improved food quantity and quality (Jalabert and Zohar, 1982; Tadesse, 1988; Admassu, 1996). A correlation between rainfall and peak breeding activity has also been reported for different species (Dadebo, 1988) and other species (Tadesse, 1988; 1997; Admassu, 1994; 1996; Teferi, 1997) in Ethiopia, and elsewhere (Fryer and Iles, 1972; Jalabert and Zohar, 1982; Lowe-McConnell, 1982; Stewart, 1988) for the same species.

Fecundity in the current study was slightly lower than the same species in different water bodies of the country. This could be due to its lower body condition and growth as compared to the species in the other lakes. Fish in poor body condition are reported to have less fecundity than those in better condition (Lowe-McConnell, 1959). Even though this study has baseline information for the proper utilization of the resources further detailed studies are required on other biological aspects (growth, mortality, feeding habits, etc) of the fish, as well as on the limnology of the lake in general.

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