Fisheries and Aquaculture Journal

Aynalem et al., Fish Aqua J 2018, 9:1
DOI: 10.4172/2150-3508.1000241

Research Article | Open Access

Diversity, Relative Abundance, Species Composition and Some Biological Aspects of Fishes in Gilgel Abay and Andassa Rivers, Blue Nile Basin, Ethiopia

Yibeletal Aynalem[1], Minwyelet Mingist[2] and Addis Getu[3*]

[1]*Department of Animal production and technology, Woldia University, Ethiopia*

[2]*Department of Fishery and wetland management, Bahirdar University, Ethiopia*

[3]*Department of Animal genetics and breeding, University of Gondar, Ethiopia*

***Corresponding author:** Addis Getu, Department of Animal genetics and breeding, University of Gondar, Gondar, PO BOX: 196, Ethiopia, Tel: +251588119078; E-mail: belaygetu2004@gmail.com

Received date: December 07, 2017; **Accepted date:** March 19, 2018; **Published date:** March 30, 2018

Abstract

Diversity, relative abundance and some biological aspect of fishes in Gilgel Abay and Andassa Rivers were studied from September 2010 to June 2011 by using gillnets of mesh sizes 6 cm, 8 cm, 10 cm and 12 cm, monofilaments of different mesh sizes, cast net, hook and lines. Fish species identification was done by using literature and specimen deposited in the laboratory. Abiotic parameters such as temperature, conductivity, pH, total dissolved solids and transparency of the rivers were also taken, using multi-meters. The analysis of independent t-test showed that there was significant deference in pH and transparency between seasons in Andassa River ($p<0.05$). In Gilgel Abay River, there was significant difference in temperature and transparency ($p<0.05$) between seasons. Totally 939 fish specimens were collected from Gilgel Abay and Andassa Rivers. Three families and thirteen species of fishes were identified from Andassa and Gilgel Abay Rivers. *Labeobarbus intermedius*, *Varicorhinus beso*, *L. nedgia* and *Clarias gariepinus* were the most dominant fish species found in both Rivers. Index of Relative Importance (IRI) and Shannon Diversity Index (H') were used to evaluate the abundance and diversity of fish species. Andassa River had higher diversity (H'=4.06) than Gilgel Abay River (H'=4.05) in dry season but lower than Gilgel Abay in wet season which was (H'=3.32) and 4.35, respectively. In wet season, the most abundant species in Andassa River were *L. intermedius*, *V. beso*, *C. gariepinus* and *L. crassibarbis*. *L. intermedius*, *L. nedgia* and *C. gariepinus* were the most abundance species in Gilgel Abay during wet season. In both seasons, *L. intermedius* was the most important species at Andassa and Gilgel Abay Rivers. In Gilgel Abay River, the most important fish species in wet and dry seasons were *L. intermedius*, *L. nedgia* and *C. gariepinus*. The sex ratio analysis showed that there was significant deviation from unity ($p<0.05$).

Keywords Diversity; Relative abundance; Species composition; Sex ratio

Introduction

Ethiopian freshwater bodies although Ethiopian is a land locked country, it has a number of lakes and Rivers. The lakes cover a total area of about 7400 km^2 and the rivers cover a total length of about 7700 km^2 [1]. The water bodies of the country are categorized under three main drainage systems, which are again divided into sub-drainage systems or watersheds [2]. One of the drainage systems is the western drainage, which includes the Baro-Akobo, Blue-Nile (Abay) and the Tekeze Rivers watersheds. The left bank tributaries of the Blue-Nile (Abay), such as rivers Didessa and Dabus drains to the southwestern parts of the western highlands of Ethiopia [3], whereas the rivers in Tekeze basin (e.g., Angereb, Tekeze and Guang) drains to the north-western parts of the western highlands of the country [4]. All the rivers in the western drainage system flow west to the White Nile in the Sudan.

Materials and Methods

Fish resource of Ethiopia

There were about 153 valid species and sub-species of fish, belonging to 12 orders and 24 families [4]. According to Golubtsov et al. [5] who reported about 168 to 183 valid species of fish as occurring in Ethiopian waters. Although the total number of fish species found in the country has not be known, the fish species that have so far been described can be categorized as Nilo-Sudanic, highland east Africa and endemic forms [6]. There are also about 10 exotic fish introduced from abroad into Ethiopia freshwaters [7]. The number of endemic fish species of the country is estimated to range from 37 to 57. The Baro-Akobo, Omo-Ghibe and Blue-Nile (Abay) basins contain representative of Nilo-Sudanic fish species. The Shebelle-Genale systems and the southern Rift valley lakes also harbor Nilo-Sudanic fish elements [3]. These systems contain Nilotic fish species because the basins had past connections with the Nile and west central Africa River systems [6]. Representative genera of Nilotic fish species in these water bodies are *Alestes, Bagrus Barilius, Citharinus, Hydrocynus, Hyperopisus, Labeo, Malapterurus, Mormyrus, polypterus and protopterus* [8]. The distribution of Nilo-Sudanic fish species in Africa extends from Atlantic coast in the west to Indian Ocean in the east. This range includes the major drainage basins such as the eastern most part of Senegal, Niger, Chad and the Nile. The Juba and Wabishebelle basins are the eastern most part of the Nilo-Sudanic ichthylogical province in Africa [6].

As recognized by Roberts [9], the highland East African fish forms are found in Northern Rift valley lakes of Ethiopia, the highland lakes (e.g., Labeobarbus of Lake Tana) and associated River systems, and the Awash drainage basin [3]. Representatives of highland East Africa fish species in theses water bodies included the genera of *Labeobarbus, Barbus, Clarias, Garra, Oreochromis and Varicorhinus* [8]. Ethiopia highland riverine fish fauna also resemble South Africa and Arabian Peninsula fish forms. For example, Cyprinids are dominant fish in highland rivers and lakes of Ethiopia and East Africa waters [9]. Similarly the above investigator stated that some of the species of cyprinid genera such as small barbs species: *B. paludinosus, B. trimaculatus and B. radiates* are widely distributed from South Africa through East Africa [10]. There are also fish groups (e.g., *Garra spp*) common to Ethiopia highlands and Arabian Peninsula *C. gariepinus* Burchell 1822, *V. beso* and *Labeobarbus spp* are commonly found in Ethiopian highland rivers and lakes [4]. It is believed that the saline lakes in Afar Region (e.g., Lake Afdera) were formed as an extension of the Red Sea as the result, their fish fauna are more related to the Red Sea and Mediterranean fauna than the Southern Rift valleys lakes of Ethiopia. About 28-30 fish species belong to 11 families and 19 genera were recorded in the Shebelle-Juba catchments within the limit of Ethiopia (Table 1). The system is unique in the country due to the presence of east African, Nilo-Sudanic and the presence of diadromous fishes. Omo-Ghibe including their tributaries and Lake Turkana are home to 79 species of fishes (Table 1). Of these species, *Nemacheilus* is endemic fish recorded from the basin [11]. The Baro-Akobo basin, the richest basin in fish fauna, is home to 91 species of fishes [12]. The number of fish species inhabiting the Abay (Blue-Nile) basin excluding the Lake Tana basin is about 45-46 (Tables 1-4).

River basin	Families	Genera	Indigenous	Endemic	Introduced
Awash	-	-	10	3	-
Wabishebelle-Juba	11	19	28-31	19	3
Omo-Turkana	19	42	79	15	-
Baro-Akobo	23	55	106	13	-
Abay (Blue-Nile)	-	-	45-46	3	1
Tekeze	9	22	32	3	1-2
Rift valley	10	13	23-31	5-6	4

Table 1: Fish species diversity in major drainage basins of Ethiopia.

Rivers	Fishing sites (code)	Relative distance each sites (km)	Habitat types	Altitude (m)	Location
Andassa	AnS1 (site one)	-	Stony	1706	11°31'05"N
					37°30'00"E
	AnS 2 (site two)	2.4	Muddy	1721	11°30'10"N
					37°28'50"E
	AnS3 (site three)	10.3	Rocky and muddy	1776	11°30'45"N
					37°24'15"E
Gilgel Abay	GAS1 (site one)	-	Rooky and Muddy	1836	11°21'35"N
					37°02'15"E
	GAS2 (site two)	1.7	Muddy	1889	11°21'45"N
					37°02'55"E
	GAS3 (site three)	4.5	Stony and muddy	1889	11°23'05"N
					37°02'00"E
	GAS4 (site four)	62	Muddy	1800	11°43'40"N
					37°11'25"E

Table 2: Sampling sites with their codes, GPS readings and estimated distance from each site.

Statement of the problem

Knowledge on diversity, population structure and population of the Ethiopia ichthyofauna is poorly known. Relatively a large number of small, medium and even some large rivers have not been well studied and explored. Therefore, further study on these rivers is a critical issue to be dealt to fill such gaps. Gilgel Abay is the major river flowing into Lake Tana. As far as literature results are concerned, no attention has been given for fish diversity, abundance and economic importance in Abay and Andassa Rivers.

- The purpose of the study is, therefore, to answer the following leading questions.
- What is the fish species composition of Gilgel Abay and Andassa Rivers?
- Do Gilgel Abay and Andassa Rivers vary in fish abundance?

Citation: Aynalem Y, Mingist M, Getu A (2018) Diversity, Relative Abundance, Species Composition and Some Biological Aspects of Fishes in Gilgel Abay and Andassa Rivers, Blue Nile Basin, Ethiopia. Fish Aqua J 9: 241. doi:10.4172/2150-3508.1000241

- Is there variation between Gilgel Abay and Andassa Rivers in fish species composition?
- What is the biology of some of the dominant fish species in these rivers?

General objectives

The main objective of this study is to provide scientific information on important fish species found in Gilgel Abay and Andassa Rivers for proper management and sustainable utilization of the fish resources.

Specific objectives

- To assess the physico-chemical parameters in Gilgel Abay and Andassa Rivers.
- To identify fish species composition in both rivers.
- To evaluate relative abundance of fish species.
- To compare well-beingness of dominant fish species.
- To estimate fecundity and its relationship with other parameters.
- Description of the Study Area.

Andassa River

Andassa River is found in West Gojjam Administrative Zone (Bahir Dar Zuria Woreda and Mecha Woreda) and it is a perennial tributary of Blue Nile River. The river had high water volume during rainy season due to high runoff and sediment accumulation from the upstream.

Climate: Andassa River has maximum and minimum mean monthly temperature 29.92°C and 11.65°C and mean monthly rainfall of 111.95 mm (Bahir Dar Meteorological Station, 2011) (Figures 1 and 2). The main rainy season is from June to September with the highest rainfall records in August (618.5 mm) and July (418.5 mm). Rainfall is generally negligible in the months of December and February.

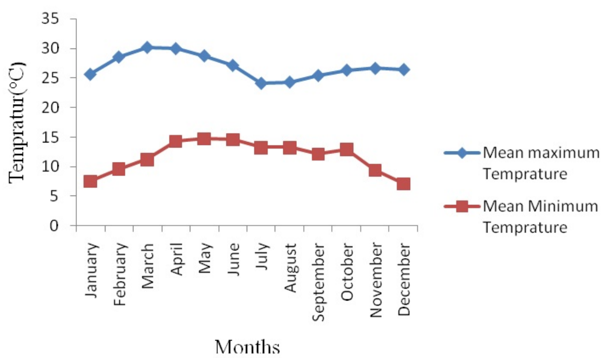

Figure 1: Mean minimum and maximum temperature (2007-2010) at Andassa River. (Source: Bahir Dar meteorological station, 2011).

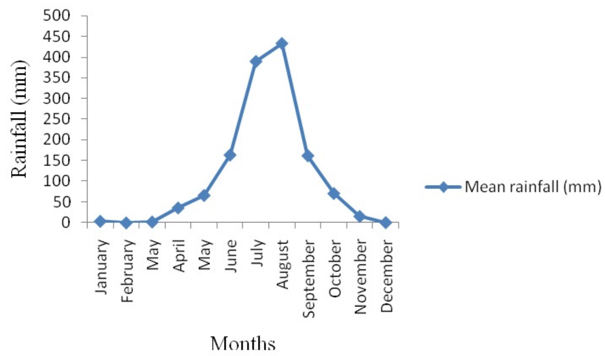

Figure 2: Mean monthly rainfall (2007-2010) at Andassa River. (Source: Bahir Dar).

Flora: There are different plant types such as grass, herbs, shrubs and trees. The most common and relatively large sized plants in the study area with their local names are Dockma (*S. guineense*) and Kaya (*C. anisata*) and (Figure 3). The buffer zone of the river was bare due to the use of the major plants for firewood, construction and expansion of farmland. Year after year, the vegetation cover is deteriorating.

Figure 3: Common plant types and birds in Andassa River.

Fauna: In the study area besides to fish, there are other vertebrate animals living in and around the rivers, however, the most common vertebrates are various species of birds like duck, Yibera (*A. aegyptiaca*) and Sabesa (*C. egret*). The most common animal observed during the study period was Arejano (Nile monitor lizard).

Gilgel Abay

Gilgel Abay River originates from the highland area of Sekela Woreda (Gash Abay town) in West Gojjam Zone. Gilgel Abay is a natural geographical boundary that separates Debub Achefer and Mecha Woreda.

Climate of Gilgel Abay: Gilgel Abay River and its surroundings have a maximum and minimum mean monthly temperature of 26.69°C and

Citation: Aynalem Y, Mingist M, Getu A (2018) Diversity, Relative Abundance, Species Composition and Some Biological Aspects of Fishes in Gilgel Abay and Andassa Rivers, Blue Nile Basin, Ethiopia. Fish Aqua J 9: 241. doi:10.4172/2150-3508.1000241

10.63°C, respectively and mean monthly rainfall of 155.41 mm (Wotet Abay Meteorological Station) (Figures 4 and 5).

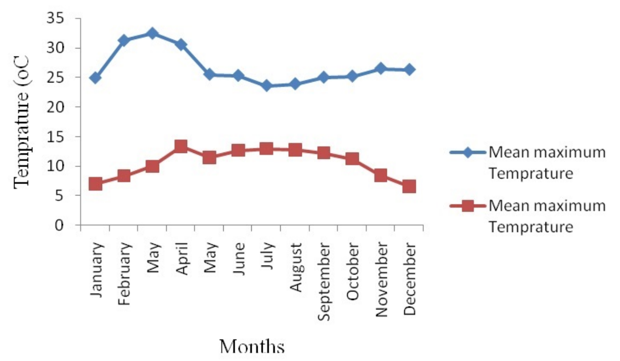

Figure 4: Mean minimum and maximum temperature (2007-2010) at Gilgel Abay. (Source: Wotet Abay meteorological station, 2011).

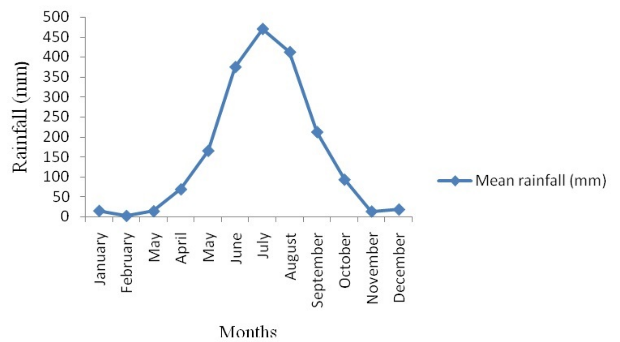

Figure 5: Mean monthly rainfall (2006-2009) at Gilgel Abay River. (Source: Wotet Abay meteorological station, 2011).

Flora: At Gilgel Abay, the major plants are locally known as Dockma (*S. guineense*), Girar (*Accacia*), Kaya (*C. anisata*) and Gemero (*C. tomentosa*) and its buffer zone was highly degraded which may be due to high population density around the area (personal observation).

Fauna: The major animal is Akustsa (Hard back). It is a fast swimming dog-like fish predator in the river. It was observed at all sites of Gilgel Abay River. In addition to this, there are different species of birds, such as Yibera (*A. aegyptiaca*), duck and Sabesa (*C. egret*).

Site selection and sampling

Reconnaissance survey was conducted to fix the sampling sites. The survey was conducted in a number of sub-areas along Andassa and Gilgel Abay Rivers. Three and four sampling sites were selected from Andassa and Gilgel Abay Rivers, respectively. Selection criteria were the nature and velocity of the flowing rivers, suitability for fishing, and accessibility of the site (Figure 5 and Table 5). The three sampling sites were selected at Andassa River. They are located at the Andassa bridge (concrete road joining Bahir Dar town and Tisisat Fall), Andassa Gideb (a small irrigation dam) and Wondatha Bridge (concrete road joining Bahir Dar and Adet town and found at Subatamit Kebele) (Table 6).

The four sites in Gilgel Abay River were as follows: The first site was at the meeting point of Gilegel Abay and Jemma Rivers (Junction 1) in Groan Kebele, the second site was at Wotet Abay, where Koga River enters to Gilgel Abay River. The third site was at junction of Gilgel Abay and Lemchema stream and the fourth site was at Chimba Kebele (near to Lake Tana) in North Achefer Woreda. GPS readings were taken to measure geographical location of the rivers and the sites. Physico-chemical parameters such as conductivity, pH, temperature and transparency were measured using standard millimetre and transparency (20 cm in diameter), respectively. Fish samples were collected both in dry and wet seasons. Each sampling site was sampled two times (one time in the wet season and one time at dry season). Samples were collected using gillnet of mesh size 6 cm, 8 cm, 10 cm and 12 cm by setting for 14 hours over night at the deeper part of the River. In addition to this, castnet, hook and lines were used to increase the probability of diversity of fish catch. Monofilament gillnet with various stretched mesh sizes (5 mm-55 mm) was set on rivers for two hours to sample small sized fish species.

Specimen of fish species were identified to species level using taxonomic key as indicated. Picture of fish specimens was taken for each species. Immediately after capture, a gentle pressure was applied on the abdomen to check whether spermiation or ovulation has occurred or not. Then, total length and fork length were measured to the nearest 1 cm using measuring board and total weight of all specimens of fish was measured to the nearest 0.1 cm using sensitive balance. After dissection, gonadal maturity of each fish specimen was identified, using a five point of maturity scale (Table 6). Gonad weight was measured to the nearest 0.1 g using sensitive beam balance. From specimen of matured females (fish at stage IV) egg sack was measured and preserved with 4% formalin for fecundity estimation. After taking the entire necessary information, individual specimens were preserved with 4% formalin and put in plastic, jar and was transported to laboratory for further identification and measurement (Figure 6).

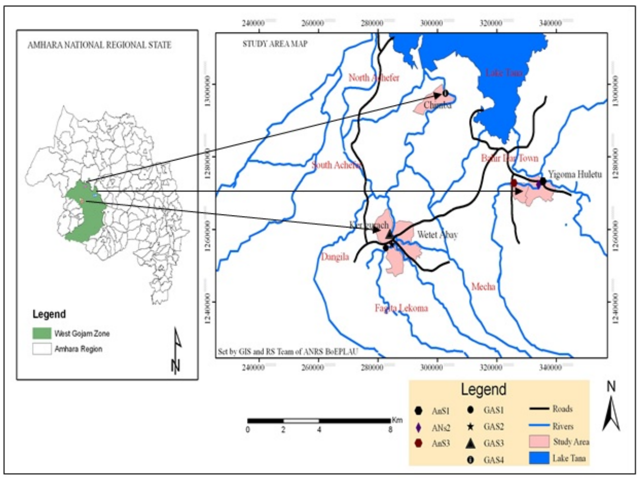

Figure 6: Map of the study area and sampling sites at Andassa and Gilgel Abay Rivers. (Source: Amhara research institute GIS team at Bahir Dar).

Laboratory studies: Specimen of fish species was soaked in tap water for one day to wash the formalin from the specimen and then, they were identified to species level using taxonomic keys. The specimens were compared with previously identified specimen specially done at

Lake Tana like *Labeobarbus*, catfish and tilapia. The morpho-metric data were converted into percentage with respect to standard length and head length.

Description of gonads		
Stages	**Maturity stage of males**	**Maturity stage of females**
1	Immature virgin a pair of small thread- like, colourless organs (with slightly serrated edges in *C. gariepinus*), difficult to distinguish between sexes (except *C. gariepinus*).	Immature virgin a pair of small thread-like, colourless organ. Difficult to distinguish between the sexes in *B. tsanensis* and *O. niloticus*. In *C. gariepinus* (size >18 cm), the ovaries discernible as tiny, bulb-like and pinkish in colour.
2	Developing virgin or recovering spent-long thin up to 1/2 length of body cavity but distinct opaque white in *C. gariepinus*, with distinct serrated edges and shorter.	Developing virgin or recovering spent-long thin up to 1/2 length of body cavity thicker than the testis and translucent yellowish white in *B. tsanensis* and *O. niloticus* and pink in *C. gariepinus* recovering spent has larger gonad size and thick wall.
3	Maturing or ripening long and thicker, 2/3 body cavity (or 1/2 in *C. gariepinus*) firm and more solid colour white in *B. tsanensis*, cream or beige in *O. niloticus* and grayish-in *C. gariepinus*.	Maturing or ripping-large gonad thicker, 2/3 body cavity colour yellowish in all ova discernible in all.
4	Ripe and running-large and thick and slimy and milky white in *B. tsanesis*, creamy in *O. niloticus*, and white *C. gariepinus*. Sperm easily flows when pressed or cut. *C. gariepinus* testis has smooth edges.	Ripe and running-Ovary large yellow, almost filing the peritoneal cavity in all Ova well developed and large may flow out when pressed.
5	Spent testis-shrunk and flaccid. Numerous folds appear in *O. niloticus* and serrated edges revert to original sharpness and colure changes grey in *C. gariepinus*.	Spent Ovary-shrink and flaccid some remnants of disintegrating opaque and ripe eggs appear in ovary of *O. niloticus* and sometimes in *B. tsanensis*, rarely in *C. gariepinus* colour changes translucent in *O. niloticus* and *B. tsanensis* but in *C. gariepinus* the ovary changes colour to grayish-red.

Table 3: Description of various gonad stages.

Species diversity and relative abundance: Estimation of relative abundance of fish was made by the contribution in number and weight of fish in the total catch in each sample effort. An Index of Relative Importance (IRI) and Shannon Diversity Index (H') were used to evaluate relative abundance and diversity of fishes, respectively [13].

IRI is a measure of relative abundance or commonness of the species based on number and weight of individuals in catches as well as their frequency of occurrence. IRI gives a better replacement of the ecologically important species rather than the weight, number or frequency alone.

$$\%IRI = \frac{(\%Wi + \%Ni) \times Fi}{\sum_{J-1}^{Z-1} (\%Wj + \%Ni) \times Fj} \times 100$$

Where, %Wi percentage weight and number of each species of total catch, %Ni=Percentage number of each species of total catch, %Fi=Percentage frequency occurrence of each species into total number of settings, % Wj and % Nj=Percentage weight and number of total species into total catch, Fj is percentage frequency of occurrence of total species into total number of settings, H' is a measure of species weighted by the relatively abundance [14]. H' is calculated using the formula below:

$$H' = \sum \text{pi} \ln \text{pi}$$

Where, pi-the proportion of individuals in the species.

Shannon index was used to indicate diversity of fishes at different sampling sites or rivers. A high value indicates high species diversity.

Sex ratio

Sex ratio was determined using the formula:

$$\text{Sex ratio} = \frac{\text{Number of females}}{\text{Number of males}} \times 100$$

Data analysis

Data was analyzed using SPSS version 16 and Excel of windows 2003/2007 for ANOVA (comparison of means). Regression, independent T test (to test physicochemical parameters), Chi-square test (to test sex ratio) and some descriptive statistics were used.

Results and Discussion

Abiotic parameters

Physical and chemical parameters (temperature, conductivity, pH, total dissolved solids and transparency) taken from all sites in Andassa and Gilgel Abay Rivers were analyzed, using independent t-test. The result of the analysis showed significant differences in pH, temperature and secchi-depth in Andassa River whereas in Gilgel Abay there is significant difference in temperature and secchi-depth (Table 4).

Temperature is a control factor for aquatic life since it affects metabolic and reproductive activities as well as their life cycles [15]. Temperature is one of the most important parameters that dramatically affect the rate of chemical and biological reaction within the water [16]. The mean temperature value in Andassa River was

(23°C) a little bit higher than Gilgel Abay River (22.96°C) but the values of temperature in these rivers were less than 32.5°C which is the limit for aquatic life [16].

PH test is one of the most common analyses in water quality analysis. Acidity ranged from 6.5 to 8.2 is optimal for most organisms [16]. PH value of Andassa River (7.02 ± 0.23) was greater than Gilgel Abay (6.56 ± 0.22). This might be due to higher pollutant load released to Andassa River from Bahir Dar city. Though detailed study is needed to find out the root causes of this pH difference in both rivers, the pH value in both rivers was in the recommended range.

Physico-chemical	River	Mean	SD	Significance
pH (pH meter)	Andassa	7.02	0.23	0.05*
	Gilgel Abay	6.56	0.22	0.24 ns
Temperature (°C)	Andassa	23	1.58	0.541 ns
	Gilgel Abay	22.96	1.95	0.026*
Conductivity (µs/cm)	Andassa	240.33	37.9	0.577 ns
	Gilgel Abay	152.85	23.88	0.228 ns
TDS (ppt)	Andassa	147.17	24.93	0.543 ns
	Gilgel Abay	89.52	29.17	0.609 ns
Transparency (cm)	Andassa	57.84	11.26	0.019*
	Gilgel Abay	50.63	6.77	0.017*
Note: *(significant at p<0.05) and ns (no significant, p>0.05)				

Table 4: Mean physico-chemical parameters in Andassa and Gilgel Abay Rivers wet and dry seasons (comparison two seasons).

Specific conductance in natural surface waters has been found to range from 50 µs/cm to 150 µs/cm. Ground water and water in arid regions usually have elevated specific conductance and the conductivity of arid waters is typically 1000 µs/cm. The specific conductance of seawater is usually expressed in terms of salinity [17]. The conductivity in Andassa River (240.33 µs/cm) was lower than Gilgel Abay River (152.85 µs/cm). The higher conductivity values in Gilgel Abay River may be due to TDS accumulation from upstream areas and the highly degraded nature of the long riverbank, bringing different dissolved substances from the farmlands.

Fish species composition in Andassa and Gilgel Abay Rivers

The dominant fish species both at Andassa and Gilgel Abay Rivers were the family Cyprinidae (*L. intermedius, L. nedgia*), Clariidae (*C. gariepinus*) and Cichlidae (*O. niloticus*). A total of 13 species were recorded in dry and wet seasons (Tables 5 and 6). These fishes were represented by family Cyprinidae, Clariidae and Cichlidae. *Labeobarbus* was the best-represented genus with 11 species. The fish fauna of the study area contain highland east Africa, for example, *L. intermedius*, *C. gariepinus* and *O. niloticus*. *C. gariepinus*, which is in the family of *Clariidae* also found in both rivers. *V. beso* was found in both seasons at Andassa and Gilgel Abay Rivers. The four dominant species were found in both dry and wet seasons in the two rivers. Andassa River has eight fish species that belong to Cyprinidae and Clariidae whereas Gilgel Abay has ten fish species that are grouped under three families Cypridae, Clarridae and Cichilidae. In Andassa River, the four dominant fish species were found all sites but in the case of Gilgel Abay they were not found at all sites in both seasons (Tables 5 and 6). In Andassa River, *L. surkis* and *L. megastoma* were sampled only at site two during wet and dry seasons, respectively (Table 5).

Species	Wet	Dry	Wet	Dry	Wet	Dry
L. intermedius	+	+	+	+	+	+
V. beso	+	+	+	+	+	+
L. nedgia	+	+	+	+	+	+
C. gariepinus	+	+	+	+	+	+
L. crassibarbis	+	-	+	+	+	-
L. surkis	-	-	+	-	-	-
L. megastoma	-	-	-	+	-	-
L. brevicephalus	-	-	+	+	-	+

Table 5: Fish species composition in Andassa River in both seasons (+Present, -Absent).

Species	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	River
L. intermedius	+	+	+	+	+	+	+	+	ü
V. beso	+	+	+	+	-	+	-	-	ü
L. nedgia	+	+	+	+	+	+	+	+	ü
C. gariepinus	+	+	+	+	+	-	+	+	ü
L. crassibarbis	-	-	+	-	-	-	-	-	ü
L. acutirostris	-	+	-	-	-	-	-	-	ü
L. tsanensis	-	-	+	-	-	-	-	-	ü
L. brevicehalus	+	-	+	+	+	+	+	+	ü
L. truttiforms	-	-	-	-	-	-	-	+	ü
L. macrophytalams	-	-	-	-	-	-	-	+	ü
O. nilotics	-	-	-	-	-	-	-	+	ü

Table 6: Fish species composition in Gilgel Abay in both seasons (+Present; -absent).

Comparison of the species composition of the present study with Lake Tana indicated that less number of species was observed in this study [18,19]. *L. intermedius*, *L. nedgia*, *L. crassibarbis*, *L. surkis*, *L. brevicephales*, *L. tsanansis*, *L. acutirostris*, *L. triuttiforms*, *L. megastoma* and *L. macroptaimus* were reported which were similar to the present study (Table 7).

Nagelkerke (14)	de Graff (19)	Dejen (20)	Ameha (8)	Present Study

L. intermedius	*L. intermedius*	*B. humils*	*L. intermedius*	*L. intermedius*
L. nedgia	*L. nedgia*	*B. tanapelagis*	-	*L. nedgia*
L. crassibarbis	*L. crassibarbis*	*B. pleurgrama*	*L. crassibarbis*	*L. crassibarbis*
L. surkis	*L. surkis*	*JuvenileLarge barbus*	-	*L. surkis*
L. longissimus	*L. longissimus*	-	*L. longissimus*	-
L. platdorsus	*L. platydorsus*	-	-	-
L. gorgorensis	*L. gorgorensis*	-	-	-
L. brevicephales	*L. brevicehalus*	*L. brevicehalus*	*L. brevicephalus*	*L. brevicehalus*
L. tsanansis	*L. tsanasis*	-	*L. nedgia*	*L. tsanansis*
L. acutirostris	*L. acutirostris*	-	*L. acutirostris*	*L. acutirostris*
L. megastoma	*L. megastoma*	-	*L. megastoma*	*L. megastoma*
L. gorguir	*L. gorguri*	-	-	-
L. daineillii	*L. daineillii*	-	*L. dainellii*	-
L. macroptaimus	*L. macroptalmus*	-	*L. macrophtalmus*	*L. macrophtalmus*
L. triuttiforms	*L. trittiforms*	-	*G. dembecha*	*L. trittiforms*
-	*C. gariepinus*	-	*C. gariepinus*	*C. gariepinus*
-	*V. beso*	-	*V. beso*	*V. beso*
-	*O. niloticus*	-	*O. niloticus*	*O. niloticus*
-	*Small Barbus*	-	-	-
-	*Garra spp.*	-	-	-

Table 7: Species composition comparison at Lake Tana and the present study.

Species diversity and abundance

Fish species	Family	Rivers			
		Andassa		Gilgel Abay	
		Wet	Dry	wet	Dry
L. intermedius	Cyprinidae	+	+	+	+
V. beso	Cyprinidae	+	+	+	+
L. nedgia	Cyprinidae	+	+	+	+
C. gariepinus	Clariidae	+	+	+	+
L. brevicephalus	Cyprinidae	+	+	+	+
L. crassibarbis	Cyprinidae	+	+	+	+
L. surkis	Cyprinidae	+	-	-	-
L. acutrostris	Cyprinidae	-	-	-	+
L. tsanesis	Cyprinidae	-	-	+	-
L. macrophytalamus	Cyprinidae	-	-	-	+

L. megastoma	Cyprinidae	-	+	-	-
L. triuttiforms	Cyprinidae	-	-	-	+
O. niloticus	Cichildae	-	-	-	+

Table 8: Fish species composition in both Rivers (+Present, -Absent).

The family Cyprinidae and Clariidae were the dominant at Andassa and Gilgel Abay Rivers. *L. intermedius*, *V. beso*, *L. nedgia*, *C. gariepinus*, *L. brevicephalus*, and *L. crassibarbis* were common both in both seasons at Andassa and Gilgel Abay Rivers. However, *L. surkis* and *L. megastoma* found only at Andassa River both in wet and dry seasons. *L. tsanensis*, *L. triuttiforms*, *L. macrophytalamus*, *L. acutirostris* and *O. niloticus* were found only at Gilgel Abay in dry and wet seasons. Fish species found at Andassa River was the same in number in both seasons. At Gilgel Abay River, there were 7 and 9 fish species during wet and dry seasons, respectively. The fish diversity at both rivers were not the same in wet and dry seasons unlike the result reported by Dejen [20] at Beles and Gilgel Beles Rivers and Alekseyev et al. [12] at Ayima, Guang, Shinfa and Gendwuha Rivers where fish diversity was higher in dry season than wet season. High density in shallower pools in dry season and too easy to collect fish species using the available fishing gears could be the reasons for high diversity (Table 8).

Gilgel Abay River has eleven species, which is greater than Andassa River (eight species) in terms of number of species whereas total number of fish catch and total weight are lower in Gilgel Abay than Andassa. Shannon diversity index was used to evaluate species diversity of sampling sites and rivers. Shannon diversity index explains both variety and the relative abundance of fish species [21]. Andassa River has more species diversity than Gilgel Abay River in dry season but lower than wet season (Tables 9 and 10). The univariate analysis showed that there was significant difference in Shannon index (H′) and number of species between Andassa and Gilgel Abay Rivers (P<0.05). Shannon diversity index was higher in dry season than wet season in Andassa River at all sites but in Gilgel Abay River [22,23]. Shannon diversity index was lower in dry season than wet season.

	Sampling sites								
	AnS1	AnS2	AnS3	GAS1	GAS2	GAS3	GAS4	An	GA
H′	1.2	1.32	1.54	1.1	1	0.81	1.14	4.06	4.05
N	4	7	5	6	5	4	7	16	22

Table 9: Shannon diversity index and number species during dry season in both rivers.

	Sampling sites								
	AnS1	AnS2	AnS3	GAS1	GAS2	GAS3	GAS4	An	GA
H′	1.04	1.08	1.28	1.11	1	1.24	0.98	3.32	4.35
N	5	7	5	5	7	4	4	17	20
An=Andassa River and GA=Gilgel Abay River.									

Table 10: Shannon diversity index and number of species during wet season in both rivers.

The number of fish species and their weight were higher in dry season than wet season at Andassa but the reverse was recorded at Gilgel Abay. The reason may be due to the spawning migration of Labeobarbus species from Lake Tana to Gilgel Abay River during the rainy season (Table 11).

Andassa River was higher than Gilgel Abay River in both seasons by total weight of fish in kg and by number except during the wet season in number (Table 11). Number of fish Species across the sites in each river for both seasons is indicated (Figure 7). In Andassa River, the number of fish species in dry season was higher than wet season. In Gilgel Abay, the number of fish species in site one and two were higher in wet season than dry season but in site three and four less than dry season.

Rivers	Seasons	Total number (N)	Total weight (Kg)	Sum of each season	
				N	Weight (Kg)

Andassa	Dry	319	114.51	539	162.25
Gilgel Abay	-	220	47.74	-	-
Andassa	-	162	58.82	400	109.16
Gilgel Abay	Wet	238	50.34	-	-
Total	-	939	271.41	-	271.41

Table 11: Total number and weight of fishes at Andassa and Gilgel Abay Rivers.

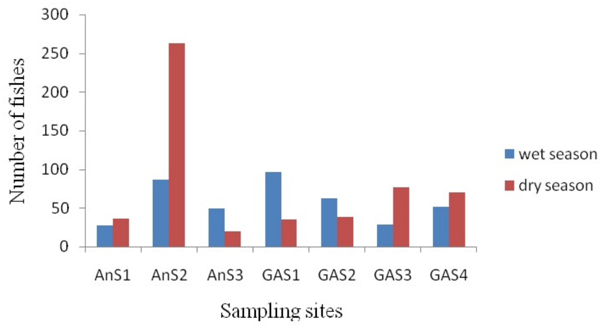

Figure 7: Number of fish species in each site for both seasons.

Abundance of fishes in both rivers is indicated in Tables 12-14.

Species	Wet	Dry	Total	%Composition	Sig
L. intermedius	102	168	270	56.13	0.000***
V. beso	15	64	79	16.42	0.000***
L. nedgia	12	24	36	7.48	0.046*
C. gariepinus	16	35	51	10.6	0.008**
L. brevichphalus	4	20	24	4.99	0.001**
L. crassibarbis	11	7	18	3.74	0.346
L. surkis	2	0	2	0.42	-
L. megastoma	0	1	1	0.21	-
Total	162	319	481	100	-
ns (non-significant (p>0.5), *significant (p<0.05), **highly significant (p<0.01), ***very highly significant (<0.001).					

Table 12: Abundance of each fish Species at Andassa Rivers in both seasons.

Species	Wet	Dry	Total	%Composition	Sig
L. intermedius	135	147	282	61.6	0.475
V. beso	33	9	42	8.95	0.000***
L. nedgia	40	27	67	14.63	0.112
C. gariepinus	20	12	32	6.99	0.157
L. brevichphalus	8	20	28	6.11	0.023*
L. crassibarbis	1	0	1	0.22	-
L. tsanensis	1	0	1	0.22	-
L. triuttiforms	0	1	1	0.22	-
L. acutirostris	0	2	2	0.44	-
L. macrophytalamus	0	1	1	0.22	-
O. niloticus	0	1	1	0.22	-
Total	238	220	458	100	-
ns (non-significant (P>0.05), and *significant, ***very highly significant (<0.001).					

Table 13: Abundance of each fish Species at Gilgel Abay River in both seasons.

Species	Season			Season		
	An	GA	Sig	AN	GA	Sig
	Wet	Wet		Dry	Dry	
L. intermedius	102	135	0.548	168	147	0.020*
V. beso	15	33	0.017	64	9	0.009**
L. nedgia	12	40	0.052	24	27	0.567
C. gariepinus	16	20	0.331	35	12	0.045*
Note:* significant and ** very significant.						

Table 14: Abundance of dominant fish species between Andassa and Gilgel Abay Rivers at both seasons.

The species composition of gillnet and monofilament catches at both dry and wet season classified based on the index of relative importance (IRI) for different sampling sites is shown in (Tables 15-18). *L. intermedius* was the most important species in Andassa River both during dry and wet seasons with % of IRI value 79.1, 77.73, 46.07 and 63.66, 50.99 and 15.82, respectively (Tables 15 and 16). At AnS3 at dry season *L. nedgia* % of IRI value 50.1 which is high important species. In wet season, *V. beso* is the second important fish species in site three (AnS3) with %IRI 30.19 (Table 15). In wet season, *L. crassibarbis* and *L. brevicepales* are less important in site AnS3 and AnS2, respectively.

Site	Fish	N	%N	W	%W	F	%F	IRI	%IRI
AnS1	*L. intermedius*	18	66.67	9142.99	55.79	4	33.33	4081.8	79.1
	V. beso	1	3.7	648.58	3.96	4	33.33	255.37	5
	L. nedgia	1	3.7	270.5	1.65	1	8.33	44.62	0.87
	C. gariepinus	3	11.11	1883.6	11.49	2	16.67	376.74	7.38
	L. crassiburbis	4	14.81	4443.3	27.11	1	8.33	349.39	6.84
Total	5	27	100	16388.9	100	-	-	5107.92	100
AnS2	*L. intermedius*	59	68.6	18944.4	57.83	4	26.67	3371.7	77.732
	V. beso	3	3.49	1547.9	4.73	3	20	164.28	3.79
	L. nedgia	6	6.98	4173.7	12.74	2	13.33	262.92	6.06
	C. gariepinus	6	6.98	2358.6	7.2	2	13.33	189.03	4.36
	L. crassiburbis	6	6.98	4592.6	14.02	2	13.33	279.97	6.46
	L. surkis	2	2.33	581.6	1.78	1	6.67	27.34	0.63
	L. brevicephalus	4	4.65	557	1.7	1	6.67	42.34	0.98
Total	7		86.046	32754.8	100	-	-	4337.59	100
AnS3	*L. intermedius*	25	51.02	2208.9	22.83	4	30.77	2272.26	46.07
	V. beso	11	22.45	4071.8	42.08	3	23.08	1489.14	30.19
	L. nedgia	5	10.2	976.9	10.1	2	15.38	312.31	6.33
	C. gariepinus	7	14.29	2017.5	20.85	3	23.08	810.83	16.44
	L. crassibarbis	1	2.04	401.1	4.15	1	7.69	47.58	0.96
Total	5	49	100	9676.2	100	-	-	4932.13	100

Table 15: Catch composition and index of relative importance (IRI) at Andassa River during wet season.

Site	Fish	N	%N	W	%W	F	%F	IRI	%IRI
AnS1	*L. intermedius*	22	61.11	3189	39.45	5	41.67	4190.06	63.66
	V. beso	7	19.44	2935.5	36.31	3	25	1393.97	21.18
	L. nedgia	1	2.78	229.7	2.84	1	8.33	46.83	0.71
	C. gariepinus	6	16.67	1729.4	21.39	3	25	951.52	14.46
Total	4	36	100	100	100	-	-	6582.37	100
AnS2	*L. intermedius*	141	53.61	43042.2	42.39	4	20	1919.96	50.99
	V. beso	53	20.15	21224.9	20.9	4	20	821.07	21.8
	L. nedgia	17	6.46	11857.7	11.68	4	20	362.82	9.63
	L. crassiburbis	7	2.66	6307.5	6.21	2	10	88.73	2.36
	C. gariepinus	27	10.27	16211.6	15.96	4	20	524.61	13.93
	L. brevicephalus	17	6.46	2408.8	2.37	1	5	44.18	1.17

	L. megastoma	1	0.38	495.7	0.49	1	5	4.34	0.12
Total	7	263	100	101548	100	-	-	3765.7	100
AnS3	*L. intermedius*	5	25	949	19.47	2	15.38	684.21	15.82
	V. beso	4	20	950.1	19.5	2	15.38	607.64	14.05
	L. nedgia	6	30	1970.2	40.43	4	30.77	2167.05	50.1
	C. gariepinus	2	10	691.7	14.19	2	15.38	372.21	8.61
	L. brevicephalus	3	15	312.2	6.41	3	23.08	494	11.42
Total	5	20	100	4873.2	100	-	-	4325.12	100

Table 16: Catch composition and index of relative importance (IRI) at Andassa River during dry season.

Site	Fish	N	%N	W	%W	F	%F	IRI	%IRI
GAS1	*L. intermedius*	58	60.4	10916.5	56.81	8	38.1	2224.45	72.37
	V. beso	18	18.75	2621.1	13.64	5	23.81	343.5	11.17
	L. nedgia	14	14.58	3119.6	16.23	4	19.05	323.79	10.53
	C. gariepinus	4	4.17	2350.5	12.23	3	14.29	178.9	5.82
	L. brevicephalus	2	2.08	209.5	1.09	1	4.76	3.17	0.1
Total	5	96	100	19217.2	100	-	-	3073.81	100
GAS2	*L. intermedius*	27	43.55	5489.2	41.36	6	30	2547.17	56.12
	V. beso	15	24.19	1895.8	14.28	4	20	769.54	16.96
	L. nedgia	13	20.97	4225.4	31.84	4	20	1056.07	23.27
	C. gariepinus	2	3.23	603.4	4.55	1	5	38.86	0.86
	L. brevicephalus	3	4.84	158.8	1.2	3	15	90.53	1.99
	L. crassibarbis	1	1.61	750	5.65	1	5	36.32	0.8
	L. tsanesis	1	1.61	150	1.13	1	5	13.72	0.3
Total	7	62	100	13272.6	100	-	-	4538.49	100
GAS3	*L. intermedius*	18	64.29	3613.7	41.99	3	30	3188.2	54.1
	L. nedgia	6	21.43	2856.8	33.19	3	30	1638.65	27.81
	C. gariepinus	3	10.71	1983.6	23.05	3	30	1012.85	17.19
	L. brevicephalus	1	3.57	1525	1.77	1	10	53.43	0.91
Total	4	28	100	8606.6	100	-	-	5893.13	100
GAS4	*L. intermedius*	32	61.539	3582.2	39.08	4	33.33	3353.92	57.99
	L. nedgia	7	13.462	1573.5	17.17	3	25	765.68	13.24
	C. gariepinus	11	21.154	3755.9	40.97	3	25	1553.2	26.86
	L. brevicephalus	2	3.8462	254.9	2.78	2	16.67	110.45	1.91
Total	4	52	100	100	100	-	-	5783.26	100

Table 17: Catch composition and IRI at Gilgel Abay River during wet season.

Site	Fish	N	%N	W	%W	F	%F	IRI	%IRI
GAS1	*L. intermedius*	20	57.14	3532.9	53.1	3	27.27	3006.4	64.6
	V. beso	7	20	1032.4	15.52	3	27.27	968.65	20.81
	L. nedgia	1	2.86	1092.2	16.42	1	9.09	175.21	3.76
	C. gariepinus	1	2.86	159	2.39	1	9.09	47.7	1.02
	L. brevicephalus	4	11.43	599.5	9.01	2	18.18	371.62	7.98
	L. acutirostris	2	5.71	237.2	3.57	1	9.09	84.36	1.81
Total	6	35	100	6653.2	100	-	100	4654.9	100
GAS2	*L. intermedius*	26	68.42	5050.6	70.12	6	50	831.24	88.6
	V. beso	1	2.63	179	2.49	1	8.33	5.12	0.55
	L. nedgia	3	7.89	213.9	2.97	1	8.33	10.86	1.16
	C. gariepinus	2	5.26	918.2	12.75	2	16.67	36.02	3.84
	L. brevicephalus	6	15.79	841.2	11.68	2	16.67	54.94	5.86
Total	5	38	84.21	7202.9	100	-	100	938.18	100
GAS3	*L. intermedius*	55	71.43	12059.3	79.3	6	46.15	6956.1	88.7
	V. beso	1	1.3	441.4	2.9	1	7.69	32.32	0.41
	L. nedgia	16	20.78	2107.78	13.86	2	15.38	532.91	6.79
	L. brevicephalus	5	6.49	599.1	3.9395	4	30.77	321.05	4.09
Total	4	77	93.50649	15207.58	100	-	100	7842.85	100
GAS4	*L. intermedius*	46	65.71	9562.1	51.19	5	33.33	584.42	74.62
	L. nedgia	7	10	3622.1	19.39	3	20	88.17	11.26
	C. gariepinus	9	12.86	4133.2	22.13	2	13.33	69.97	8.93
	L. brevicephalus	5	7.14	708.3	3.79	2	13.33	21.87	2.79
	L. triuttiforms	1	1.43	274	1.43	1	6.67	2.9	0.37
	L. macrophytalams	1	1.43	285.6	1.53	1	6.67	2.96	0.38
	O. niloticus	1	1.43	84.7	0.51	1	6.67	12.9	1.65
Total	7	70	100	18680	100	-	100	783.28	100

Table 18: Catch composition and IRI at Gilgel Abay River during dry season.

Mean percentage of IRI the dominant fish species *L. intermedius*, *V. beso*, *L. nedgia* and *C. gariepinus* are different each river. Among these species *L. intermedius* the first abundant species in both rivers than the rest dominant fish species. *C. gariepinus* was less abundant specie in Gilgel Abay at site two (GAS2) but it was the second most abundant specie in site four (GAS4) (Figure 8).

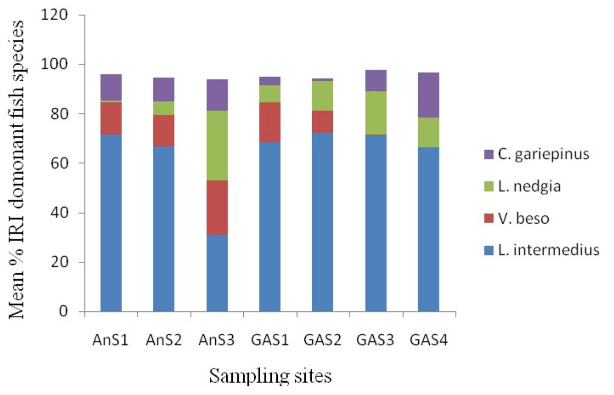

Figure 8: Mean percentage of IRI of the dominant fish species in each site.

Conclusion

- The fish fauna diversity of the both Rivers is dominated by cyprinidae fish species. Of the total 13 species, 11 species are included in the family cyprinidae. The rest are included in the family Clariidae and Cichlidae.
- Eleven and eight species were identified from Gilgel Abay and Andassa Rivers, respectively.
- *L. intermedius*, *V. beso*, *L. nedia* and *C. gariepinus* were the most dominant fish species in both rivers.
- From the total number of 939 fishes collected in Andassa and Gilgel Abay Rivers during the study period 9 (0.96%) specimens were unsexed, 930 fishes (99.04%) were sexed. Among the sexed 681 (73.23%) were females and 249 (26.77%) were males, implying a numerous females.
- The total weight of fish's 271410 gram and average weight of per fish 289.7 gram.
- Absolute fecundity of the three dominant fish species (*L. intermedius*, *L. nedgia* and *V. beso*) were strongly positively correlated with total length, total weight and gonad weight.

Recommendations

- There should be a detail study on the diversity, relative abundance and biology of fish species in the upper streams of both rivers.
- Year round data should be collected to have clear understanding on the reproductive biology of fishes.
- Rehabilitation works should be done on the buffer zones of both rivers. Gilgel Abay River deserves a special attention as the riverbank is highly degraded.
- Further study is needed on those fishes with low catch rates.
- *V. beso* could be taken as a good candidate for commercial fish production in the locality.

References

1. Wood R, Talling JF (1998) Chemical and algal relationships and salinity series of Ethiopian inland waters. Hydrobiologia 158: 29-67.
2. Tedla S (1973) Freshwater fishes of Ethiopia. Haile Selassie I University, Department of Biology Addis Ababa, Ethiopia, pp: 101.
3. Getahun A, Stiassny MLJ (1998) The freshwater biodiversity crisis: the cause of the Ethiopian freshwater fauna. SINET: Ethiopia J Sci 21: 207-230.
4. Minister of Water Resource (MoWR) (1998) Tekeze River basin integrated master plan project. Sectoral Report 6: 20.
5. Golubtsov AS, Mina MV (2003) Fish species diversity in the main drainage systems of Ethiopia: Status of knowledge and research perspectives. Ethiop J Natu Reso 5: 281-318.
6. Getahun A (2005b) An overview of the diversity and conservation status of the Ethiopian freshwater fish fauna. In proceeding of the Pan-Africa fish and fisheries society, Cotonoue, Benin.
7. Tedla S, Meskel F (1981) Introduction and transplantation of freshwater fish species in Ethiopia. SINET: Ethiop J Sci 4: 69-72.
8. Ameha A (2004) The effect of birbira, Milletia ferruginea (Hochst) Baker on some Barbus spp (Cyprinidae, Teleostei) in Gumara River (Lake Tana), Ethiopia pp: 24-25.
9. Roberts TR (1975) Geographic distribution of African freshwater fishes. Zool J Linn Soc 57: 241-319.
10. Tudorancea C, Gebremariam Z, Dadebo E (1999) Limnology in Ethiopia. In: Wetzel RG and Gopal B (editors). Limnology in developing countries. International Association for limnology 2: 63-118.
11. Tesfaye G (2006) Diversity, relative abundance and biology of fishes in Angereb and Sanja Rivers, Tekeze Basin, Ethiopia. MSc. thesis, Addis Ababa University, Ethiopia pp: 89.
12. Alekseyev SS, Yu D, Mina MV, Mironovsky AN (1996) Small, large barbs, spawning in tributaries of Lake Tana: what are they? Folia Zool 45: 85-96.
13. Golubtsov AS, Darkov AA, Yu D, Mina MV (1995) An artificial key to fish species of the Gambella region (the White NileBasin in the limit of Ethiopia). Joint Ethio-Russian Biological Expedition, Addis Ababa (JREBE) pp: 84.
14. Nagelkerke LAJ (1997) The barbus of Lake Tana, Ethiopia morphological diversity and its implication for taxonomy, tropic resources partitioning, and fisheries. PhD Thesis. Agricultural University Wageningen. The Netherlands.
15. Begon M, Haper JL, Townsend CR (1990) Ecology: individuals, population and communities. 2nd edition. JetBlackwell, Scientific Publication. University Saints Malaysia, Penang, Malaysia pp: 945.
16. Murdoch T, Martha C (1999) The stream keeper's field guide: watersheds inventory and stream monitoring methods. A product of the adpot-A-stream Foundation. Everett WA pp: 296.
17. Keeper CI (1998) Volunteer training manual: CookInlet keeper citizens Environmental Monitoring Program. Cook Inlet keeper Homer, Alaska, Wageningen, the Netherlands pp: 51.
18. American Public Health Association (APHA) (1992) Standard methods for examination of water and wastewater, 18th edition. Health Association, Washington, DC.
19. de Graaf M (2003) Lake Tana, s piscivorous Barbus (Cyprinidae, Ethiopia). Ecology, Evolution, exploration. Doctoral Thesis. Experimental Zoology group Wageningen University, Wageningen, the Netherlands.
20. Dejen E (2003) The small barbus Lake Tana. Doctorial thesis, Experimental Zoology group. Wagening University pp: 190.
21. Berie Z (2007) Diversity, relative abundance and biology of fishes in Beles and Gelgel Beles Rivers, Abay basin, Ethiopia. MSc thesis, Addis Ababa University, Ethiopia.
22. Tewabe D (2008) Diversity, relative abundance and biology of fishes in Gendwuha, Guang, Shinfa and Ayima Rivers, Tekeze and Abay basin, Ethiopia. M.Sc thesis, Addis Ababa University, Ethiopia pp: 108.
23. Naesje TF, Hay CJ, Nickansor N, Keokemoer JH, Strand R, et al. (2004) Fish population, gillnet catch and gillnet selectivity in the Kwando River. Namibia. Norwegian Institute of Nature research Tungasletta 2. No-7485.