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Abundance and species compositions of the fishes in blue Nile River, Ethiopia

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Abstract
In the present study we evaluate the relative abundance and species composition of fishes in Blue Nile River below the fall during the wet season (September-October, 2010) and dry season (March-April, 2011). Fish samples were collected by using monofilaments gillnets (5-55 mm) and multifilament gillnets, having mesh sizes of six, eight, ten, twelve and fourteen centimeter stretched bar mesh, having a length of twenty five meter and depth of one and half meter, on three sampling sites. Sefiana site had the higher diversity (average H'= 3.02). *Labeobarbus intermedius* was the most dominant (39.67% by number) followed by *Labeo forskalii* (27.77%) and *M. kannume* (11.67%). The other species, *L. nedgia, B. docmak*, *L. crassibarbis, C. gariepinus* and *O. niloticus* were found in 9.57%, 5.13%, 3.50%, 1.98% and 0.70%, respectively. All the fish species except *L. crassibarbis*, *B. docmak* and *C. gariepinus* were showed significant differences in abundance between seasons with overall catch composition of 39.67%, 27.77%, 9.57%, and 11.67% for *L. intermedius*, *L. forskalii*, *L. nedgia* and *M. kannume*, respectively. *L. intermedius*, *L. forskalii*, *L. nedgia* and *M. kannume* were the most important species in both seasons and in most of the sampling sites. The studied habitats are in danger being eroded and therefore catchment rehabilitation should be considered and the massive seasonal fishing by the local communities should be reduced.

Keywords: Abundance, basin, composition, diversity, relative, species

1. Introduction
Ethiopia is the water-tower of East Africa and has a number of inland water bodies. The Lakes and rivers cover a total area and length of about 7400 km^2 and 7700 km, respectively (Wood and J. Talling, 1988) [25]. In Ethiopia, there are nine major river basins. The Blue Nile basin is the largest basin in Ethiopia. Rivers of this basin drain the great central and north-west plateau. It accounts for almost 20% of Ethiopia's land area and 50% of its total average annual run-off (BCEOM, 1999; Getahun, 2005 a, b) [1, 8, 9].

Some of the families of fish identified within the Nile basin and its tributary rivers are Mormyridae, Characidae, Cyprinidae, Bagridae, Schlibidae, Mockokidae, Clariidae and Cichlidae (MoWR, 2010) [16]. The family Cyprinidae is the only group of fish that is more diverse in the Blue Nile drainage system than in White Nile system.

Studies on species diversity and abundance are important to obtain information on the quality and quantity of the available habitats. However, knowledge on the fish diversity, species distribution in Ethiopian ichthyo fauna is scarce (Getahun, 2005) [8]. Relatively a large number of small, medium and even large rivers have not been well studied including the ones explored in this study, the Blue Nile River below the Tiss Issat fall (Blue Nile River 30km downstream from the out flows and is isolated from the lower Nile basin by 45m high water falls. So the name of this famous fall is called Tiss Issat fall). The absence of information about fish species composition and relative abundance in this river triggered the necessity to conduct this study. Therefore, the studies to addressed the following research questions: 1) What is the species composition and relative abundance of fishes in the 'Blue Nile River Below the fall?
2) Does the fish species composition in the study different from Lake Tana?

2. Materials and Methods
The source of Blue Nile River is Lake Tana and flows at the Eastern outskirts of Bahir Dar town, forming the famous Blue Nile Fall (Tiss Issat Fall) after 30 km travel from its source which drops down into a gorge with a depth of about 45 m (Dile, 2009) [6]. Blue Nile River

basin lies in the west of Ethiopia between latitude 7°45' and 12°45' N, and longitude 34°05' and 39°45' E (MoWR, 2010) [16]. The present study was conducted in below the famous Blue Nile Fall of the Blue Nile River to the border between East and West Gojjam. It lies between West Gojjam (Yelimana Densa and Gonge Kolela districts) and South Gondar zones (Simada District), specifically the sites are Sefiana (10km after the Blue Nile fall), Abenaze (30km) and Wotetomider (60km) (Figure 1).

2.1. Field Sampling

Seven sampling sites were selected by considering nature and velocity of the flowing river, accessibility, interference by human beings and other farm animals and substrate type of the sediments and suitability for setting gillnets, the coordinates of the sampling sites were determined using GPS (Figure 1 and Table 1). Data was collected both in dry season (March-April, 2011) and wet season (September –October, 2011). Fish was sampled by an overnight setting of multifilament and monofilament gillnets. Multifilament gillnets had mesh sizes 6, 8, 10, 12 and 14 cm stretched bar mesh and a length of 25 m and a depth of 1.5 m. Whereas monofilament gillnets had mesh sizes of 5 mm - 55 mm and a length of 25 m and a depth of 1.5 m. Fish were identified to the species level using the keys developed by Nagelkerke (1997) [18]. After taking the entire necessary information, individual specimen were preserved with 4% formalin and put in plastic jar and was transported to the laboratory of Bahir Dar Fisheries and other Aquatic Life Research Center for further identification and to serve as a reference specimen.

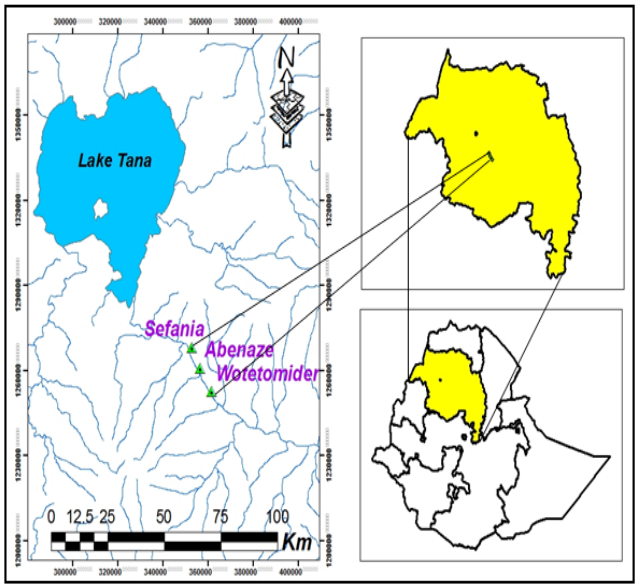

Fig 1: Map of the study area and sampling sites

Table 1: Sampling sites, estimated distance from the fall and coordinates in the river

Fishing Site	Distance from Tisisat fall(km)	Altitude(m)	Habitat	Width (m)	Coordinate (GPS)
Sefiana	8	1548	Clear water and rocky, sandy	350	11^0 27.7' 07" N;37 37.9' 60″ E
Abenaze	30	1528	Turbid muddy	250	11^0 24.3' 06" N; 37^0 40' 51" E
Wotetomider	60	1493	Clear water and rock gravel	200	11^0 31.5' 03" N; 37^0 52.9' 48" E

2.2. Species diversity and relative abundance

Estimation of relative abundance of fish was made by the contribution of the catch in each sampling effort. An Index of Relative Importance (IRI) and Shannon -Diversity Index (H') were used to evaluate relative abundance and diversity of fish, respectively. An 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 (Kolding, 1989) [12]. IRI gives a better replacement of the ecologically important species rather than the weight, number or frequency alone (Sanyanga, 1996) [20].

$$\%IRIi = \frac{(\%Wi + \%Ni) \times \%Fi \times 100}{\sum_{j=1}^{j=1} (\%Wj + \%Nj) X \%Fj}$$

Where, %Wi and %Ni are percentages weight and number of each species of total catch, respectively. %Fi is a percentage frequency occurrence of each species in total number of settings. %Wj and Nj are percentage weight and number of total species in total catch. Fj is percentage frequency of occurrence of total species in total number of settings. The Shannon index of diversity (H'): H' is a measure of species weighted by the relative abundance (Begon *et al*., 1990) [2]. H' is calculated as follows:

$H' = \sum pi \ln pi$

Where, pi - the proportion of individuals in the i^{th} species. Shannon index is used to indicate diversity of fishes at different sampling sites or rivers.

2.3. Data Analysis

Descriptive statistics was used to analyze the mean value of the biomass weight during wet and dry seasons and also the mean, range and standard error of the species length frequency. The significant difference of species relative abundance during wet and dry season was analyzed using t-test. One way ANOVA was used to determine the significant difference of species diversity between sites. SPSS version 16 and Microsoft Excel sheet 2007 was used to analyze and manage the data.

3. Results and Discussion

3.1. Species composition

A total of eight species were identified, namely: *L. intermedius*, *L. forskalii*, *M. kannume*, *L. nedgia, L. crassibarbis, C. gariepinus* and *O. niloticus* (Table 2). They are represented by a single class Actinopeterygii (ray-finned fishes), *4 orders (*Cypriniformes, Osteoglossiformes, Siluriformes and Perciformes), 5 families (Cyprinidae, Cichlidae, Bagridae, Clariidae and Mormyridae) and 6 genera. In the studied river, the family Cyprinidae followed by Mormyridae was the dominant family. The freshwater fish fauna of in the studied river contained a mixture of Nilo-Sudanic (*M. kannume*, *B. docmak* and *L. forskalii*) and highland East African forms (*L. intermedius*, *L. nedgia*, *L. crassibarbis, C. gariepinus* and *O. niloticus*).

Whereas *L. intermedius*, *L. forskalii M. kannume*, *L. crassibarbis, L. nedgia and B. docmak* were found in most of the sampling sites, *C. gariepinus* and *O. niloticus* were not

found at the lower site (named Wotetomider) in the Blue Nile River (Table 2). The number of fish species was low at Wotetomider and Abenaze as compared to Sefiana sampling site (Table 2). Thus, *L. intermedius*, *L. nedgia* and *L. forskalii* were collected from all the sampling sites in both seasons (Table 2). Whereas *M. kannume* and *B. docmak* were collected from all the sampling sites only in wet seasons. Blue Nile River below the Tiss Issat Fall was dominated by the family Cyprinidae and Bagridae mainly by the genus *Labeobarbus and Bagrus*.

Table 2: Fish distribution among thee sampling sites during both wet and dry seasons (NB: present, +, absent, -)

Sites	Seasons	Species							
		L. intermedius.	***L. forskalii***	***L. forskalii***	***L. crassibarbis***	***M. kannume***	***B. docmak***	***C. gariepinus***	***O. niloticus***
Sefiana	Wet	+	+	+	+	+	+	+	+
	Dry	+	+	+	+	+	+	+	+
Abenaze	Wet	+	+	+	+	+	+	+	-
	Dry	+	+	+	+	+	+	+	-
Wotetomider	Wet	+	+	+	+	+	+	-	-
	Dry	+	+	+	+	-	-	-	-

3.2. Species diversity and abundance

Shannon diversity index (H') was used to evaluate species diversity in all sampling sites. Shannon diversity index explains both variety and the relative abundance of fish species (Naesje *et al*., 2004) [17].

The H' was highest at Sefiana with the values of (H' = 1.44) followed by Abenaze (H' = 1.33), and Wotetomider (H' = 1.23) during dry season (Table 3). The H' was highest at Wotetomider with the values of (H' = 1.64) followed by Abenaze (H' = 1.60) and Sefiana (H' = 1.58) during the wet season sampling period (Table 3). *Bagrus docmak*, *L crassibarbis*, *C. gariepinus* and *O. niloticus* were no significant variation (P > 0.05) in H' and N among all the sampling sites in both seasons. The number of fish species was 553 (dry season) and 304 (wet seasons). Shannon diversity index (H') value was generally higher in wet season than dry season in all the sampling sites (Table 3). Generally the Shannon diversity index indicates that there was species segregation among the sampling sites and seasons, indicating all the eight fishes species are adapted to live in all the sampling sites.

Table 3: Shannon diversity index (H') and number of fish species (N) in wet and dry season

Season	H'/N	Sampling Sites		
		Sefiana	**Abenaze**	**Wotetomider**
Dry	H'	1.44	1.33	1.23
	N	8	6	4
Wet	H'	1.58	1.60	1.64
	N	7	7	6

During the study period 2320 kg and 1280 kg total biomass of specimens were collected during dry and wet seasons, respectively(data not shown). Dry season showed higher values than wet season in terms of weight (kg) and number of specimens of fishes. In all sampling sites the number of fishes was high during the dry season than wet (Table 4). The reason for such variations could be probably due to the high turbidity of the river water, velocity of the water and low temperature during wet season may have attributed to the less number of fish caught in that season. During wet season, there was also higher water discharge; fishes could have highly dispersed in the large volume of water in this season as compared to the dry season and it became difficult to catch them. In addition, the variation in catches between wet and dry seasons might be due to the variation gillnet efficiency and time of setting of gillnet. Wood logs, leaves, roots and grasses which were brought by flooding, could have decreased the efficiency of gillnets during the wet season.

3.3. Relative abundance of fish during wet and dry seasons

Labeobarbus intermedius, *L. forskalii*, M. kannume and *L. nedgia* were showed very highly and highly significant variation in number of catches between dry and wet seasons (P<0.01) and (P< 0.05), respectively (Table 4). In this study, *L. intermedius* was the most abundant specie, constituting of 39.67% in the total number of catch. *Labeo forskalii, L. nedgia, M. kannume, B. docmak,* and *L. Crassibarbis,* were found in relative abundance of 27.77%, 9.57%, 11.67%, 5.13%, and 3.50%, respectively (Table 4). The species composition of all catches both in dry and wet seasons ranked based on the IRI value for different sampling site (Tables 5 and 6). *Labeobarbus intermedius* was the most important fish species in dry season at Sefiana, Abenaze, and Wotetomider with IRI values of 58.82%, 54.54%, and 48.05%, respectively but *L. forskalii* was the most important fish species in dry seasons at Abenaze and Wotetomider and wet seasons at Sefiana with IRI values of 37.27%, 22.41% and 27.37%, respectively (Table 5and 6). *L. intermedius*, *L. forskalii* and *L. nedgia* were the most important fish species in dry season for sites Sefiana and Wotetomider with IRI values of 58.82%, 24.56%, 7.21%, and 48.05, 22.41%, 22.23%, respectively. The %IRI value of *L. intermedius* was higher in dry season than wet season at all sampling sites (Table 5).

Table 4: Total catches of fishes in dry and wet seasons (t-test)

Seasons					
Fish species	**Wet**	**Dry Total**		**Percentage Composition**	**P-value**
L. intermedius	97	243	340	39.67	0.000***
L. forskalii	59	179	238	27.77	0.000***
L. nedgia	30	52	82	9.57	0.015*
L. crassibarbis	16	14	30	3.50	0.715^{ns}
M. kannume	69	31	100	11.67	0.00**
B. docmak	27	17	44	5.13	0.132^{ns}
C. gariepinus	6	11	17	1.98	0.225^{ns}
O. niloticus	0	6	6	0.70	-

Note: *(P<0.05) (significant), ** (P<0.01) (highly significant), *** (P<0.001) (very highly significant), and ns (P>0.05) (non significant)

Table 5: Index of Relative Importance (IRI) of fishes in all sampling sites during dry season.

Sites	Fish	N	%N	W	%W	F	%F	IRI	%IRI
Sefiana	*L. intermedius*	113	41.9	56184	48.2	7	21.21	1915	58.82
	L.forskalii	95	35.2	35714	30.78	4	12.12	799.5	24.56
	L. nedgia	19	7.04	6818	5.88	6	18.18	234.8	7.21
	L. crassibarbis	4	1.48	5438	4.69	2	6.06	37.38	1.55
	M. kannume	18	6.67	4281	3.69	4	12.12	125.5	3.86
	B. docmak	9	3.33	4074	2.04	3	9.09	62..22	1.91
	C. gariepinus	6	2.22	2364	1.01	4	12.12	51.63	1.59
	O. niloticus	6	2.22	1171	1.00	3	9.09	29.38	0.90
	Total	270	100	116044	51.43	-	-	32.55	-
Abenaze	*L. intermedius*	74	45.1	31355	31.84	6	31.6	3049	54.54
	L.forskalii	56	34.15	19411	26.7	4	21.12	2084	37.27
	L. nedgia	8	4.88	1626	4.08	2	10.5	79.42	1.42
	M. kannume	13	7.93	2486	6.10	3	15.8	189.5	3.39
	B. docmak	18	4.88	3716	3.89	2	10.5	115.5	2.07
	C. gariepinus	5	3.05	2369	1.00	2	10.5	73	1.31
	Total	164	100	60963	48	-	-	5590	-
Wotetomider	*L. intermedius*	56	47.1	26447	15	6	26.09	2483.5	48.05
	L.forskalii	28	23.5	7978	17	7	30.43	158.12	22.41
	L. nedgia	25	21	9204	21	7	30.43	1149.32	22.23
	L. crassibarbis	10	8.4	11304	5.01	3	13.04	378.02	7.31
-	Total	119	100	54933	100	-	-	5169.01	-

(NB: %Wi and %Ni = percentages in weight and number of each species of total catch. %Fi = percentage frequency occurrence of each species in total number of settings. %Wj and Nj = percentages in weight and number of total species in total catch. Fj = percentage frequency of occurrence of total species in total number of settings).

Table 6: Percentage of Index of Relative Importance (IRI) of fishes in all sampling sites during wet season.

Sites	**Fishes**	**N**	**%N**	**W**	**%W**	**F**	**%F**	**IRI**	**%IRI**
Sefiana	*L. intermedius*	32	29.09	12702	29.74	5	18.52	1089.94	30.55
	L.forskalii	20	18.18	8314	19.74	7	25.93	976.06	27.37
	L. nedgia	3	2.73	968	2.27	2	7.41	36.99	1.04
	L. crassibarbis	6	5.43	6827	15.98	2	7.41	158.80	4.45
	M. kannume	38	34.45	9237	21.63	5	18.52	1040.22	29.17
	B. docmak	8	7.27	3210	7.52	4	14.81	219.08	6.14
	C. gariepinus	3	2.73	1454	3.40	2	7.41	45.42	1.27
	Total	110	100	42712	100	-	-	3565.98	-
Abenaze	*L. intermedius*	43	36.75	18361	34.77	6	22.22	1589.29	42.17
	L.forskalii	24	20.51	9794	18.54	7	25.93	1012.60	26.87
	L. nedgia	5	4.27	4666	8.83	1	3.70	48.55	1.29
	L. crassibarbis	4	3.42	6257	11.85	2	7.41	113.08	3.00
	M. kannume	27	23.08	7048.6	14.78	5	18.52	701.03	18.60
	B. docmak	11	9.40	4488	8.50	4	14.81	265.18	7.04
	C. gariepinus	3	2.56	1442	2.73	2	7.41	39.22	1.04
	Total	117	100	52813	100	-	-	3768.95	-
Wotetomider	*L. intermedius*	22	28.57	8606	27.75	7	31.82	1728.44	43.58
	L.forskalii	15	19.48	5401	16.16	4	18.18	648.03	16.34
	L. nedgia	22	28.57	8598	25.73	4	18.18	987.25	24.89
	L. crassibarbis	6	7.79	6490	19.42	2	9.09	247.34	6.24
	M. kannume	4	5.19	755	2.26	2	9.09	67.76	1.71
	B. docmak	8	10.39	3570	10.86	3	13.64	287.34	7.24
	Total	77	100	33420	100	-	-	3966.20	-

(NB: %Wi and %Ni = percentages in weight and number of each species of total catch. %Fi = percentage frequency occurrence of each species in total number of settings. %Wj and Nj = percentages in weight and number of total species in total catch. Fj = percentage frequency of occurrence of total species in total number of settings.)

There might be several reasons for variation in abundance between wet and dry seasons. Variation in available nutrients and habitats, temperature, fishing effort, fish behavior, size and life history stages of fishes and others might have contributed to the variation in abundance of the catches. Moreover, water level (Karenge and Kolding, 1995) [11] and turbidity of water may also affect abundance.

Generally in this study, fish species composition (8 species) of the Blue Nile River after the Tiss Issat fall (which is was low (Table 7) as compared to results reported by other workers in the upper Blue Nile, Lake Tana and Tekeze drainage basins. Oumer (2011) [19] reported 17 species from head of Blue Nile River (Lake Tana to Tiss Isat Fall), Tesfaye (2006) [21] identified 10 species from Sanja and Angereb Rivers, Beletew (2007) [3] reported 17 species from Beshilo, Dura and Ardi Rivers, Berie (2007) [4] 23 species from Beles and Gelegel Beles, Tewabe (2008) [22] 27 species in Guang, Ayima, Gendwuha and Shinfa Rivers, Melak (2010) [13] 59 species from Baro and Tekeze Basins. The low species diversity may be related to the flow variability has an effect on fish assemblage and productivity of the river. The presence of few fish species and dominance of few family in this study seemed

that these cyprinid fishes, being riverine origin, are specifically segregated or adapted in the Blue Nile and its tributaries. Flow variability might also have an effect on fish assemblages, for example, high flows could destroy fish habitat and wash away the already laid fish eggs. The fish species compositions after the Tisisat fall of Blue Nile River were different from above the fall and Lake Tana as compared with Mohammed Omer (2011) and (Nagekerke, 1997) [18] reports, respectively. This might be due to the isolation the lake's ichthyofauna from the lower Nile basin (de Graaf, 2003) [5] and special adaption of the riverine cyprinids. In this study, *L. forskalii* was identified which was not recorded from de Graaf (2003) [5] in Lake Tana and Oumer *et al*. (2011) [19] in head of Blue Nile River. Cyprinids is the dominance family especially *L. intermedius* and *L. nedgia* were common in most of the Ethiopian inland water bodies previously reported in Lake Tana (de Graaf, 2003) [5], Tewabe *et al*. (2009) [23], Anteneh (2008), Oumer *et al*. (2011) [19], Gebremedihn *et al*. (2012) [7], and recently Mequaninnet (2012) [14] in the same river basin. The presence of this specie. So like *L. intermedius* and *L. nedgia* is found in most of the river systems in Ethiopia. The preliminary survey done by Golubstov and Mina (2003) [10], about 4-5 km downstream from Tissisat falls recorded the four typical Nilotic species: *Morymurs hasslequistii*, *L. forskalii*, *Raiamas senegalensis* and *Bagrus docmak*. Except *L. forskalii* and *B. docmak* none of them was found. As mentioned above, this may be due to some kind of ecological niching of the existing fishes in the same river system. Differences in sampling habitats (river width, substrate type, source distance and depth), fishing effort, type of gear and gillnet efficiency, sampling seasons and altitude might have contributed to the variation in the catch rates and species diversity.

Table 7: Comparison of fishes species composition at Lake Tana source of Blue Nile River (BNR), BNR before the Fall and BNR after the Fall (+ = present and - = absent)

Species	Lake Tana (Nagelkererke, 1997)	BNR Before the fall (Oumer *et at*., 2011)	BNR After the fall (This study, 2011)
L. intermedius	+	+	+
L. nedgia	+	+	+
L. crassibarbis	+	+	+
L. surkis	+	+	-
L. longissimus	+	+	-
L. platydorsus	+	+	-
L. gorgorensis	+	+	-
L. brevicephales	+	+	-
L. tsanansis	+	+	-
L. acutirostris	+	+	-
L. megastoma	+	+	-
L. gorguri	+	+	-
L. daineillii	+	+	-
L. macrophthalmus	+	-	-
L. triuttiforms	+	-	-
G. dembecha	+	+	-
V. beso	+	+	-
C. gariepinus	+	+	-
O. niloticus	+	+	-
Small Barbus	+	-	-
B. docmak	-	-	+
L. forskalii	-	-	+
M. kannume	-	-	+

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