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LENGTH-WEIGHT RELATIONSHIP, BODY CONDITION AND SEX RATIO OF TILAPIA (*OREOCHROMIS NILOTICUS* L.) IN LAKE CHAMO, ETHIOPIA

Yirgaw Teferi [1] and Demeke Admassu [2]

[1] National Fisheries and Other Aquatic Resources Research Center (NFLARR), Ethiopian Agricultural Research Organization (EARO), PO Box 64, Sebeta, Ethiopia

[2] Department of Biology, Faculty of Science, Addis Ababa University PO Box 1176, Addis Ababa, Ethiopia

ABSTRACT:. The length-weight relationship of 1429 fish ranging in size from 120 to 610 mm Total Length (TL) and from 36 to 4800 g Total Weight (TW) was computed based on monthly samples collected between March 1996 and March 1997. The relationship between total length and total weight for both sexes was curvilinear and statistically significant. The regression equation for the females was $TW=0.0225TL^{2.97}$ $r^2=0.98$, $P<0.05$ and that for the males was $TW=0.0211TL^{2.99}$ $r^2=0.98$, $P<0.05$. There was a significant variation in the mean monthly condition factor of both sexes (ANOVA, $P<0.05$). The mean ± SE Fulton's condition factor ranged from 2.10 ± 0.03 to 2.35 ± 0.10 for the males, from 1.96 ± 0.03 to 2.1 ± 0.04 for the females. Sex ratio of *O. niloticus* was not significantly different from 1:1 in the total samples. However, numerically females were significantly more ($P<0.05$) in number than males in samples taken between March and May whereas males dominate in samples taken between October and February. There was also a significant variation in sex ratio in samples of fish larger than 400 mm TL and dominated by males ($P<0.05$). However, sex ratio did not deviate significantly from the theoretical ratio 1:1 ($P>0.05$) in samples of fish less than 400 mm TL.

Key words/phrases: body condition, Ethiopia, length-weight relationship, *Oreochromis niloticus*, sex ratio

INTRODUCTION

Knowledge of the condition factor of fish is often a necessary prerequisite to a demographic analysis of a fish population (Demeke Admassu, 1990). This is so, because, the condition factor displays a considerable variation between species and for the same species with time, sex and age (Bagenal and Tesch, 1978). Condition factor may also indicate the feeding activities of fish overtime, and hence indirectly measures the well being of the fish (Le Cren, 1951; Bagenal and Tesch, 1978). Furthermore, length of sexual maturity of tilapia depends on the condition of the fish. *O. niloticus* individuals that are

in poor body condition start to breed at smaller size than those in good condition (Balarin and Hatton, 1979).

Therefore, parameters like length-weight relationship and condition factor (C.F.) of fish have been utilized in many kinds of fish population analyses (Le Cren, 1951). Such studies have been conducted in Lakes Zwai, Langeno, Awassa and Tana (Zenebe Tadesse, 1988; 1997; 1998; Demeke Admassu, 1990). However, such relevant information is not available for the fish in Lake Chamo. The present study was, therefore, conducted to examine the condition, length-weight relationship and sex ratio of *O. niloticus* in Lake Chamo.

Detail information on the study area is provided in Zenebe Tadesse (1998), Demeke Admassu (1998) and Yirgaw Teferi *et al.* (2000).

MATERIALS AND METHODS

A total of 1429 samples of *O. niloticus* ranging in length from 120 to 610 mm total length (TL) and from 36 to 4800 g total weight (TW) were collected between March 1996 and March 1997 using gillnets (120, 140, 200 and 240 mm, stretched mesh) and beach seine net (20 mm mesh size). Total length, total weight and sex of each specimen were recorded.

Length-weight relationship for both sexes was calculated separately using least squares regression analysis (Bagenal and Tesch, 1978). Body condition of both sexes was also determined separately by calculating Fulton's and relative condition factor (Le Cren, 1951; Bagenal and Tesch, 1978). Fulton's and relative condition factor for each fish and average values for each month were calculated using the formulae below and statistically tested (One way ANOVA).

$$\text{Fulton's condition factor} = TL/TW^3 \times 100$$
$$\text{Relative Condition Factor} = TL/aTW^b$$

where a and b are intercept and slope of the length-weight regression equation, respectively.

Length frequency (%) of the fish caught during this study was determined after classifying the data into six TL groups of 100 mm width. Mid-point of length class (TL mm) was used to determine the length frequency composition of both sexes. Sex ratio (female to male) was also determined for various size classes of fish and then statistically tested (Chi-square) if it varied seasonally and with fish length.

RESULT

The relationship between total length and total weight of *O. niloticus* in Lake Chamo was curvilinear and statistically significant (r^2=0.98, P<0.05) (Fig. 1). The regression equation for the females (n=689) was $TW=0.0225TL^{2.97}$, r=0.99 and that for the males (n=740) was $TW=0.0211TL^{2.99}$, r=0.99.

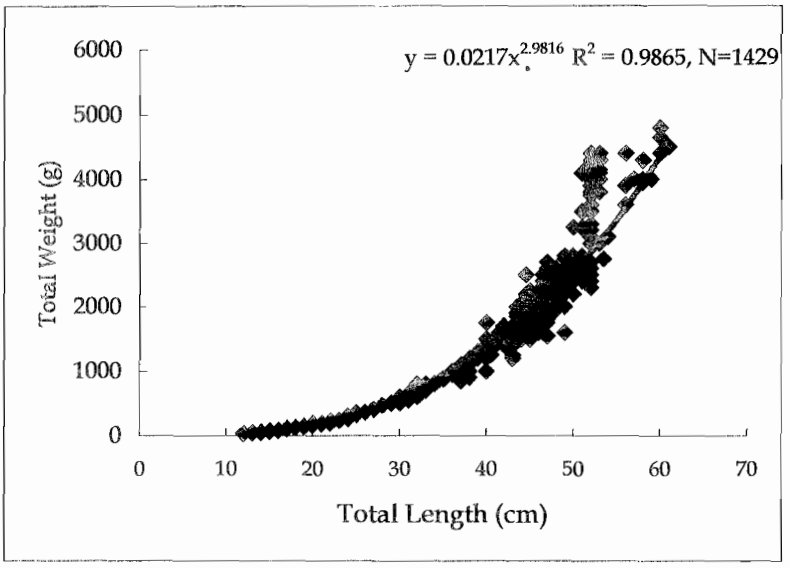

Fig. 1. Length-weight relationship of *O. niloticus* in Lake Chamo.

Fulton's condition factor (mean ± SE) of females *O. niloticus* in Lake Chamo ranged from 1.96 ± 0.03 to 2.10 ± 0.04 whereas that of males ranged from 2.10 ± 0.03 to 2.35 ± 0.10 (Fig. 2-a). Relative condition factor of females ranged from 0.94 ± 0.01 to 1.01 ± 0.02 whereas that of males ranged from 1.02 ± 0.01 to 1.13 ± 0.06 (Fig. 2-b). There was a significant variation in the mean monthly Fulton's and relative condition factor for both sexes (ANOVA, P<0.05). The condition factor of the males declined from March to May and also from October to January, but a rapid increase was observed from January to March. There was also a gradual increase from May to July (Fig. 2-a&b). The condition of the females was lower from May to July and from October to December, but higher between July and October (Fig. 2-a&b). Therefore, seasonal variation in the condition factor of the females also followed a similar pattern to that in the males except in June and July. The condition factor of the males was higher in these months but not in the females. In addition, it was observed that the males showed a rapid rate of decrease in condition factor from March to May.

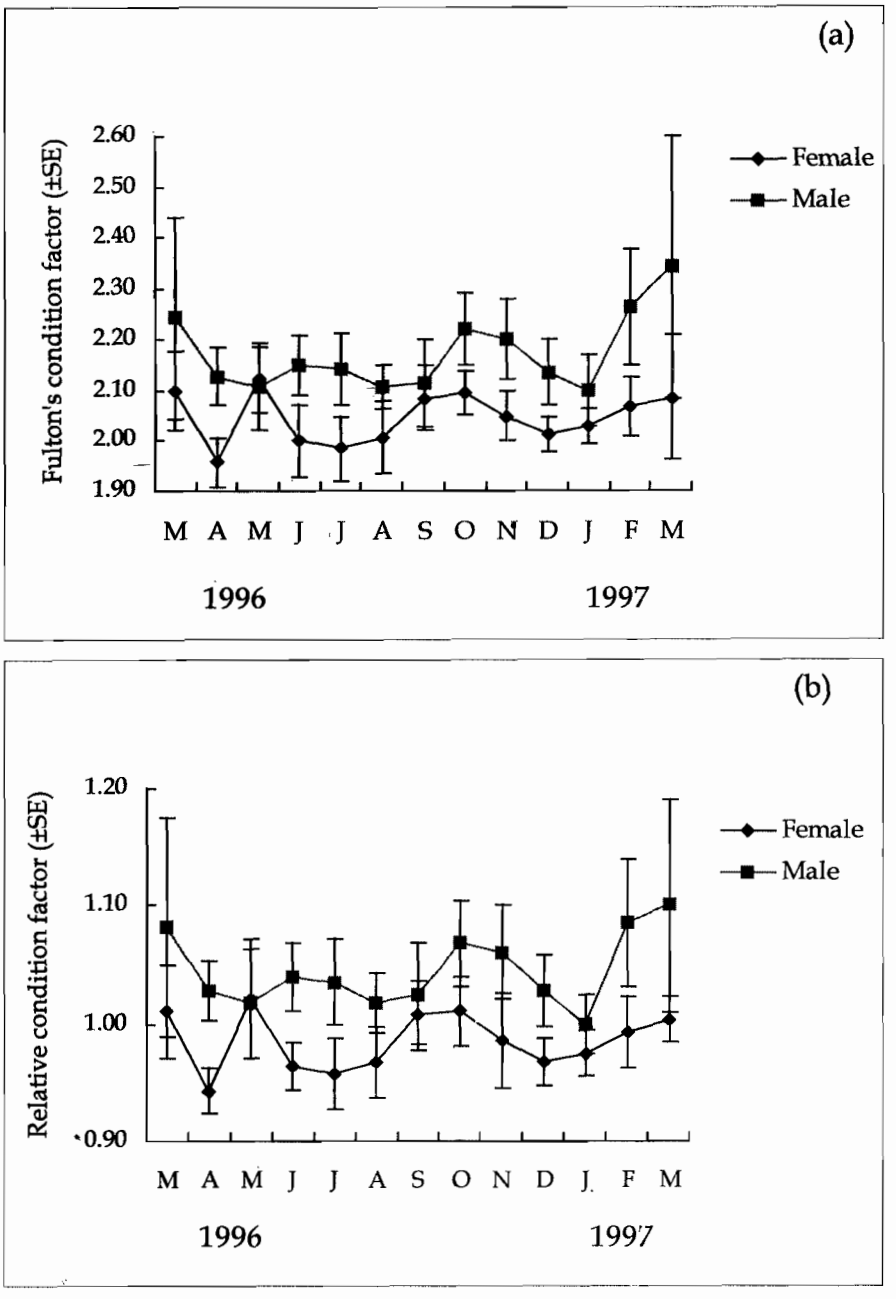

Fig. 2. Fulton's condition factor (a) and relative condition factor (b) of *O. niloticus* in Lake Chamo (values are mean ±SE).

Of 1429 individual *O. niloticus* caught during this study, 689 (48%) were females and 740 (52 %) were males. The size of fish ranged from 120 to 610 mm TL and from 36 to 4800 g TW. The largest female caught was 580 mm TL and the heaviest was 3950 g (TL = 570 mm). In contrast the largest male caught was 610 mm TL and the heaviest was 4800 g (TL=600 mm). In general, males were larger in length and heavier in weight than females in the samples collected during the study periods.

The total ratio of females to males was 1:1.07 (Table 1), which did not deviate significantly from the theoretical ratio of 1:1 (P>0.05). Females were significantly greater (P< 0.05) in number than males in the samples taken during March, April and May whereas males dominate in samples taken between October and February. However, the sexes were equally frequent in the samples taken in the other months as well as in the total sample. Sex ratio was also calculated after grouping the data into various length classes. There was a significant variation in sex ratio only in fish greater than or equal to 400 mm TL (Table 2).

Table 1. Number and sex ratio (female: male) of *O. niloticus* in Lake Chamo.

Month	Female	Male	Sex ratio (F:M)	P-value (Chi-square)
M, 1996	55	34	1:0.62	0.03*
A	101	63	1:0.60	0.00*
M	84	55	1:0.65	0.01*
J	65	53	1:0.82	0.27
J	41	54	1:1.30	0.18
A	50	50	1:1.00	1.00
S	50	37	1:0.74	0.16
O	33	55	1:1.67	0.02*
N	42	70	1:1.67	0.01*
D	37	65	1:1.76	0.01*
Jan, 1997	57	103	1:1.81	0.00*
F	34	80	1:2.35	0.00*
M	40	21	1:0.53	0.01
Total	**689**	**740**	**1:1.07**	**0.18**

*** Significant, P<0.05**

Table 2. Number of length groups (TL) and sex ratio (female: male) of *O. niloticus* in Lake Chamo.

Length group (mm)	Female	Male	Sex ratio (F:M)	P-value (Chi-square)
100–199	24	28	1:1.17	0.58
200–299	14	12	1:0.86	0.69
300–399	36	40	1:1.11	0.65
400–499	451	540	1:1.20	0.00*
500–599	164	118	1:0.72	0.01*
>600	0	2		0.16
Total	**689**	**740**	**1:1.07**	**0.18**

* =Significant at 5% level, P<0.05

DISCUSSION

There was a curvilinear relationship between total weight and total length in *O. niloticus* in Lake Chamo. Total length and total weight in *O. niloticus* in Lakes Zwai, Awassa and Tana were also related in a curvilinear fashion (Zenebe Tadesse, 1988; 1997; Demeke Admassu, 1990). The regression coefficient obtained in the present study was near the cube value (b=2.97 for females, b=2.99 for males). This finding is in agreement with the theoretical 'cube law' suggested by Allen (1938 cited in Demeke Admassu, 1990). Thus, the fish may grow isometrically; that is, increase in weight at a rate approximately equal to the cube of increase in length. *O. niloticus* from Lakes Zwai, Awassa and Tana was found to have a regression coefficient of 3.03 (Zenebe Tadesse, 1988), 2.90 (Demeke Admassu, 1990) and 2.74 (Zenebe Tadesse, 1997), respectively. These values are roughly similar to the coefficient obtained in this study.

The value of mean Fulton s condition factor of *O. niloticus* in Lake Chamo (2.35) is much superior to either Lakes Langano (C.F = 1.67), Zwai (C.F.= 1.89), Tana (1.90) or Awassa (C.F. = 2.03) (Zenebe Tadesse, 1988; Eyualem Abebe and Getachew Teferra, 1992). *O. niloticus* grows faster in Lake Chamo than in most other lakes in Ethiopia (Demeke Admassu, 1998). In most lakes, *O. niloticus* reaches a maximum weight of *ca* 1-kg but in Lake Chamo the average weight is around three times higher. The largest fish caught in this study was over 600 mm TL and about 5 kg TW, which is the largest tilapia so far recorded in Ethiopian inland waters. One of the reasons for the better growth performance and high body condition of *O. niloticus* in Lake Chamo could be related to the phytoplankton community composition which differs from that in other lakes (Zenebe Tadesse, 1998; Yirgaw Teferi *et al.*, 2000). As the fish in Lake Chamo are supplied with good quality food (highly digestible), they may grow relatively rapidly (Zenebe Tadesse, 1998). The high water temperature of 25° C throughout the year in Lake Chamo is conducive for the fish to digest and absorb food more efficiently than fish in other cooler lakes (Getachew Teferra, 1993). Therefore, the excellent body condition and better growth performance of *O. niloticus* in Lake Chamo is very likely the compounded effect of both food quality and food quantity. The high water temperature of the lake all year round also promotes feeding rate and conversion efficiency.

There was significant seasonal variation (ANOVA, $P<0.01$) in Fulton's and relative condition of *O. niloticus* in Lake Chamo. The pattern of seasonal fluctuation in Fulton's and relative condition factor of both sexes was similar throughout the year except in the months of June and July. The condition of female *O. niloticus* in Lake Chamo was significantly low in June and July (ANOVA, $P< 0.01$). Condition of fish can be affected by factors such as the environment, food supply, food quality, feeding rate, degree of parasitization and reproductive activity (Bowen, 1979; Getachew Teferra, 1987; Teshima *et*

al., 1987). *O. niloticus* in Lake Chamo reproduces throughout the year with a peak between March and June. During this period the fish spends most of its energy for reproduction (Demeke Admassu, 1990; 1998; Yirgaw Teferi *et al.*, 2001). Furthermore, maternal mouth brooders, like *O. niloticus*, females fast during the early stages and probably often throughout the brooding period (Fryer and Iles, 1972). Starvation during spawning will have a significant effect on the condition of the female fish. Thus, the poor condition of the females in June and July is likely to be a result of high reproductive activity during the preceding months in which the fish were intensively breeding.

There was significant change in sex ratio of *O. niloticus* in the samples caught between October and May. Females dominate in samples taken between March and June, which coincided with the spawning season. More females were also caught in September. On the other hand, males dominate the catch taken between October and February. This may be explained by differences in the spawning behavior of the fish (Fryer and Iles, 1972). The males build and guard spawning grounds where they court several females. The females move to this area for fertilization, and then move with their brood to the brooding sites (Lowe - McConnell, 1958). Therefore, males stay longer in the bottom while females are mostly active and stay near the water surface. Hence, during the spawning seasons, females are more likely to be caught in passive gears such as gill nets than males. A similar phenomenon has been observed for *O. niloticus* in Lake Awassa (Demeke Admassu, 1994). The present study has also observed a significant variation in sex ratio only in fish greater than or equal to 400 mm TL. The number of fish greater than 400 mm TL was significantly dominated by males.

Generally, *O. niloticus* in Lake Chamo is found to be in a better body condition than the same species found in other rift valley lakes of the country.

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