ISSN NO. 2320-5407

Journal homepage: http://www.journalijar.com

INTERNATIONAL JOURNAL OF ADVANCED RESEARCH

RESEARCH ARTICLE

Composition of commercially important fish species and some perspectives into the biology of the African Catfish *Clarias gariepinus* (Burchell), Lake Ziway, Ethiopia

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Manuscript Info

Manuscript History:

Received: 11 November 2013
Final Accepted: 29 December 2013
Published Online: January 2014

Key words:
Commercially important fish species, Lake Ziway, Length-weight relationship, Reproductive biology, Ethiopia

Abstract

Composition of commercially important fish species as well as some aspects of the biology; sex ratio and length weight relationship of *Clarias gariepinus* in Lake Ziway was studied. Lake Ziway is located in the Great East African Rift Valley of Ethiopia. Samples of *Oreochromis niloticus, Clarias gariepinus, Carassius carassius, Cyprinus carpio* and *Labeobarbus intermedius* were collected monthly between January and April, 2013 using longline and gillnets of various mesh sizes. *Clarias gariepinus* was the second most dominant species which comprises 24 % of the catch next to *Oreochromis niloticus* (31 %) while *Labeobarbus intermedius* constituted only 4% of the catch. *I*n all cases, except for *Labeobarbus intermedius,* there was a preponderance of females over males. However, sex ratio was not significantly different from 1:1. Estimated fecundity of *Clarias gariepinus*, which was linearly related with fish and gonad sizes ranged from 443 to 1301 eggs per gram with a mean of 972. Absolute fecundity was estimated within a range of 10,000 to 560,000 eggs with a mean of 151,741. The relationship between total length of (23 to 80 cm) and total weight (165 to 6500 g) of *Clarias gariepinus* was curvilinear and represented as $TW = 0.065\ TL^{2.83}$, $R^2 = 0.91$, $P < 0.05$.

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, 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.

According to Getahun (2005) there are about 38 species and two sub-species endemic to Ethiopia. Lake Tana from Abay drainage basin exclusively has larger number of endemic species in the country (Getahun, 2005). According to Golubtsov and Mina (2003) the total numbers of valid fish species known from Ethiopian inland water bodies is about 168 to 183 including 37-57 country wide endemics. There are also about 10 exotic fish species introduced from abroad into Ethiopian freshwaters (Tedla and H/Meskel, 1981). The Rift valley is the region with highest number of introduced fish species. At this moment, results of various studies indicate that the number of species could increase to 200 and above (JERBE, 2007).

Therefore, though some stocks show signs of overfishing, the fishery could be expanded so that it can contribute to food security and the economy. Such an opportunity is provided by Lake Ziway; one of the Ethiopian Rift Valley lakes. Lake Ziway harbors the African catfish, *Clarias gariepinus*, and other commercially important fish species (*Oreochromis niloticus*, *Carassius carassius, Cyprinus carpio* and *Labeobarbus intermedius*), in which some are native and others exotic that were introduced into the lake by the Ministry of Agriculture with the aim of fishery development.

C. gariepinus is a widely distributed species, and contributes greatly to the fishery of Africa (Willoughby and Tweddle, 1978; Viveen *et al*. 1986) and Ethiopia (Tedla, 1973; Tadesse, 1998). In Ethiopia, it is believed to occur almost in all water bodies containing fish (Tedla, 1973), and about 95 % of the fish catch of Ethiopian fishery is due to *O. niloticus*, *C. gariepinus* and different species of Barbs (Tadesse, 1998). Therefore, *C. gariepinus* is both ecologically and economically among the most important fishes in Ethiopia. Hence, knowledge on its biology, such as reproduction, would have significant importance for the development of the fishery. However, currently lack of such knowledge for Lake Ziway hinders rational exploitation of the resources and the intention of making a study on the lake is to assess the composition and sex ratio of commercially important fish species of the lake, and to estimate length-weight relationship of *Clarias gariepinus.*

METHDOLOGY

Study Area

Lake Ziway is found in the Great East African Rift Valley Lakes of Ethiopia. It has an open water area of 434 km^2, average depth of 2.5 m, and an elevation of 1636 m.a.s.l. The Ziway Watershed falls in between 7°15'N to 8°30'N latitude and 38°E to 39°30'E longitude covering a total area of about 7300 km^2 (Fig. 1). It is composed of two main rivers, Meki and Katar, flowing into the lake and one river, Bulbula, flowing out of the lake. The climate is characterized by semi-arid to sub-humid with mean annual precipitation and temperature of 650 mm and 25°C, respectively.

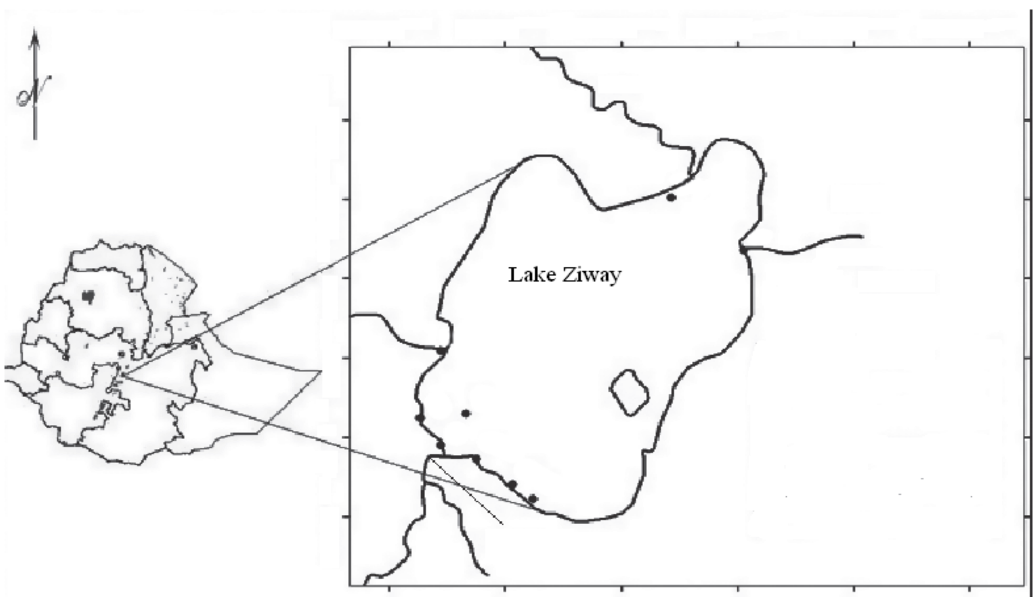

Fig. 1: Map of Lake Ziway

Sampling site and sample collection

Sampling sites were grouped into the following areas: Site A (South Part of the Lake; around Sher Flower Farm); Site B (Bulbula River Mouth); Site C (East Part of the Lake; around Yerera (Tulu Gudo Island); Site D (Katare River Mouth); and Site E (Meki River Mouth). Samples were collected monthly between January and April, 2013.

Sampling sites were selected based on geographical proximity and/or habitat similarity (river mouths neighboring floodplains, depth and distance to shore). In each sampling site fishing was conducted using different mesh sizes of gillnets (6 cm, 8 cm, 10 cm, 12 cm and 14 cm stretched mesh). In addition, longline of number nine were set in parallel to the gill net in all sampling sites. All gears were set parallel to the shoreline in the afternoon (05:00 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 0.1g, respectively. Gonad weight of *C. gariepinus* was measured for fecundity study. Finally the samples were put in plastic jars containing 10 % formalin and labeled with all necessary information. The specimens were transported to Ziway Fisheries Resource Research Center for further identifications.

Data analysis

The data collected were entered into SPSS software program Windows version 19, to analyze species composition, sex-ratio, Length-weight relationship and the relationship between fecundity and total length, total weight and gonad weight.

I. Estimation of sex-ratio

Both female and male fishes were recorded for each sampling occasion. Sex-ratio (female: male) was then calculated for the total sample. Chi-square test was employed to test if sex ratio varied from one - to - one in the total sample as in Admassu (1994).

II. Length-weight relationship

The relationship between total length and total weight of the selected species (*C. gariepinus*) was calculated using power functions as in Bagenal and Tesch (1978) as follows:

$TW = aTL^b$

Where: TW = Total weight (gm)

TL= Total length (cm)

a = Intercept of the regression line

b = Slope of the regression line

III. Fecundity estimation

The fecundity of ripe gonads preserved in Gilson's fluid was estimated gravimetrically (Simpson, 1959). To estimate fecundity the preservative was replaced with water and the eggs were washed repeatedly, decanting the supernatant.

The fecundity estimate was then obtained by weighing the entire eggs, and two sub-samples of 1000 eggs, each of which were all similarly, dried. The eggs were counted and weighed using a sensitive balance (ACB plus-3000g). The total number 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 AND DISCUSSION

Fish capture from the sampling sites

Five fish species of commercial importance were collected from the study sites. The species collected were: *Oreochromis niloticus*, *Clarias gariepinus*, *Carassius carassius* *Cyprinus carpio* and *Labeobarbus intermedius* (Table.1).

These species were included in the families *Cichlidae*, *Cyprinidae* and *Clariidae*. Among these family *Cichlidae* and *Clariidae* were collected from all sampling sites and from the family *Cyprinidae* only *Labeobarbus intermedius* was found at the two sites; B and D (Table 1).

Table 1. Fish species caught in the Lake (Av - Available, NA - Not available).

Family	Species	Site				
		A	C	D	B	E
Cichlidae	*Oreochromis niloticus*	Av	Av	Av	Av	Av
Cyprinidae	*Labeobarbus intermedius*	NA	NA	Av	Av	NA
	Cyprinus carpio	Av	Av	Av	Av	Av
	Carassius carassius	Av	Av	Av	Av	Av
Clariidae	*Clarias gariepinus*	Av	Av	Av	Av	Av

Composition of fishes in the lake

A total of 685 different fish specimens were collected from different sampling sites. *Clarias gariepinus* was the second dominant species which accounts 24 % next to *Oreochromis niloticus* (31 %). *Cyprinus carpio, Carassius carassius and Labeobarbus intermedius constituted 23, 18 and 4%, respectively* (Fig. 2).

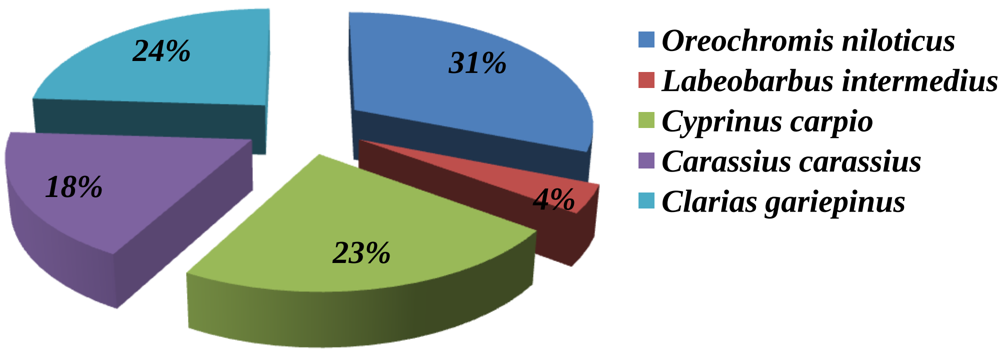

Fig.3: Fish species composition (%) in the lake

The catch proportion of the fishes in the lake has declined as compared to the previous catch (Deraro Horra, Personal communication). This is due to the fact that there were different pressures on the lake that affect the production of fishes. In Ethiopia there has been a great increase in the extent of irrigation schemes in recent years (Getahun and Stiassny, 1998). Water is being removed directly from the lakes and/or diverted from rivers that feed the lakes. This has created considerable water level declines in several Rift Valley Lakes (e.g. L. Ziway) which damaged the breeding grounds of fish species that spawn in shallow parts of the lakes, such as Nile tilapia (*O.niloticus*) (Gebre-Mariam and Dadebo, 1989) and this has caused reduced tilapia stocks in L. Ziway (Gebre-Mariam, 2002).

Sex ratio of the fishes

Table 3, below, shows the total number of fishes caught by species and sex and the ratios of each. Except in *L. intermedius* species, in all the other species females seem to be more numerous than males but statistically the ratio was not significantly different from 1:1 (Chi-square, P > 0.05). The overall sex ratio (1.25:1) was significantly different from 1:1 showing a preponderance of females (Table 2).

Table 2. Number of females, males and the corresponding sex ratios of the fishes in the lake

	Species	Total	F	M	Sex-ratio	X^2
Cichlidae	*Oreochromis niloticus*	214	121	93	1.30 : 1	3.664
Cyprinidae	*Labeobarbus intermedius*	27	11	16	0.06 : 1	1.364
	Cyprinus carpio	156	89	67	1.33 : 1	3.103
	Carassius carassius	123	68	55	1.26 : 1	1.374
Clariidae	*Clarias gariepinus*	165	91	74	1.23 : 1	1.973
	Total Catch	685	380	305	1.25 : 1	8.212

Hence, in this the result is not similar to the result for the same species in Lake Langeno (Teka, 2001). Unbalanced sex ratio for Lake Langeno was attributable to behavioral differences between the sexes, making females more vulnerable to gears such as gill nets and long-line (Teka, 2001). Although for *O. niloticus*, 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 by collecting long period data in relation to seasons and gears to see if the same factors could be responsible for sex ratio results of *C. gariepinus*in Lake Ziway.

Length-Weight relationship for *C. gariepinus*

The Length-weight relationship of *C. gariepinus* in Lake Ziway was curvilinear and statistically highly significant ($P < 0.05$). The equation of both sexes was as follows.

$TW = 0.065 \text{ X } TL^{2.83}$, $R^2 = 0.91$, n = 135

Therefore, an equation combined for sexes was fitted and shown in Fig. 3. The equation was for fish ranging in length from 23 to 80 cm, and in total weight from 165 to 6500 g. The slope (b=2.83) was close to the theoretical value of 3.

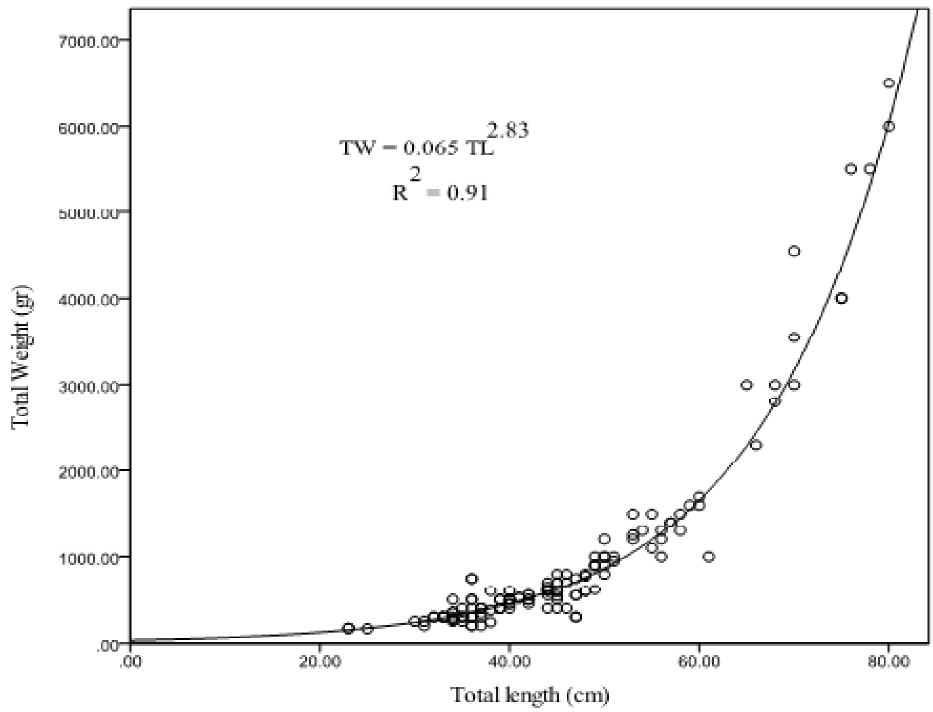

Fig.3: Length-weight relationship of *C. gariepinus* in Lake Ziway

Evidence obtained by using length-weight equations fitted in the present study and that by Dadebo (1988) and Teka (2001), a 30 cm fish length, *C. gariepinus* would be 190 g in L. Awassa, 169.3 g. in L. Langeno, and 250 g in L. Ziway.

In addition currently *C. gariepinus* in Lake Ziway heavier than a similar sized fish (80 cm length weight 3800 g) of the previous study of Lake Ziway (Tugie and Taye, 2004). Hence, *C. gariepinus* in Lake Ziway would be heavier than a similar sized fish in L. Langeno, Awassa and previous study of the same lake. For this reason, it can be concluded that *C. gariepinus* population in L. Ziway grows relatively faster than that in L. Langeno and 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 Lake Ziway than in the two lakes.

Fecundity estimation for *C. gariepinus*

Fecundity was estimated for 40 ripe females whose total length and total weight ranged from 47 cm to 80 cm and 750 g to 6500 g, respectively. Fecundity of ripe ovaries ranged from 443 to 1301 eggs per gram with a mean of 972 eggs per gram. Absolute fecundity was estimated to range from 10,000 to 560,000 with a mean of 151,741. Fecundity was linearly related to total length, total weight and gonad weight (Figs.4, 5 and 6).

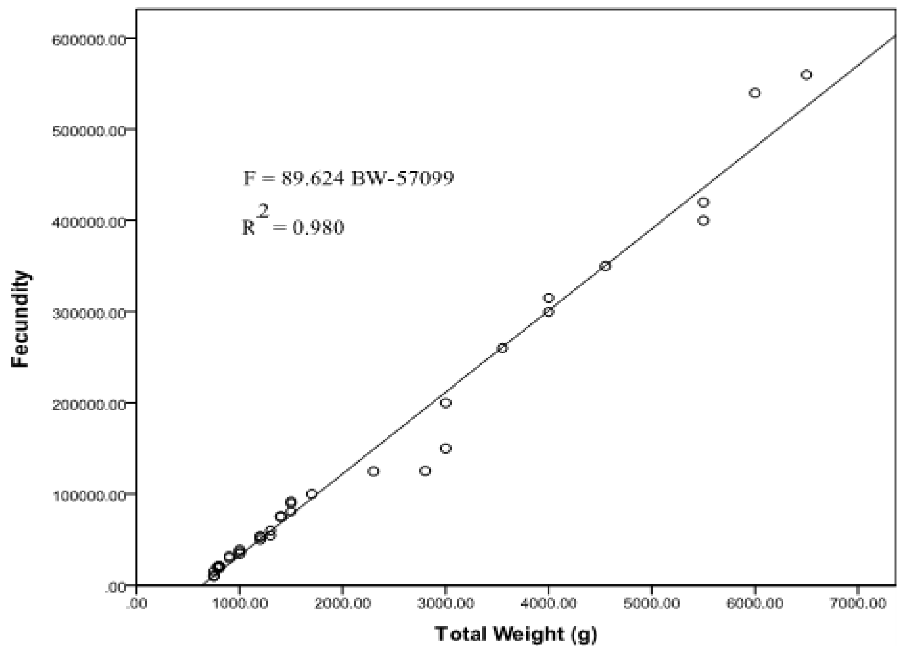

Fig. 4: Relationship between fecundity (F) and total weight (TW) of *C.gariepinus* in Lake Ziway

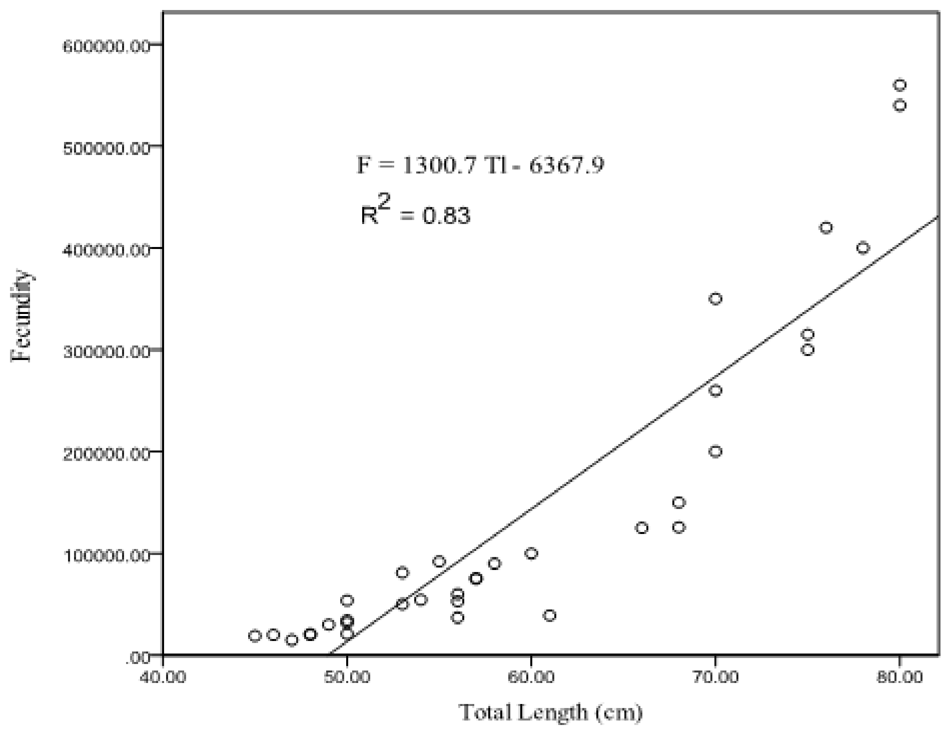

Fig. 5: .Relationship between fecundity (F) and total length (TL) of *C. gariepinus* in Lake Ziway

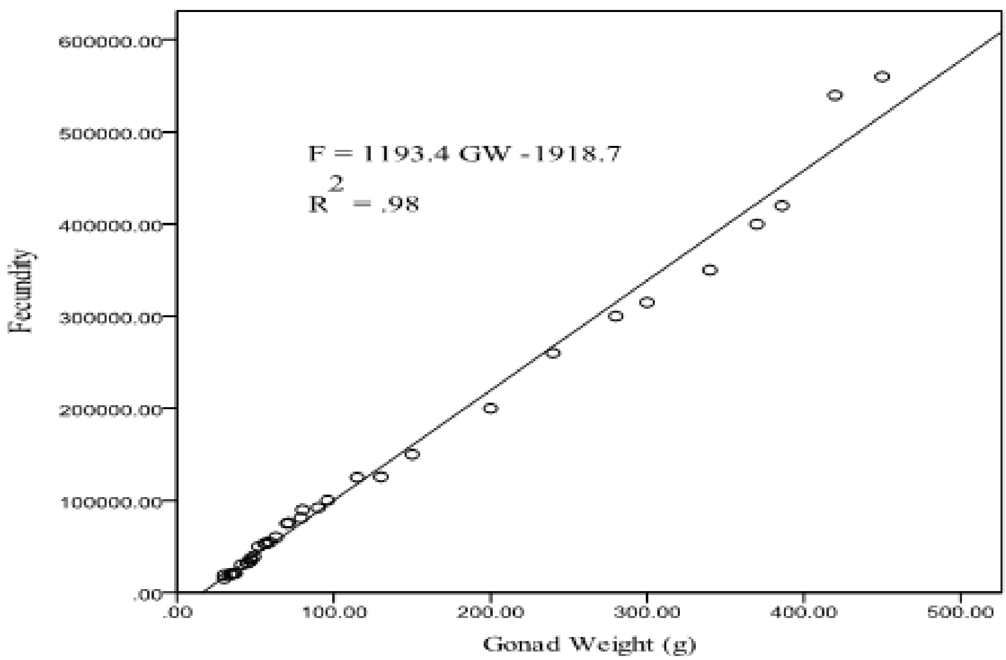

Fig. 6: Relationship between fecundity (F) and gonad weight (GW) of the fish in Lake Ziway

Fecundity ranged from 443 to 1301 eggs per gram which was slightly higher than the same species in L. Awassa, which ranges from 435 to 1176 eggs per g (Dadebo, 1988). At this time absolute fecundity of *C. gariepinus* ranges from 10,000 to 560,000 which were higher the finding of Tugie and Taye, 2004 (ranges from 7900 to 335,290 eggs) of the same lake. Currently high fecundity of *C. gariepinus* in L. Ziway could be due to its higher body condition and growth as compared to the species in Lake Awassa and the same lake of previous studies, which in turn is a reflection of high favorable biotic and abiotic factors. Fish in poor body condition are reported to have less fecundity than those in better condition (Lowe-McConnell, 1959).

CONCLUSIONS AND RECOMMENDATIONS

Clarias gariepinus was the second dominant fish next to *Oreochromis niloticus* in the lake. The sex ratio, length weight relation and fecundity of *C. gariepinus* in Lake Ziway were comparable to those of the species in some other Ethiopian Lakes (Awassa and Langeno). This suggests that *C. gariepinus* population in Lake Ziway may have general characteristics similar to the populations in the other lakes. Hence, this study does not include all the information of the fishes in general and *C. gariepinus* in particular. For that reason, further detailed studies are required on diversity and abundance of the fish species in the lake in general and, ecological issues of the lake in particular that affects the production of fishes. There is also a need for detailed studies of breeding and feeding behaviors of the fish species in the lake, prospect for sustainable fish resource utilization and socio-economic aspects of the lake in relation to other issues (CPUE of fishes in different gears, demand and supply of fishes from the lake, etc.).Current limnology of the lake must be assessed in relation to diversity and abundance of the fishes. The most prominent threats to the lake are related to deforestation, overgrazing by domestic animals around the lake and irrigation for the cultivation of horticultural products. Therefore, sustainable utilization and conservation measures should be taken around the lake. In parallel to this, however, fish stock assessment studies are strongly recommended to estimate optimum fishing level and sustainable yield.

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