ISSN: 2347-5129
(ICV-Poland) Impact Value: 5.62
(GIF) Impact Factor: 0.352
IJFAS 2015; 3(2): 136-141

www.fisheriesjournal.com
Received: 13-08-2015
Accepted: 14-09-2015

Gizachew Teshome
Semera University, College of Natural Sciences, Department of Biology, P.O. Box 132, Semera, Ethiopia.

Abebe Getahun
Addis Ababa University, College of Natural Sciences, Department of Zoological Sciences P.O. Box 1176, Addis Ababa, Ethiopia.

Minwyelet Mengist
Bahir Dar University College of Agriculture and Environmental Science, Department of Fisheries, Wetlands and Wildlife Management, P.O. Box 79, Bahir Dar, Ethiopia.

Biniyam Hailu
Bahir Dar Fishery and Aquatic Life Research Center, Bahir Dar, Ethiopia.

Correspondence
Gizachew Teshome
Semera University, College of Natural Sciences, Department of Biology, P.O. Box 132, Semera, Ethiopia.

Some biological aspects of spawning migratory *Labeobarbus* species in some tributary rivers of Lake Tana, Ethiopia

Gizachew Teshome, Abebe Getahun, Minwyelet Mengist, Biniyam Hailu

Abstract
Some biological aspect of spawning migratory Labeobarbus species in small tributary rivers of Lake Tajjna (Qimon, Guanta, Shini and Chibirna) Rivers were studied starting from August 2013 to December 2013. Fish were collected bimonthly using 6 and 8 cm monofilament gillnets and 6, 8, 10 and 12 cm mesh size poly filament gillnets. A total of 933 adult Labeobarbus specimens were collected within five sampling months at all sampling rivers. Descriptive statistics was used to present the data. One way ANOVA was used to analyze the Fulton condition factor of fishes. Length–weight relationship of the dominant Labeobarbus species (L. intermedius, L. brevicephalus and L. nedgia) showed statistically significant curvilinear relationships. Fulton condition factor for L. brevicephalus showed significant difference among four rivers ($P<0.05$) and L. intermedius showed non-significant difference. Fulton's condition factor of L. intermedius showed significant difference between sexes ($P<0.001$) and time of spawning ($P<0.01$). The present findings showed that the unique Lake Tana Labeobarbus species flock reproductive and productive performance were determined by development activities that are taken from each tributary rivers and streams like sand mining and irrigation activities. Finally this crucial problem should be taken appropriate mitigation measures in order to create sustainable development.

Keywords: Fulton condition, Labeobarbus, Spawning migration, River.

1. Introduction

Ethiopia has abundant water resources in East Africa and has a number of lakes and rivers in which the majority of the lakes are suited in Rift Valley of East Africa. Lake Tana is the largest lake in Ethiopia which is home to endemic and diverse fish species. It has seven feeder tributary rivers and more than 60 small tributary rivers [1]. There are three major fish families that are found throughout the country: Cichlidae, Clariidae and Cyprinidae. The largest family found mainly in Lake Tana is Cyprinidae and it is represented by four genera: These are *Barbus* represented by three species: *B. humilis, B. pleurograma,* and *B. tanapelagius* [5], *Varicorhinus* represented by one species, *V. beso*, *Garra* represented by four species: *G. dembecha, G. tana, G. regressus* and *G.* small mouth [7] and *Labeobarbus* which is the most abundant genus of the family and consists of 16 species forming a unique species flock in Lake Tana [1]. Small tributary rivers and streams of Lake Tana were not studied as spawning grounds and also currently, the reproductive status of lake fisheries were not studied. The aim of the study was to identify some biological parameters for estimate the reproductive performance of spawning migratory species in some tributary rivers of Lake Tana for sustainable utilization of the Lake Tana fishery.

2. Materials and Methods

2.1. Description of the study area

Lake Tana is the largest lake and situated in the north-west of Ethiopia, at an altitude of 1830m with a surface area of 3200 km^2 and a watershed of 16500 km^2 and forms the headwaters of the Blue Nile, which carries more than 80% of the total volume of the Nile River at Khartoum, Sudan [8]. More than 60 small seasonal tributaries and seven permanent rivers (Gumara, Ribb, Megech, Gilgel Abbay, Gelda, Arno-Garno and Dirma) feed the lake [1]. Gumara has a number of streams namely: Dukalit, Kizin, Wonzema, Bawaza and Guanta. These days, the river is becoming seasonal mainly due to upstream water pumping irrigation activities and catchment degradation. Ribb River originates from Gunna Mountains, at an altitude of above 3000 m a.s.l. and has a catchment of 130 km length and drainage area of about 1790 km^2. A number of tributary rivers join it such as Chibirna, Shini, Kirarign, Keha, Barya, Hamus and Melo Rivers [8]. Qimon River is located in northeastern part of Lake Tana at 12°11.000'N and 37°34.587'E. This river starting from Kulikal Ber watershed in Gondar Zuria District and its upstream of the river characterize clear from turbid, densely forest, gravels beds and mouth of the river has no sand, mud, grass, and water hyacinth.

2.2. Flora and fauna

The flora and fauna components of all sites are different due to natural and anthropogenic interface. During the rainy season, the upper part of all rivers was dominantly covered by densely populated shrubs and trees. Qimon River is characterized by dense forest in upper part of the river stream and mouth of this river is also densely covered by shrubs, grass, and water hyacinth. Guanta River is characterized by dense vegetation. Naturally this river, starting from the head up to the mouth, is highly turbid throughout the year due to the fact that it is dominated by loam soil as opposed to the sandy, Chibirna and Shini Rivers. There are also different invertebrates and vertebrates including birds and fishes (*Labeobarbus* spp., *O. niloticus* and *Clarias gariepinus*) in the studied rivers. Monitor Lizard ('Arjano') *Varanus niloticus* was found in all sampling rivers. The most common vertebrates at the river mouths are bird species such as great white pelican (*Pelecanus onocrotalus*), African fish eagle (*Haliaeetus voice*), Egyptian goose (*Alopochen aegyptiaca*), King fisher and common crane. The only mammal, which is found in the Qimon River mouth, is hippopotamus (*Hippopotamus amphibious*).

2.3. Sampling sites and materials used

The sampling sites (Figure 3.1 and Tables 3.1 and 3.2) were selected after preliminary assessment. Sampling sites were fixed using GPS. Four rivers were selected as sampling sites based on the nature, velocity of flowing river, human interference such as irrigation canals and sand mining activities, and suitability for fish spawning.

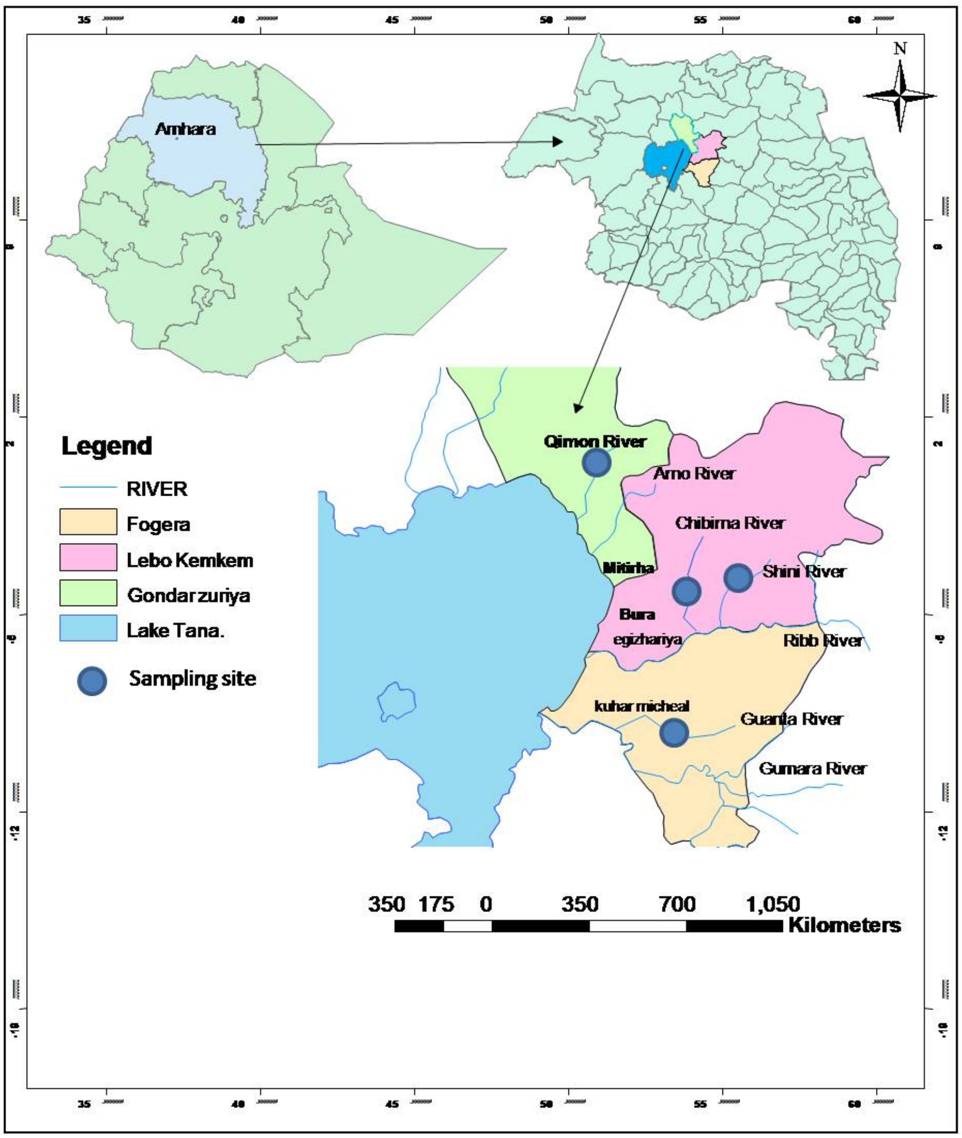

Fig 1: Map of Lake Tana and sampling sites at some inflowing rivers.

Multifilament gillnets with 6, 8, 10 and 12 cm stretched mesh size and monofilament gill nets with 4, and 6 cm mesh size were used for collecting fish specimens. Monofilament nets which had a panel length of 25 m and depth of 1.5 m were used in all sampling times and sites. Gillnets with panel lengths of 25 m and 1.5-2 m depth was used. In all studied sites, monofilaments were set during the daytime for about 2 hrs and gillnets were set during daytime for about 4 hrs. After capture of the specimens' total length, fork length, standard length and total weight were measured to the nearest 0.1 cm and 0.1 g precision for length and weight, respectively. Catch per unit effort was calculated as the numbers of fish specimens per the time of gillnet setting. The collected specimens of *Labeobarbus* species were identified to species level using the key developed by [12, 11].

Table 1: Locations of sampling sites for spawning migration

River	District	Characteristics	GPS Reading Elevation (m)	
Qimon	Gondar Zuria	Gravel, forest cover	12°11.000'N 37°34.587'E	1796
Shini	Libo Kemkem	Sandy	12°05.906' N 37°45.702' E	1881
Chibrna	Libo Kemkem	Forest coverage	12°04.402'N 37°44.075'E	1835
Guanta	Fogera	High sediment and muddy	11°50.708'N 37°39.768'E	1812

2.4. Some biological aspect of spawning migratory *Labeobarbus* Spp.

3.4.1. Length-weight relationship

The relationships between fork length and total weight of the most dominant *Labeobarbus* species were calculated using power function of (TW = aFL^b) where; TW – total weight (g), FL- fork length (cm), a and b are intercept and slope of regression line, respectively. The line fitted to the data was described by the regression equation for each species.

2.4.2. Fulton's Condition Factor (FCF)

The well-being of each dominant *Labeobarbus* species from each river was studied by using Fulton's condition factor. Fulton's condition factor (%) was calculated as:

$$FCF = \frac{TW}{FL^b} \times 100$$

Where, TW - total weight (g) and FL - fork length (cm); b - slope of regression line

2.4.3. Sex Ratio

Sex ratio is the ratio of females to males. After dissecting the abdomen part of a given fish specimen, sex was identified easily by its reproductive organ. Sex ratio was determined by using this formula:

$$\text{Sex ratio} = \frac{\text{number of males}}{\text{number of females}}$$

2.5. Data analysis

Data analysis was made using SASS version 9.2 and Microsoft Excel. Sex ratio was analyzed using Chi-square (χ^2). One way ANOVA was also performed to determine the FCF between sex of fish species and seasonal variation of condition factor. For all ANOVA test, mean comparison was performed using post hoc (LSD) to identify the difference between each parameter among sampling sites.

3. Results

3.1. Spawning migration of *Labeobarbus* species in Guanta, Qimon, Shini and Chibrna Rivers

3.1.1. Length-weight relationship

Total weight of the dominant *Labeobarbus* species *(L. intermedius, L. brevicephalus* and *L. nedgia)* showed curvilinear relationship with fork length (FL). The relationship was statistically significant (P<0.001; Figure 2).

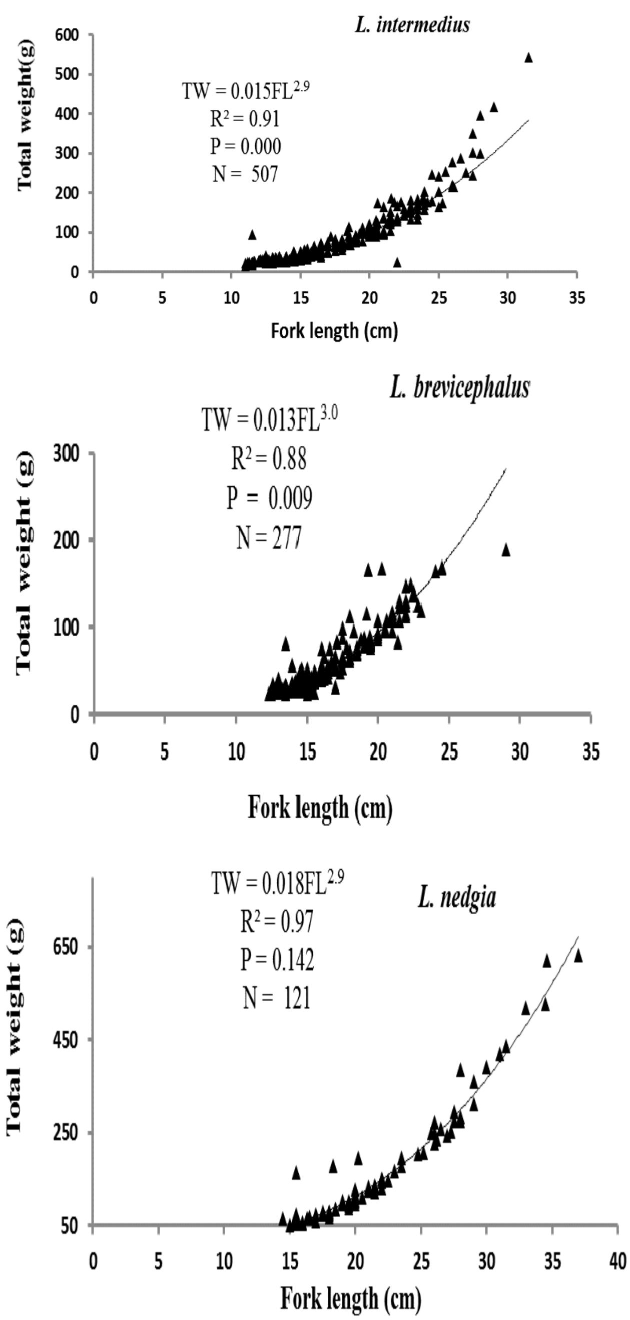

Fig 2: Length-weight relationships of the three dominant *Labeobarbus* species

3.1.2. Fulton's condition factor

Fulton's condition factor of *L. intermedius* showed significant difference between sexes (P<0.001) and time of spawning (P<0.01) (Table 4.2). Where, for *L. brevicephalus* it showed significant (P<0.019) variation between sexes but not (P>0.05) during times of spawning (time of spawning were performed between in peak and non-peak time of spawning months (Tables 3). Fulton condition factor for *L. brevicephalus* also showed significant difference among four rivers (P<0.005) and *L. intermedius* showed non-significant difference (Table 4).

Table 2: Mean ± SE of Fulton's condition factor for the most dominant *Labeobarbus* species by sex.

Species	Sex	N	Mean ±SE	P. value
L. intermedius	Female	180	1.25 ± 0.46	0.000
	Male	327	1.08 ± 0.32	
L. brevicephalus	Female	102	1.25 ± 0.38	0.019
	Male	175	1.16 ± 0.01	
L. nedgia	Female	78	1.72 ± 0.63	0.66
	Male	43	1.80 ± 0.63	

N is sample size, P is significant difference (One way ANOVA)

Table 3: Mean ± SE of the Fulton's condition factor for the dominant *Labeobarbus* species in different spawning seasons (pool data from all sampling rivers)

Species	Sampling months	N	Mean ± S.E	P value
L. intermedius	Peak time of spawning (August-October)	369	1.27± 0.22	0.009
	Non-peak time of spawning (November & December)	138	1.37 ± 0.02	
L. brevicephalus	Peak time of spawning (August-October)	224	1.21 ± 0.02	0.959
	Non-peak time of spawning (November & December)	53	1.21 ± 0.03	
L. nedgia	Peak time of spawning (August-October)	95	1.46 ± 0.04	0.537
	Non-peak time of spawning (November & December)	26	1.41 ± 0.04	

N is sample size, P is significance difference at 0.05 (One way ANOVA).

Table 4: Spatial difference of Fulton condition factor for the two dominant *Labeobarbus* species (one way ANOVA)

River	*L. intermedius*		*L. brevicephalus*	
	N	Mean± S.E	N	Mean± S.E
Chibirna	188	1.35±0.02	47	1.36± 0.097 ^{a}
Guanta	81	1.33±0.68	73	1.15±0.019c
Qimon	113	1.25±0.045	126	1.18±0.018^{cb}
Shini	124	1.27±0.014	31	1.26±0.034^{ba}
Total	506	1.30±0.017	277	1.21± 0.019
Sig. level		P<0.079		P<0.005

Subscript letters showed post hoc test of mean comparisons significance difference at 0.05.

3.1.5. Sex ratio

From the total of 933 *Labeobarbus* specimens which were caught in spawning months, 377 (40.41%) were females and 556 (59.59%) were males. Males were dominant over females for *L. intermedius* and *L. brevicephalus* while for *L. nedgia* males were less than females (Table 5).

Table 5: Numbers of females, males and the corresponding sex ratios of *Labeobarbus* species (Chi-square test)

Species	Female	Male	Sex ratio M:F	Chi-square	P value
L. brevicephalus	102	175	1:0.58	39.63	0.000
L. crassibarbis	2	0	-	-	-
L. intermedius	180	327	1:0.55	20.99	0.000
L. megastoma	2	3	1:0.67	2.22	0.136
L. nedgia	78	43	1:1.82	9.88	0.024
L. truttiformis	3	9	1:0.33	1.21	0.547
L. tsanensis	3	2	1:1.5	0.44	0.84
Overall	377	556	1:0.68	52.63	0.000

Significant levels at 0.05

4. Discussion

4.1. Physical characteristics of spawning grounds in some tributary rivers of Lake Tana

Lake Tana tributary rivers (Shini, Guanta, Qimon and Chibirna Rivers) were characterized by fast flowing, clear, highly oxygenated water, and gravel-bed Rivers or streams. All biological functions of living organisms in aquatic ecosystem such as growth, reproduction, feeding and sexual maturity were determined by abiotic factors [10]. In the same agreement with [2, 8] were reported at Megech and Ribb Rivers, respectively. This study indicated that all studied tributary rivers had different physico-chemical parameters due to different watershed, anthropogenic activities like sand mining in upstream of the rivers, and environmental natural variability. Highly oxygenated water and gravel beds are general requirements for *Labeobarbus* spawning due to their critical importance in the development of eggs and larvae [8].

In general, the variability of physico-chemical parameters in flowing rivers had strong relations with biological functions of any aquatic organism. Recently the Lake Tana fish production is declining as compared to the last ten years due to environmental and anthropogenic factors and these factors may cause the decline of riverine migratory species. This result is in line with [9] who reported similar results on some physico-chemical parameters that showed significant predictors of the migration dynamics and reproductive status of two *Barbus* species from Lake Chilwa basin (Malawi).

4.2. Length-weight relationship and Fulton condition factor

The regression coefficient was different among species, for example *L. intermedius* had a 'b' value of 2.9 and *L. brevicephalus* had a coefficient value "b" of 3.00; however both species were indicates that had isometric growth. Moreover, in agreement with Getahun (2008) in Ribb River, most dominant *Labeobarbus* species showed nearly isometric growth. Similar results have been reported in other water bodies for different fish species such as [14] in Sanja River and [15] in Borkena and Mille Rivers.

Environmental factors like food quality and quantity, water level and disease determined the fish growth and reproduction potential. The measure of fish condition can be linked to various factors such as environment, quality and quantity of food, rate of feeding, reproductive potential, water level fluctuation and disease. The current study indicates that females have better condition factor than males in the case of *L. intermedius* and *L. brevicephalus*. This may be due to small fork length records for most of the sampled male specimens and the larger total weight of female specimens due to their gonadal development. The mean values of FCF for the two dominant *Labeobarbus* species (*L. intermedius* and *L. brevicephalus*) contradict with [6] and [2] in Arno-Garno and Megech Rivers, respectively.

The sex variation was different between months; during August males were dominant while at the end of September females were dominant in some sampling sites. This indicated that males were early migrating to upstream tributary rivers than females. Generally, the result indicated that the number of spawning females declined in the catches due to the overall decline in the stock of cyprinid fish in Lake Tana from time to time. Similar results were obtained for other cyprinid fishes like *Labeo horie* and *Lates niloticus* in Lake Chamo [4]. The variation of sex ratio between male and female migratory fish species may have different biological mechanisms such as different maturity rates, different mortality rates and different time of migration, and different rate of migration [13]. Similar results were also observed in other species such as *Labeo coubie* (1:1.67) and *Rasbora tawarensis* (1:3.39) [3].

5. Conclusions and Recommendation

5.1. Conclusions

Some biological aspects of spawning migratory *Labeobarbus* species were studied for estimate the status of reproductive performance of Lake Tana fishes. A Fulton condition factor is the basic environmental determinant factor. Based on the result of length-weight relationship, most male sampled *Labeobarbus* species were matured early than female fish species. It concludes that spawning grounds and routs were degraded due to the presence of sand mining activities. Lake Tana tributary rivers and streams were found highly intensified by agricultural practice. These practice had negative effect on the environmental and water quality by removal of spawning grounds and damaging physico-chemical parameters. Finally, water quality is the main factor for the development of reproductive capability of migratory species.

5.2. Recommendation

Spawning migration seasons and grounds should be protected from any human activities and the regional fisheries regulation and proclamation must be properly implemented. The community, governmental and non-governmental organizations, policy makers and fishers should be aware of the reproductive strategy of the migratory fishes and human impacts for sustainable utilization of the resources. Lake Tana Labeobarbus species need to be conserved and also integrated fish farming with irrigation development should be implemented for the sustainable development. Unless proper wise use of Lake Fisheries, the species will be destroyed for the last time. So, for sustainable development environment should be have harmonized developmental activities that will create favorable condition for wild stock of Lake Tana fish.

Labeobarbus Juvenile in Shini and Arno River

Shini River diversion   Sand mining in Arno River

L. megastoma   *L. crassibarbis*

Appendix: Picture samples were taken from in some tributary rivers of Lake Tana

6. References

1. Anteneh W, Getahun A, Dejen E, Sibbing FA, Nagelkerke LAJ, Graaf de M *et al*. Spawning migrations of the endemic *Labeobarbus* (Cyprinidae, Teleostei) species of Lake Tana, Ethiopia: status and threats. Journal of Fish Biology. 2012; 81:750-765.
2. Anteneh W. The spawning migration and reproductive biology of *Labeobarbus* (Cyprinidae: Teleostei) of Lake Tana to Dirma and Megech Rivers Ethiopia. *SINET:* Ethiopian Journal of Science 2005; 31:21- 28
3. Claudine TT, Minette TE, Joseph T. Reproductive Strategy of *Labeobarbus batesii* (Teleostei: Cyprinidae) in the Mbô Floodplain Rivers of Cameroon, International Journal of Zoology, 2013, 452329-8.
4. Dadebo E, Ahlgren G, Ahlgren I. Aspects of reproductive biology of *Labeo horie* Heckel (Pisces: Cyprinidae) in Lake Chamo, Ethiopia. African Journal of Ecology. 2003; 41:31-38.
5. Dejen E, Osse JWM, Sibbing FA. Ecological position of 'small barbs' and their potential for fisheries: An option to reduce fishing pressure on 'large barbs' of Lake Tana (Ethiopia)? Aquat Ecos Health and Manage 2003; 6(3):337-342.
6. Gebremedhin S. Spawning migration of Labeobarbus species of Lake Tana to *Arno-Garno River*, Lake Tana sub-basin, Ethiopia. MSc Thesis, Bahir Dar University Ethiopia, 2011.
7. Geremew A. Taxonomic revision, relative abundance, and aspects of the Biology of some species of the genus Garra, Hamilton 1922 (Pisces: Cyprinid) in Lake Tana, Ethiopia. MSc. Thesis Addis Ababa University, Ethiopia, 2007.
8. Getahun A, Dejen E, Anteneh W. Fishery studies of Ribb River, Lake Tana Basin, Ethiopia, Ethiopian Nile Irrigation and Drainage Project Coordination Office, Ministry of Water Resources, Ethiopia, Final Report 2008; 2:1573.
9. Jamu DM, Chimphamba JB, Brummett RE. Land use and cover changes in the Likangala catchment of the Lake Chilwa basin, Malawi: implications for managing a tropical wetland. African Journal of Aquatic Science. 2003; 28:123-135.
10. Murdoch T, Martha C. The Stream Keeper's Field Guide: Watershed Inventory and Stream Monitoring Methods. A Product of the Adopt-A-stream Foundation. Everett, WA, 1999, 296.
11. Nagelkerke LAJ, Sibbing FA. The large barbs (*Barbus* spp., Cyprinidae, Teleostei) of Lake Tana (Ethiopia), with a description of a new species, Barbus osseeinsis. Netherlands Journal of Zoology. 2000; 50:179-214
12. Nagelkerke LAJ. The barbs of Lake Tana, Ethiopia: morphological diversity and its implications for taxonomy, trophic resource partitioning and fisheries. PhD Thesis, Wageningen University, The Netherlands, 1997.
13. Sandovy Y, Shapiro DY. Criteria for the diagnosis of hermaphroditism in fishes. *Copeia* 1987; 1:136-156.
14. Tesfaye G. Diversity, relative abundance and Biology of fishes in Angereb and Sanja Rivers, Tekeze b*asin, Ethiopia*. MSc Thesis, Addis Ababa University, Ethiopia, 2006, 89.
15. Tessema A. Diversity, relative abundance and biology of fishes in Borkena and Mille Rivers, A wash basi*n, Ethiopia*. MSc Thesis Bahir Dar University, Ethiopia, 2010.