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SHORT COMMUNICATION

DIVERSITY AND RELATIVE ABUNDANCE OF FISHES IN SOME TEMPORARY AND PERENNIAL WATER BODIES OF THE BARO BASIN, GAMBELLA, ETHIOPIA

Tesfaye Melak[1,*] and Abebe Getahun[2]

ABSTRACT: The diversity and relative abundance of fish species of the Baro basin were studied using samples taken from seven sites. Fishes were sampled using seines, dip nets (mesh sizes 0.5 cm and 1 mm), hook and line, fish traps, cast net (local fishermen) and electro-fishing. Specimens were identified to species level using taxonomic keys found in the literature. Shannon diversity index (H') and Index of Relative Importance (IRI) were computed to evaluate diversity and relative abundance of fish species, respectively. A total of 51 species belonging to 38 genera, 20 families and 11 orders were identified. The number of species varied among sampling sites. Thus, the highest number of species was recorded from Alwero (H'=2.56) followed by Obela, Baro at Gambella and Gilo (H'=2.03 each), Itang (H'=1.91) and Tdha (H'=0.35). Mormyridae, which comprised 8 species, was the most dominant family in number of species followed by Mochokidae (7 species) and Cyprinidae (6 species). *Barbus prince* was found in six of the studied sites whereas *Oreochromis niloticus* was found in five sites, *Brycinus macrolepidotus*, *Siluradon auritus*, *Clarias gariepinus*, *Barbus stigmatopygus* and *Polypterus senegalus* were each found in four sites, and thus, were considered the most dominant. IRI showed that *O. niloticus* (IRI=37.2%) was the most abundant species followed by *S. auritus* (IRI=14.6%), *B. macrolepidotus* (IRI=13.1%), *B. stigmatopygus* (IRI=10.0%), *B. prince* (IRI=9.8%), and *P. senegalus* (IRI=7.4%). Further comprehensive assessment of the fish diversity of the basin and socio-economic aspects for sustainable fish resource utilization is recommended.

Key words/phrases: Baro basin, Ethiopia, Fish diversity, Relative abundance.

[1] Department of Fisheries, Wetlands and Wildlife Management, College of Agriculture and Environmental Sciences, Bahir Dar University, P.O. Box 79, Bahir Dar, Ethiopia. E-mail: tesfayemelak@yahoo.com
[2] Department of Zoological Sciences, College of Natural Sciences, Addis Ababa University, P.O. Box 1176, Addis Ababa, Ethiopia. E-mail: abebeg@bio.aau.edu.et
* Author to whom all correspondence should be addressed

INTRODUCTION

Ethiopia lies between 8º 00′ N and 38° 00′ E and consists of 12 river basins. The drainage patterns are the result of the uplifting during the Tertiary Period (Abebe Getahun and Eshete Dejen, 2012). With its different geological formations and climatic conditions, Ethiopia is endowed with considerable water resources and wetland ecosystems and is often referred to as the 'water tower of northeast Africa' (Leykun Abunie, 2003). Thus, it is endowed with a total of 7,000 km of flowing (rivers and streams) (Wood and Talling, 1988) and 7,700 km^2 of standing waters (MOA, 2003).

The first explorer of Ethiopian freshwater fish was Rüppell in the 19th century. At the beginning of the 20th century, G.A. Boulenger undertook extensive work on African fish diversity, including on Ethiopian species (Abebe Getahun, 2007). Shibru Tedla (1973) was the first review work on the Ethiopian ichthyofauna by an Ethiopian author. Abebe Getahun and Stiassny (1998) reviewed the Ethiopian ichthyofauna with particular reference to conservation and recently, some aspects of the diversity and conservation of the freshwater fishes of Ethiopia were studied and reviewed by Abebe Getahun (2007).

According to various works (JERBE, 1995; Abebe Getahun and Stiassny, 1998; Abebe Getahun, 2007), the fish fauna of Ethiopia is a mixture of Nilo-Sudanic, East African and endemic forms. The Nilo-Sudanic forms are represented by genera such as *Alestes*, *Bagrus*, *Citharinus*, *Hydrocynus*, *Hyperopisus*, *Labeo*, *Malapterurus*, *Mormyrus*, *Polypterus* and *Protopterus*. The highland East African forms are represented by the genera *Barbus*, *Clarias*, *Garra*, *Oreochromis* and *Varicorhinus*. The Ethiopian endemics are so far represented by species such as *Danakilia franchettii*, *Nemacheilus abyssinicus*, some species of *Garra* and a large number of *Labeo barbus* species (Abebe Getahun, 2007).

According to Abebe Getahun (2007), the Ethiopian fish fauna consists of 152 reported valid species of which 41 species are endemic. However, Golubtsov and Darkov (2008) reported 180 species categorized within 70 genera and 29 families. A more recent listing puts this number to 200 species, with 194 indigenous and six exotic species (Redeat Habteselassie, 2012).

The southwestern part of Ethiopia is drained by the White Nile whose main tributaries within Ethiopia are Baro, Akobo and Pibor. The highest fish diversity but low level of endemism is recorded from the Baro basin. Low level of endemism is probably attributable to past and present connections

with the Nile and West and central African river systems (Abebe Getahun, 2007).

Shibru Tedla (1973) indicated that only 8 fish species have been recorded from the Baro basin. However, more than 90 fish species were recorded by JERBE in the same basin (Golubtsov *et al*., 1995). Abebe Getahun (2007) indicated that there were 87 fish species of which only one (*Nemacheilus abyssinicus*) was endemic to this basin. More recently, Golubtsov and Darkov (2008) indicated that there are 113 fish species included in 60 genera and 26 families from the same basin. The wide difference in number of species in the Baro basin justifies further work on fish species diversity. Therefore, this study attempted to investigate the diversity and abundance of fish species in some sites within the basin.

MATERIALS AND METHODS

Description of the study area

The study was conducted in Baro basin within Gambella National Regional State located in the southwestern part of Ethiopia (Fig. 1). The maximum and minimum mean monthly air temperature of the basin is 40.3°C and 19.3°C, respectively, at Gambella station and 39.1°C and 14.3°C, respectively, at Itang station. The main rainy season is between May and the end of October with mean monthly rainfall ranging from 0 mm to 190.2 mm at the Gambella station and between 0 mm to 141.6 mm at the Itang station (Gambella and Itang Meteorological stations). A total of seven sampling sites were selected based on velocity of water, habitat type, depth of water and substrate type consideration (Table 1). Sampling sites Gi, BG and BI are more turbid than the other sampling sites with muddy substrata. Sites Oc, Td, Ob and Al have a clear water with sandy, gravel and rocky substratum, respectively (Table 1). Oc, Td, Ob are temporary streams whereas the rest are perennial. The channel width at sampling sites was between 20 and 50 metres with slight stream gradient. *Acacia* tree and elephant grasses are the dominant vegetation and Nile crocodile was common in the sampling sites.

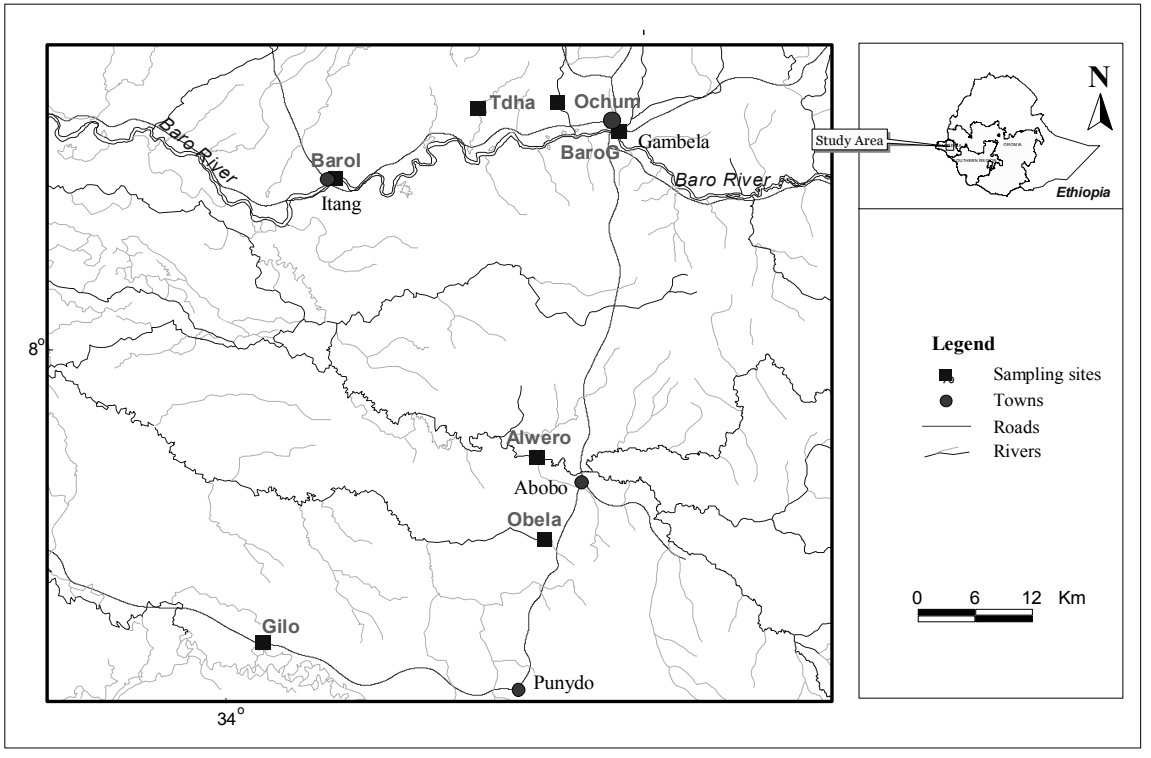

Fig. 1. Fish sampling sites used in the current survey within the basin.

Table 1. Currently surveyed fish sampling sites in Baro basin with the respective habitat types and coordinate points.

Site	Code	Habitat type	Coordinate
Alwero river at Abobo below dam	Al	Clear water, rocky, sandy, gravel	7 °52'24" N 34°29'48" E
Baro river at Gambella	BG	Turbid; muddy subs.	8°14'54"N 34°34'59"E
Gilo river at Lake Tata	Gi	Turbid; muddy subs.	7°39'34"N 34°10'55"E
Baro river at Itang	BI	Turbid; muddy subs.	8°11'28"N 34°15'57"E
Obela stream on the road from Gambella to Gog	Ob	Clear water, rocky, sandy, gravel	7°49'56"N 34°18'12"E
Tdha stream on the road from Gambella to Itang	Td	Clear water, rocky, sandy, gravel	8°16'13"N 34°25'36"E
Ochum stream on the road from Gambella to Itang	Oc	Clear water, rocky, sandy, gravel	8°16'40"N 34°31'11"E

Samples were taken during September 24 to October 24, 2008 since most of the sampling sites were temporary streams so that the fish will be available this time. Each sampling site was sampled twice using simple seines, dip nets (stretched mesh sizes 5 mm and 1 mm), hooks and lines and fish traps. In addition, cast nets of the local fishermen were also used in areas where simple seine and dip nets were not suitable. Furthermore, electro-fishing was also applied in smaller and fast running streams. Three days were spent for each site and samples were taken in the morning and afternoon.

Immediately after capture, total length and total weight of the dominant fish species were measured to the nearest 0.1 cm and 0.1 g, respectively, and were preserved in labelled plastic jars containing 5-10% formalin. The samples were then transported to the Department of Zoological Sciences, Addis Ababa University, for further investigation.

Identification

Specimens were identified to species level using taxonomic keys found in Boulenger (1909; 1911; 1915; 1916), Shibru Tedla (1973), Golubtsov *et al*. (1995), Skelton (2001), Paugy *et al*. (2003) and Stiassny *et al*. (2007).

Species diversity and relative abundance

Shannon diversity index (H') (Shannon and Weaver, 1949 cited in Leal-Flórez, 2007) was calculated as:

$$H = -\sum_{i=1}^{S} p_i \ln p_i$$

where p_i is the fraction of individuals belonging to the i^{th} species, S is total number of species. A high value of H' indicates high species diversity.

Relative abundance was studied by calculating index of relative importance (%IRI) in which high value of this index shows the most important species (Jutagate *et al*., 2005). IRI is a measure of the relative abundance or commonness of a species based on number and weight of individuals in catches. It gives a better representation of the ecological importance rather than the weight, number or frequency of occurrence alone (Sanyanga, 1996).

Index of relative importance (%IRI) was calculated as:

$$\%IRIi = \frac{(\%Wi + \%Ni) \times Fi}{\sum_{j=}^{S=} (\%Wj + \%Nj) \times \%Fj} \times 00$$

where %Wi and %Ni are percentage weight and number of each species of total catch, %Fj is percentage of frequency of occurrence of each species in total number of settings, %Wj and %Nj are percentage weight and number of total species of total catch, %Fj percentage frequency of occurrence of total species in total number of setting and S is the total number of species.

Data analysis

Data were analyzed using excel sheet of Microsoft office 2007 and SPSS statistical software for Windows, version 15.

RESULTS AND DISCUSSION

Species diversity and distribution

During the sampling period, a total of 949 specimens were collected from all the sampling sites, and 51 species within 38 genera and 20 families were recorded (Table 2). There are some unidentified species in the sampling sites still. All the representatives of the 20 identified families were reported by Golubtsov *et al*. (1995), Golubtsov and Mina (2003), Abebe Getahun (2007) and Golubtsov and Darkov (2008). It has also been reported by Brook Lemma (2008) that there were 13 endemic species from the White Nile drainage basin within the limits of Ethiopia. However, only one endemic fish species (*N. bleheri*) was recorded in this study. No exotic fish

species was recorded from the basin. The number of species identified was limited as compared with 115 identified before. This could probably be because the sampling sites were limited to only 7, of which 3 were temporary tributaries of Baro river. Species which are found in the main river may have escaped investigation as time and effort was spent mainly on the tributaries.

A higher number of species were recorded from Alwero (Al) (30 species), Obela (Ob) (23 species) and Baro at Itang (BI) (18 species). The number of species identified from Gilo (Gi), Baro at Gambella (BG), Ochum (Oc) and Tdha (Td) was 11, 10, 8 and 2, respectively (Table 2).

The diversity of fish in the studied basin contained a mixture of Nilo-sudanic (*Bagrus*, *Citharinus*, *Hydrocynus*, *Micralestus*, *Labeo*, *Mormyrus*, *Pollymirus* and *Polypterus*), East African (*Barbus*, *Clarias*, *Oreochromis* and *Sarotherodon*) and endemic (*N. bleheri*) forms. Mormyridae was the most dominant family in number of species comprising 8 species followed by Mochokidae (7 species) and Cyprinidae (6 species) (Table 2). The availability of more of shared species and less of endemic ones may be due to past connection between the White Nile and the Baro drainage basin (Abebe Getahun, 2007). The presence of these forms in the Nile basin has earlier been reported by Boulenger (1909), Shibru Tedla (1973), Golubtsov *et al*. (1995), Abebe Getahun and Stiassny (1998), Abebe Getahun (2000; 2007), Golubtsov and Mina (2003) and Golubtsov and Darkov (2008).

Among the 51 species identified, *Barbus prince* Rüppell, 1835 was found in six sites; *Oreochromis niloticus* Linnaeus, 1758 was found in five sites; *Brycinus macrolepidotus* Valenciennes, 1849, *Siluranodon auritus* Geoffroy Saint-Hilaire, 1827, *Clarias gariepinus* Burchell, 1822, *Barbus stigmatopygus* Boulenger, 1903 and *Polypterus senegalus* Cuvier, 1829, were found in four sites (Table 2). However, *Gymnarchus niloticus* Cuvier, 1829, *Marcuseniu cyprinoides* Linnaeus, 1758, *Mormyrops anguilloides* Linnaeus, 1758, *Pollimyrus isidori* Valenciennes, 1846, *Brycinus nurse* Rüppell, 1832, *Ichthyborus besse* Joannis, 1835, *Barbus humilis* Boulenger, 1901, *Labeo coubie* Rüppell, 1832, *Auchenoglanis occidentalis* Valenciennes, 1840, *Synodontis caudovittatus* Boulenger, 1907 and *Ctenopoma muriei* Boulenger, 1906 were found in two sampling sites and the rest of the species were found in only one sampling site (Table 2).

Table 2. Fish species composition of all the sampling sites, percentages of the number and frequency of occurrence (%No. and %F) of identified species in the current study from Baro basin (x: present; _: absent).

Order	Family	Species	Al	Ob	Oc	Td	BG	BI	Gi	%F	No.	%No.
Polypteriformes	Polypteridae	*Polypterus bichir*	_	x	_	_	x	x	_	2.80	3	0.32
		Polypterus senegalus	x	x	x	_	_	x	_	3.74	23	2.42
Osteoglossiformes	Gymnarchidae	*Gymnarchus niloticus*	_	_	_	_	x	x	_	1.87	2	0.21
	Osteoglossidae	*Heterotis niloticus*	_	_	_	_	_	x	_	0.93	1	0.11
	Mormyridae	*Brevimyrus niger*	_	x	_	_	_	_	_	0.93	2	0.21
		Hippopotamyrus pictus	_	_	_	_	x	_	_	0.93	1	0.11
		Marcusenius cyprinoides	x	_	_	x	_	_	_	1.87	3	0.32
		Mormyrops anguilloides	x	_	_	_	x	_	_	1.87	3	0.32
		Mormyrus caschive	_	_	_	_	x	_	_	0.93	1	0.11
		Mormyrus hasselquistii	x	_	_	_	_	_	_	0.93	1	0.11
		Petrocephalus bovei	_	_	_	_	_	x	_	0.93	40	4.21
		Pollimyrus isidori	x	_	_	_	_	x	_	1.87	2	0.21
Gonorynchiformes	Cromeriidae	*Cromeria nilotica*	_	_	_	_	_	x	_	0.93	12	1.26
Characiformes	Alestidae	*Brycinus macrolepidotus*	x	x	_	_	_	x	x	1.87	3	0.32
		Brycinus nurse	x	_	_	_	_	_	x	3.74	24	2.53
Characiformes	Alestidae	*Hydrocynus brevis*	x	_	_	_	_	_	_	0.93	1	0.11
		Micralestes acutidens	x	x	x	_	_	_	_	2.80	4	0.42
	Distichodontidae	*Distichodus engycephalus*	x	_	_	_	_	_	_	0.93	2	0.21
		Ichthyborus besse	_	x	_	_	_	_	x	1.87	17	1.79
		Nannaethiops bleheri	_	_	_	_	_	_	x	0.93	4	0.42
	Citharinidae	*Citharinus latus*	x	_	_	_	x	x	_	2.80	3	0.32

Order	Family	Species	Al	Ob	Oc	Td	BG	BI	Gi	%F	No.	%No.
Cypriniformes	Cyprinidae	*Barbus anema*	_	x	x	_	_	_	x	2.80	120	12.64
		Barbus humilis	x	_	x	_	_	_	_	1.87	66	6.95
		Barbus prince	x	x	x	x	_	x	x	5.61	64	6.74
		Barbus stigmatopygus	x	x	x	_	_	_	x	3.74	98	10.33
		Labeo coubie	x	x	_	_	_	_	_	1.87	2	0.21
		Labeo horie	x	_	_	_	_	_	_	0.93	1	0.11
Siluriforms	Bagridae	*Bagrus bajad*	x	_	_	_	_	_	_	0.93	1	0.11
		Bagrus docmak	_	_	_	_	x	_	_	0.93	1	0.11
	Claroteidae	*Auchenoglanis biscutatus*	x	_	_	_	_	_	_	0.93	3	0.32
		Auchenoglanis occidentalis	x	x	_	_	_	_	_	1.87	2	0.21
		Chrysichthys auratus	x	_	_	_	_	_	_	0.93	4	0.42
	Schilbeidae	*Schilbe intermedius*	x	x	_	_	_	x	_	2.80	64	6.74
		Siluranodon auritus	x	x	_	_	_	x	x	4.67	100	10.54
	Amphiliidae	*Andersonia leptura*	_	_	x	_	_	_	_	0.93	2	0.21
Siluriforms	Clariidae	*Clarias gariepinus*	x	x	_	_	x	x	_	3.74	6	0.63
		Mochokus brevis	_	_	_	_	_	x	_	0.93	8	0.84
		Mochokus niloticus	x	x	_	_	_	x	_	2.80	6	0.63
		Synodontis batensoda	x	x	_	_	_	_	x	2.80	6	0.63
		Synodontis caudovittata	x	_	_	_	_	x	_	1.87	2	0.21
		Synodontis schall	_	_	_	_	x	_	_	0.93	6	0.63
		Synodontis sorex	_	_	x	_	_	_	_	0.93	2	0.21

Order	Family	Species	Al	Ob	Oc	Td	BG	BI	Gi	%F	No.	%No.
Atheriniformes	Poeciliidae	*Aplocheilichthys kingii*	_	x	_	_	_	_	_	0.93	2	0.21
	Aplocheilidae	*Epiplatys spilargyreius*	x	x	_	_	_	_	_	2.80	10	1.05
		Nothobranchius virgatus	_	x	_	_	_	_	_	0.93	7	0.74
Perciformes	Cichlidae	*Hemichromis letourneuxi*	_	x	_	_	_	_	_	0.93	65	6.85
		Oreochromis niloticus	x	x	_	_	x	x	x	4.67	23	2.42
		Sarotherodon galilaeus	_	x	_	_	_	_	_	2.80	66	6.95
	Anabantidae	*Ctenopoma muriei*	_	x	_	_	_	x	_	1.87	42	4.43
		Ctenopoma petherici	x	_	_	_	_	_	_	0.93	15	1.58
Tetraodontiformes	Tetraodontidae	*Tetraodon lineatus*	x	_	_	_	_	_	_	0.93	3	0.32

The value of the Shannon-Weaver Index (H') ranged from 1.5 (low species richness and evenness) to 3.5 (high species evenness and richness). The value indicated that species diversity was relatively highest at Al (H'= 2.56) followed by Ob (H'= 2.27), BG and Gi (H'= 2.03 each), BI (H'= 1.91), Oc (H'= 1.47) and Td (H'=0.35). The reason for more diversity in Al, Ob and BI could be that these sites were well-vegetated, relative to other sites. Such habitats are preferred by most juvenile and small fish species because of slower current and stagnant water for resting, an abundant supply of food and warmer water.

Relative abundance

Out of the 949 specimens sampled in the study, the most abundant species in number were *B. anema*, *S. auritus* and *B. stigmatopygus*. These species contributed 120 (12.7 %), 100 (10.6 %) and 98 (10.4 %) of the total catch by number, respectively (Table 2). *Bagrus bajad* Forskål, 1775, *Bagrus docmak* Forskål, 1775, *Heterotis niloticus* Cuvier, 1829, *Hippopotamyrus pictus* Marcusen, 1864, *Labeo horie* Heckel, 1846, *Hydrocynus brevis* Gunther, 1864, *Mormyrus caschive* Linnaeus, 1758, *Mormyrus hasselquistii* Valenciennes, 1846 and *Aplocheilichthys kingii* Boulenger, 1913 were the least abundant species by number; they all had one specimen each (Table 2).

From all the identified species, only six species were measured for their weight and length, as they were dominant in number and frequency of occurrence and relatively among the commercially important species in the area. These were *P. senegalus*, *S. auritus*, *B. macrolepidotus*, *B. prince*, *B. stigmatopygus*, and *O. niloticus*. Even if *Barbus anema* was the dominant species in number, its weight was difficult to be measured as it was less than the sensitivity of the balance used (i.e. 0.1g). The species collected were analyzed based on Index of Relative Importance (IRI). Accordingly, *O. niloticus* (37.2%) was the most abundant followed by *S. auritus* (14.6%), *B. macrolepidotus* (13.1%), *B. stigmatopygus* (10.0%), *B. prince* (9.8%) and *P. senegalus* (7.4%) (Table 3). These fish species are among the commercially important species in Gambella regional state (Hussien Abegaz *et al*., 2010). The reason for their abundance could be associated with seasonal fishing activity and movement of fishes. According to Hussien Abegaz *et al*. (2010), fishing is highly seasonal in the Baro, Gillo, Alwero and Pibor rivers. Flooding between June and October prevents most fishermen from operating and thus the main fishing season is restricted to the drier periods between October and May. In addition to this, small fishes are susceptible to

fishing gears during the transition period from wet season to dry season. At this time, small and juvenile fishes move from flooded area to the river as the flood water recedes.

Table 3. Percentage of number, weight and Index of Relative Importance (IRI) of the most dominant species.

Species	Twt	%Wt	%IRI
B. prince	146.1	0.6	9.8
B. stigmatopygus	191.5	0.8	10.0
B. macrolepidotus	5477.9	23.4	13.1
O. niloticus	14004.7	59.8	37.2
P. senegalus	2643.2	11.3	7.4
S. auritus	967.6	4.1	14.6

NOTE: TWt- Total weight of specimens, %Wt- Percentage total weight of the species, %IRI- percentage index of relative importance of the species

It has been stated by Ward (1998) that biodiversity patterns are directly and indirectly influenced by the geomorphology of riverine landscapes. Golubtsov *et al*. (2002), also mentioned that the discharge of water influences the Ethiopian fish diversity. So the differences in fish diversity and abundance in the sites might be associated with the differences in habitat type, volume of water and vegetation cover of the area in addition to the efficiency of fishing gears and the extent of fishing effort exerted for sampling during the study period.

Therefore, since there are many temporary and permanent water bodies in the basin, comprehensive assessment of the diversity of fish in relation to habitat type, water volume and vegetation cover and socio-economic aspects in the Baro basin must be investigated for sustainable fish resource utilization.

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