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MAJOR FISH COMPOSITION OF ALWERO DAM AND BARO/KIR RIVER OF GAMBELLA, SOUTH WEST ETHIOPIA

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AUTHORS' CONTRIBUTIONS

This work was carried out in collaboration among all authors. Authors GA, TG and KT Conceptualized the writing and Formal analysis by authors GA, TG , Investigation by authors GA, TG, Methodology by authors GA, TG, KT. Original draft written by author GA and review and editing by authors GA, TG. All authors read and approved the final manuscript.

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ABSTRACT

Introduction: Fish are the top listed water bodies' resources which are consumed by human beings worldwide and contributed a substantial part of the nutrition supply and important source of diets.
Methods*:* A study has been conducted in Baro/Kir River and Alwero dome of Gambella people's regional state to identify the major components of fish. Totally 24 fish species from 386 specimens have been collected using gillnet with mesh sizes of 4-14cm, cast net, hook, lines, and traditional fishing gears were also used such as spears and they are identified using FAO standards, biological atlases, and senior biologists in to order, family and species.
Results: The outcome of this study showed that a total of 24 species grouped in 6 orders and 15 families were identified. Baro/Kir River considerably has the highest number of fish diversity (H=2.22) from the sampled sites. The *Siluriformes* were the most diverse family. Besides, the most abundant species were *Tilapia zilli, Orcharomis nilotics, Lates niloticus* and *Heterotis nilotics* and with 63, 53, 42and 37 respectively.
Conclusion: This was carried out in one season (dry season) and limited site. Hence, it is difficult to generalize the fish diversity status of the region. Therefore, further study should be conducted to figure out accurate information on the diversity of fish species in the Gambella region's main water bodies.

Keywords: Fish; species; river; dam; Ethiopia.

1. INTRODUCTION

Water covers 71% or ¾ of the Earth's surface from that 97.5% of the water on Earth is salt water and only 2.5% is freshwater, 98.8 % of that water is in ice and groundwater. Less than 0.3% of fresh water is in rivers, lakes, and the atmosphere Sub-Saharan Africa is the poorest region in the world [1].

Among the top listed water bodies' resources, fish is the most important one consumed by human beings worldwide and contributed a substantial part of the nutrition supply and important source of diets [2]. Besides fish used for consumption and earning economic gain for human beings, they are also used for water body ecosystem balancing and recreation purposes in most developed countries [3].

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From searches of the works of literature, the diversity of fish worldwide is over 32,000 known species. Out of them, almost 27,000 species include bony fish, whereas 970 species out of the remaining include rays, sharks, and chimeras, and 108 lampreys and hagfish [2].

In Ethiopia, there are 180 different species of fish and 30 of those are native to the country [4]. The country has a total area of lakes and reservoirs stands estimated at 7000 to 8000 km^2 and the important rivers stretch over 7000 km in the country [5].

In Ethiopia, wetland covers about 2% [6]. Except coastal and marine-related, all forms of wetlands are represented in Ethiopia. More than 50 % of these wetlands are the major lakes and the rest are swamps and marshes. The largest swamps and flood plains in Ethiopia are found in Gambella that comprises 125 km^2 of the total area of Ethiopian small water bodies estimated to 275km^2 [7].

The fish consumption per head per year of Ethiopia is very low based on FAO estimates. For instance, the per capita assessments in 2009 were estimated at 0.2 kg, which places the country in the lower end of fish consumers amongst African countries (where the average is 9.4 kg). Later on in 2012, the national estimates indicated a higher yearly per capita consumption of 0.34 kg [8]. Certainly, this national average does not reflect regional differences in consumption. It is obvious that in areas surrounding lakes and rivers, yearly consumption would show variability as studies indicated it can reach 21 kg per capita [9]. Domestic supply is fulfilled entirely by capture fisheries and fishery resources are assessed as underexploited overall. However, the rapid growth of population and the progressive shortage of livestock products had changed the situation to a growing demand for fish [7]. Even if the available stocks of these fishery waters will be fully exploited shortly, both current and future demand for fish by the population cannot be met according to the Ethiopian Investment Authority [10].

Among the species of fish: tilapia (*Oreochromisniloticus*), flathead catfish (*Pylodictisolivaris*), and common carp (*Cyprinuscarpio*) are common in most water bodies of Ethiopia [2].

Many years back research outputs and reports indicated that Gambella Region is potentially rich in fish population and can supply fish for the majority of the country's population if well utilized and processed. Although the fish utilization and consumption pattern are increasing, information on the current challenges of fish production and utilization in Gambella is absent and there are no current studies on the species types abundantly present in the area used for human consumption. In the Baro-Akobo Basin, only eight fish species have been recorded from the Baro basin [11]. Abebe Getahun [12] also indicated that only one species (Nemacheilusabyssinicus) is endemic to this basin. The diversity of fish fauna Baro drainage basins contains a mixture of Nilo-Sudanic (*Bagrus, Citharinus, Hydrocynus, Micralestus, Labeo, MormyrusPollymirus,* and *Polypterus*), East African (Barbus, Clarias, Oreochromis, and Sarothrodon), and endemic (Garra) forms. Tesfaye Melake(2009) recorded from Baro and Tekeze drainage basins comprised 51 fish species from Baro River and 10 species have been recorded from Tekeze Basin of which 3 are endemic *(G. duobarbis, G. geba* and *G. ignestii*). Overall, the fish communities in most parts of the fish resource-rich areas of Gambella water bodies are not well studied and documented except many years back report by the Russian [13]. Henceforth, this study was conducted to examine the fish community populations and species in Gambella regional states in Alwero dam and Baro/Kir River.

2. MATERIALS AND METHODS

2.1 Research Location and Description of the Study Area

This study was conducted in Gambella Peoples regional State, southwest Ethiopia located 777 km from Addis Ababa the main capital city. Administratively, the region consists of three zones (Anywa, Nuwer & Mejeng) and 13 Woredas. The geographical location lies between latitudes 6^0 22' and 8^0 30' N, and longitudes 33^0 10' and 35^0 50' E. The Gambella region elevation ranges from ~1,000 to ~2,000 m above sea level (masl) in the east, from ~500–900 masl in the center, and ~300–500 masl in the west [14]. This altitude indicates the gentle slopes to the west, while its easternmost part consisted of the high plateau, mountain peaks, and rugged terrain. The variable topographic features of the region influence the vegetation cover, the soil type, and the climatic conditions. The annual rainfall of the region with an elevation of 400-500 m. a. s. l is 900mm-1500mm while, it reaches up to 1900-2100mm as the elevation increased to 2000 m. a. s. l. It is during the wet season (from May to October) that 80-90 percent of the total rainfall occurs in the region and December, January, and February are considered to be the dry season. The relative air humidity increases during the wet season (70-80 %) and sharply decreases in the dry season (43-60 %). Sometimes the maximum daily relative air humidity during the wet season reaches 100 %, while the minimum daily relative air humidity reaches 9%

in the dry season. The total annual value of the surface water evaporation in the region has been estimated to reach 1612 mm; the maximum. The study sites were located in the Abobo and Itang special districts of Alero and Baro/Kir rivers of Gambella respectively.

2.2 Filed Work Study

Based on accessibility and fishing practices; Alwero dam and Baro/Kir river were selected for this study (**Fig. 1**).

The characteristics of ADA sampling sites have clear water, rocky, sandy, gravel, and KIR have turbid water, sand, and muddy(Table 1). The coverage (width) of all sampling sites was between 35 and 45. The *Acacia* species tree and elephant grasses are the most dominant vegetation's and Nile crocodile was common in the sampling sites.

2.3 Baro Kir/Openo River

Baro Kir/Openo river is among the thirty-five major water bodies which are found in the region and it has a length of 285km in which its depth and side increase downstream. It is located 49 kilometers from Gambella city and around 5 kilometers far away from Itang's special district. The local people adapted to live on the riverbank since time immemorial and fishing is one of the main sources of their income. Baro/ Kir River originated from high land mountainous areas particularly, from Bure in Oromia and the other sources from Masha and Tepi in Southern Nation and Nationality. Moreover, all these rivers in Gambella provide or contribute to Baro/Kir/ river can increase the water level during the wet season. The area is well known by diverse grasslands and scattered trees surrounding it at the lower end and the soil type is muddy loam, slightly clay, and sand in which the depth increases downstream.

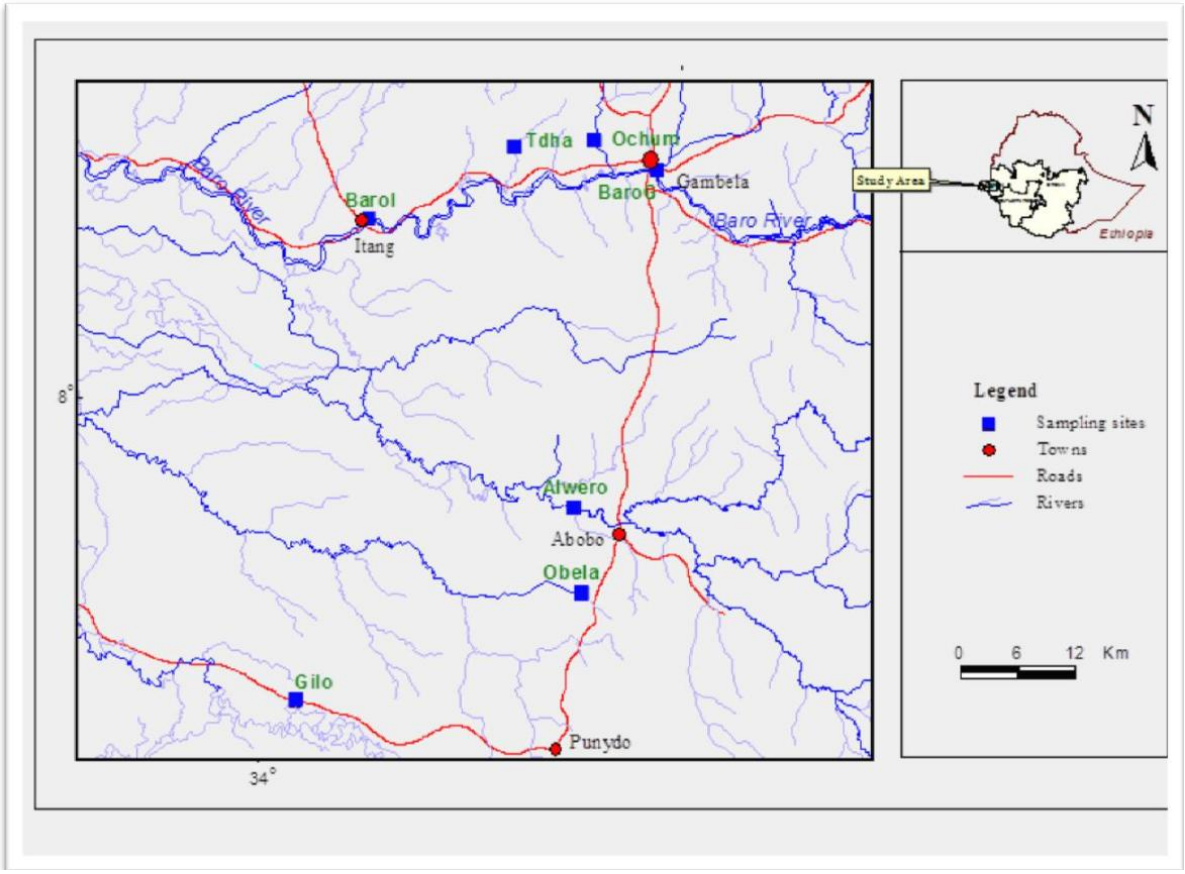

Fig. 1. Water Bodies with Sampling Sites

Table 1. GPS data and some characters of sampling sites

Site	Code	Habitats	GPS coordinate
Alwero Dam	ADA	Clearwater, rocky, sandy, gravel	07^0 58' 32" N
Kir River	KIR	Turbid water, sand, mud	08^0 15' 47" N

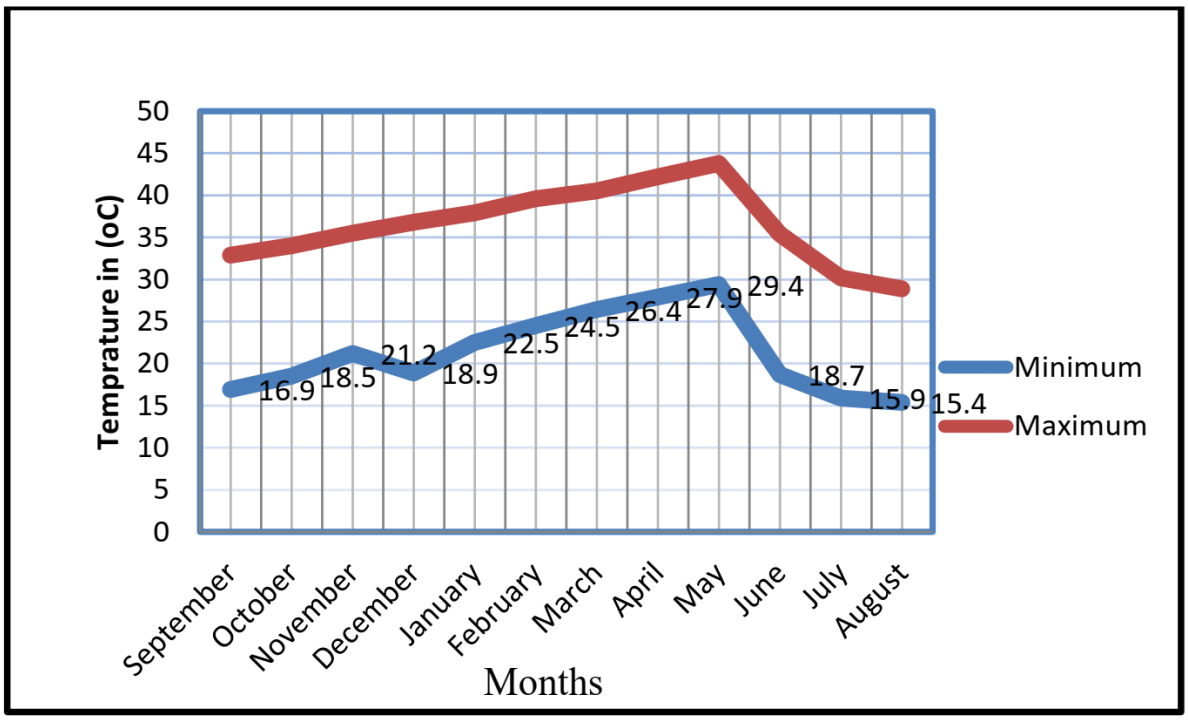

Fig. 2. Minimum and Maximum Temperature Recorded Data on Itang special woreda

The average monthly minimum and maximum recorded temperature on 2017/18 from Itang special districts were 27.9 and 42.2 degrees Celsius respectively (**Fig. 2**).

2.4 Study Design

This study was cross-sectional and has been conducted in the dry period between December 2016 and June 2017. Two water bodies were selected (River and Dam) in the Baro-Akobo Basin, Southwest of Ethiopia Gambella regional States. The physical parameters were measured between 6:30 and 7:30 at two sampling sites in the open water zone. Water samples were collected just below the surface at a depth of 0.5 meters. The water temperature has been measured at 1 m intervals over a vertical transect from just below the surface to 10 m depth (or less when depth was <10 m) for the case of dam and pond sites [15]. Fish specimens were collected using gillnet with mesh sizes of 4-14cm, cast net, hook, lines, and traditional fishing gears. In this study, physical parameters including water temperatures, altitude, and water temperature were measured.

2.5 Laboratory Study

Identification: Fish identification was made to species level by using taxonomic keys. Keys found in Abebe Getahun [12] Boulenger [16-19] Paugy et al. [20] Shibru Tedla [11] Skelton [21] and Stiassny & Getahun [22] were used for the identification and description of fish species. Shannon diversity index (H) [23] was used to estimate the diversity of fish species in Alero dam and Kir River.

2.6 Data Collection Instruments

Fishing gears and nets, boats, hooks, preservatives, ice-boxes, pH measuring instruments, chlorophyll testing kits, mineral testing kits, thermometer, Geographic Positioning system tools(GPS), watch(waterproof) and analog, balances, meters, knives, gloves, Refrigerators, species identification manuals (FAO guidelines) and biological atlases were used in the filed experiments.

Shannon diversity index (H) was used to estimate the diversity of fish species in the two water bodies and H is calculated as:

$$H = \sum_{i=1}^{s} -(Pi * lnPi)$$

Where:
H = the Shannon diversity index
P_i = fraction of the entire population made up of species i
S = numbers of species encountered
$\sum$ = sum from species 1 to species S
ln=natural logarithm of the number.

2.7 Data Analysis

Data were analyzed using Excel and SPSS statistical software for windows version 20.

3. RESULTS

3.1 Physical-chemical Parameters

Physical and chemical parameters such as conductivity, pH, and dissolved oxygen of the two water bodies are more or less similar as indicated in Table 2. There is a slight difference in the water temperature where the Alwero dam showed an increased amount by 3^0C that might be due to the water slightly stagnant compared to the continuous running river of Baro/kir. The physical-chemical parameters that were measured have been summarized in Table 2.

3.2 Fish Species Diversity of the Study Sites

A total of 24 fish species belonging to 6 orders and 15 families has been identified. The order Siluriformes is the most diverse order which consists *Bagrus docmak,,Malapterurus electricus, Parailia (physailia) pellucida, Auchenoglanis biscutatus, Auchenoglanis occidentalis, Clarias gariepinus, Heterobranchus bidorsalis, Heterobranchus longifilis, Parachanna obscura Synodontis caudovittata Synodontis nigrita* and *Synodontis vermiculatus* which is 12 (50%) of the species and the Characiformes order ranks in the second place with five species. In general, the fish species identified are listed in Table 3 and arranged in order, family and species respectively.

The diversity of species identified in sampling sites has shown relatively uniform distribution among the sampling sites. Table 4 indicates the Shannon diversity index (H) of the two sampling sites. Different authors that have been conducted in the study region revealed that River consists of the highest diversity of fishes in the present study than the dam. This may be because of behavioral adaptation of fishes, for example, *Lates niloticus* and *Bagrus docmak*, are adapted to live in deep water or beneath the water for feeding and reproduction.

3.3 Relative Abundance

In this study, a total of 386 fish specimens was collected from the two sites during the dry season. Out of this, the most abundant fish species were *Tilapia zillii, Oreochromis niloticus, Heterotis niloticus, Citharinus citharus,* and *Synodontis caudovittatus* with 22.79%, 16.32%, 11.14%, 7.25%, and 6.477 respectively. *Synodontis Khartoumensis, Tetraodon lineatus, Distichodus niloticus ,Auchenoglanis biscutatus, Heterobranchus bidorsalis, Parailia(physailia)pellucida,* and *Lates niloticus* contributes 3,3,3,2,2,1,1 number of species respectively(Table 5).

Based on their abundance body weight was measured for the species *Tilapia zillii, Oreochromis niloticus, Heterotis niloticu*s, and *Citharinus citharus.* The total measured bodyweight of these abundant species was 161980.95 grams. Of this *Oreochromis niloticus* comprises 49165.2 gram and this covers 30.35 % of the total weight of all specimens examined (Table 6).

4. DISCUSSION

The identified fish diversity of the studied water bodies contains a mixture of Nilo-Sudanic (*Bagrus, Citharinus, Hydrocynus,* and *Labeo*), East African (*Clarias,* and *Oreochromis*. The reason could be because of the connection between White Nile and Baro/Kir River. Baro/Kir River is the tributaries of the White Nile [12]. The presence of these forms in the Nile basin has been reported by [11–13,21,24,25]. The riverine fishes are very mobile; they move long distances up and down for various reasons such as spawning and search for food [26].

According to Tesfaye 6], the Ethiopian fish fauna includes 180 species categorized in 70 genera and 29 families. However, Abebe Getahun [12] reported 152 valued species of which 41 species are endemic to Ethiopia. In the present study, 24 species within 6 orders and 15 families were recorded from the two water bodies.

To investigate the fish diversity in both the study sites Shannon Diversity Index ($H^{'}$) has been used and calculated. Based on the present finding, a higher number of H has been observed in Baro/Kir River with H=2.21 and this implies the most diverse fish species in the study sites. Whereas the Shannon Diversity Index ($H^{'}$) for Alwero dam is 1.99 and this value shows the fish species diversity in the present site is a medium.

Table 2. Mean average physical-chemical parameters at the two sampling sites

Sampling sites	Conductivity (µs/cm)	Temperature Water (^{0}C)	pH	Dissolved oxygen DO (mg/l)
Kir/Openo River	100	25.1	7.0	35
Alwero dam	101	28.1	7.01	33.5

Table 3. Identified Fish species from the sampling sites

Order	Family	Species
1. Osteoglossiformes	Gymnarchidae	*Gymnarchus niloticus*
	Osteoglossidae	*Heterotis niloticus*
2. Characiformes	Alestidae	*Alestes dentex*
		Hydrocynus froskahlii
		Hydrocynus bervis
	Distichodontidae	*Distichodus niloticus*
	Citharinidae	*Citharinus citharus*
3. Cypriniformes	Cyprinidae	*Labeo niloticus*
4. Siluriforms	Bagridae	*Bagrus docmak*
	Malapteruridae	*Malapterurus electricus*
	Schilbeidae	*Parailia (physailia) pellucida*
	Claroteidae	*Auchenoglanis biscutatus*
		Auchenoglanis occidentalis
	Clariidae	*Clarias gariepinus*
		Heterobranchus bidorsalis
		Heterobranchus longifilis
	Mochokidae	*Parachanna obscura*
		Synodontis caudovittata
		Synodontis nigrita
		Synodontis Khartoumensis
5. Perciformes	Cichlidae	*Tilapia zillii*
		Oreochromis niloticus
	Latidae	*Lates niloticus*
6. Tetraodontiformes	Tetraodontidae	*Tetraodon lineatus*

Table 4. Shannon Diversity Index (H`) in the two sampling sites

Water Body	Number of Species	H
Alwero Dam	10	1.99
Kir River	14	2.21

Alestiidae were found in flowing water for which they are adapted to this condition and few species were identified from Baro/Kir River. Baro/Kir River which ranked first in fish diversity in the study site had been reported by different researchers [6,12,13,25,27].

The reason behind these differences was probably because wetlands and vegetated nearshore habitats are required by fishes to complete their life cycle and habitats contain a diversity of submerged, emergent, and floating aquatic vegetation that provides shelter, food, and protection from predators [28]. Baro/Kir River is endowed with much water and good habitats that contain a diversity of submergence and emergent aquatic vegetations and phytoplankton. This might have contributed to the higher abundance of fish in the river.

The *G. niloticus* of the family Gymnarchidae was found in the Baro/Kir River and has also been reported from the same basin by other workers [6,12,13,24,25,29].

The Osteoglossidae, a very ancient family; characterized apart from other features, by its ovaries lacking oviducts [20], was represented by one species, *H. niloticus*, and has been sampled from Baro/Kir River only and this species has also been recorded from the Blue Nile and Omo-Turkana drainage basins [13,20,24,25].

The Alestidae family is widely distributed in inter-tropical Africa [20]. Alestiidae were found in flowing water for which they are adapted to this condition and few species were identified from Baro/Kir River.

It was represented by *Alestes dentex, Hydrocynus froskahlii,* and *Hydrocynus bervis.* A study by Golubtsov & Darkov [25] reported that H. *brevis, B. nurse, B. macrolepidotus,* and *M. acutidens. B. nurse, B. macrolepidotus* and *M. acutidens* were recorded from the Omo-Turkana [25]. The family Distichodontidae belongs to the order Characiformes. This family is endemic to Africa [20]. The family was represented by single species, which is *Distichodus*

niloticus and this species has been reported by [29] from the same basin.

The Citharindae was represented by a single species *Citharinus citharu*, from the Baro Basin. A similar result has been reported by Thachuor [29] from Baro basin.

According to Golubtsov & Darkov [25], the family Cyprinidae is taxonomically the most diverse group of the Ethiopian. In the present study, this family was represented by one species *Labeo niloticus.*

The family Bagriidae was represented by *B. docmak* and it was sampled from Alero and Baro/Kir River. Besides, these species were reported by Zeleke Berie [30], Tesfaye [31], and Moges Beletew [32].

The Clarotidae is represented by three species. The family Claroteidae was represented by two species *Auchenoglanis biscutatus* and *Auchenoglanis occidentalis.* Furthermore, the species *Auchenoglanis occidentalis* has been also reported from the Omo [12,25] and the Wabi Shebele basins [12]. *C. auratus* was recorded in the present investigation from the Baro Basin only. Its existence there has been reported by Abebe Getahun [12] and Golubtsov & Darkov [25]. Schilbeidae was represented by *Parailia (physailia) pellucida.*

The family Clariidae was represented by three species *Clarias gariepinus Heterobranchus bidorsalis* and *Heterobranchus longifilis.* The *C. gariepinus* has been reported from all the drainage basins of Ethiopia [12,25,30–32] and the *Heterobranchus bidorsalis* was also reported from Baro Basin by Thachuor [29].

The family Mochokidae was represented by four species *Parachanna, obscura, Synodontis, caudovittata Synodontis nigrita,* and *Synodontis Khartoumensis*. The Species *Synodontis* is the most species-rich catfish genus in Ethiopia Golubtsov & Darkov [25].

Table 5. Distribution and abundance of common and commercially important fishes

Species	Site	Number	N%
Tilapia zillii	Alwero and Baro/Kir	88	22.78
Oreochromis niloticus	Kir and Alwero	63	16.3
Heterotis niloticus	Baro/Kir	43	11.1
Citharinus citharus	Alwero	28	7.3
Alestes dentex	Baro/Kir	25	6.5
Synodontis caudovittatus	Baro/Kir	25	6.5
Gymnarchus niloticus	Baro/Kir	21	5.4
Clarias gariepinus	Baro/Kir	18	4.7
Hydrocynus brevis	Baro/Kir	13	3.4
Malapterurus minjiriya	Baro/Kir	10	2.6
Labeo niloticus	Baro/Kir	8	2.1
Bagrus docmak	Alwero and Baro/Kir	6	1.5
Auchenoglanis occidentalis	Alwero	5	1.3
Heterobranchus longifilis	Alwero	5	1.3
Hydrocynus forskahlii	Baro/Kir	5	1.3
Parachanna obsura	Alwero	4	1.0
Synodontis nigrita	Baro/Kir	4	1.0
Synodontis Khartoumensis	Alwero	3	0.8
Tetraodon lineatus	Alwero	3	0.8
Distichodus niloticus	Baro/Kir	3	0.8
Auchenoglanis biscutatus	Alwero	2	0.5
Heterobranchus bidorsalis	Alwero	2	0.5
Parailia (physailia) pellucida	Alwero	1	0.3
Lates niloticus	Baro/Kir	1	0.3

Table 6. Commercially important fishes and their abundance in weight and number

Species	N	% N	F	%F	W(g)	%Wt
Tilapia zillii	88	39.64	12	15.38	45349.9	27.99
Oreochromis niloticus	63	28.38	14	17.95	49165.2	30.35
Heterotis niloticus	43	19.37	8	10.26	42945.4	26.51
Citharinus citharus	28	12.61	8	10.26	24520.4	15.14

The family Cichlidae was represented by two species *Tilapia zillii* and *Oreochromis niloticus* and both species have been sampled from Baro/Kir River and Alero dam Abebe Getahun [12] reported that *O. niloticus* is found in all the drainage basins of Ethiopia. However, Golubtsov & Darkov [25] reported the absence of this species from the Wabi Shebele and Juba drainage basins.

The family Tetraodontidae was represented by one species *Tetraodon lineatus.* The family Tetraodontidae occurs mainly in marine waters, with only a few species adapted to freshwaters or brackish waters. It is characterized by the presence of teeth forming a beak-like structure consisting in each jaw of two pieces fused on the midline and covered by a layer of enamel [20,21]. It has been reported from species, *T. lineatus* from Baro Basin by Tesfaye Melake [6].

5. CONCLUSION

In conclusion, the present study, 24 fish species from 386 specimens have been collected using fish gillnet with mesh sizes of 4-14cm, cast net, hook, lines, and traditional fishing gears. The fish species are identified using FAO standards, biological atlases, and senior biologists in to order, family, and species levels. The Family Siluriformes is the most diverse which consists *Bagrus docmak,*, *Malapterurus electricus, Parailia (physailia) pellucida*, *Auchenoglanis biscutatus*, *Auchenoglanis occidentalis*, *Clarias gariepinus*, *Heterobranchus bidorsalis*, *Heterobranchus longifilis*, *Parachanna obscura Synodontis caudovittata Synodontis nigrita* and *Synodontis vermiculatus* which is 12 (50%) of the species and the Characiformes order ranks in the second place with five species. Besides, the families Citharindae and Tetraodontidae were represented by a single species *Citharinus citharu* and *Tetraodon lineatus* respectively. A higher value for Shannon index (H) has been observed in Baro/Kir River with H=2.21 and this implies the most diverse fish species in the study sites. Generally, the identified fish diversity from the studied water bodies contains a mixture of Nilo-Sudanic (*Bagrus, Citharinus, Hydrocynus,* and *Labeo*), East African (*Clarias*, and *Oreochromis).* The reason could be because the connection between the White Nile and Baro River is the tributaries of the White Nile. Since the present study was carried out in one season (dry season) and limited site (Alwero dam and Baro/Kir River) it is difficult to generalize the fish diversity status of the region therefore, further study should be conducted to figure out the accurate information on the diversity of fish species in the Gambella region main water bodies.

CONSENT

It is not applicable.

ETHICAL APPROVAL

All ethical issues passed under the Gambella university ethical review committee.

DECLARATIONS

To be used for all articles, including articles with biological applications.

SUPPLEMENTARY MATERIALS

Supplementary material is available at the following link:
https://www.journalajfar.com/index.php/AJFAR/libraryFiles/downloadPublic/2

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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