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Research Article

Fishes of the Alitash National Park: Taxonomic Accounts with Identification Keys of Fish in Floodplain Rivers of Abbay and Tekeze Basins, Ethiopia

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Ethiopia has considerable freshwater potential. Currently, the recognized fish diversity in the country's freshwater ecosystem is more than 200. Despite the presence of such high fish diversity with considerable economic returns, ichthyofaunal studies on Ethiopian rivers are scarce. Thus, this study aimed to identify and compare ichthyofaunal diversity and distribution in floodplain rivers of the Abbay and Tekeze Basins, Ethiopia. Fish were collected using gillnets, cast nets, hooks, electrofishing, and mosquito nets and identified to the species level. Gillnets had stretched mesh sizes of 4–14 cm with a panel length of 25–75 m and a width of 1.5–2 m per mesh size. They were set in the afternoon (5:00 p.m.) and lifted the following morning (7:30 a.m.). Immediately after capture, fish were preliminary identified in the field and tagged with proper information (e.g., sampling locality and date of collection). Similar fishing efforts were applied at all sampling sites for two dry and two wet months over a period of two years (2018-2019). In the present study, both alpha and beta diversity indices were also examined. Identification keys and an annotated checklist of species were generated for easy naming of the entire fish species in the basins. In the ichthyological collection, 43 fish species with 11 new records from the Ayima, Gelegu, and Shinfa Rivers were identified. The first two rivers in the Abbay Basin were the richest in species and number of individuals. Gelegu River had the highest abundance as well. Generally, this study was conducted in areas where no fish biodiversity studies have been undertaken, and the results obtained from this study could be important for fish biodiversity conservation.

1. Introduction

The Ethiopian freshwater fish fauna is composed of the Nilo-Sudanic, East African, and endemic forms [1]. Fish faunal studies in the country's riverine ecosystems are limited, and thus, the current full account and true extent of Ethiopian fish diversity are incomplete. This is because, in Ethiopia, ichthyological studies in fluvial habitats are limited and even taxonomically uncertain [2, 3]. Therefore, results pertaining to fish diversity studies in Ethiopia are likely underestimated: new species are continually discovered, and some require more scrutinizing procedures for identification (e.g., [4, 5]). As a result of problems related to identification, the ichthyofaunal accounts of Ethiopia have been narrated differently over time (e.g., [2, 6, 7]).

Recognizing the full picture of biodiversity in an area is a central tenet in ecological studies [8]. Thus, ecologists have long ventured to distinguish between different components of biodiversity (e.g., [9, 10]). In biodiversity studies, local diversity (α), differentiation (β diversity), and regional diversity (γ) can be recognized to comply with complete biodiversity measurements at different stages [10]. Accordingly, α measures species richness at a single locality and tells how finely species are partitioning ecological resources,

whereas β diversity can reflect the level of habitat selection or species composition among sites within a geographical area [9, 11]. Among the different measures of β diversity, Whittaker beta diversity (βw) is widely used in ecology [12] and important for human-dominated landscapes, where habitat modification can lead to homogenization of communities [13]. A high βw index indicates a low level of similarity and vice versa. This is unquestionably the case in the Ethiopian lotic habitats, where practically all major river basins are affected by various forms of human activity [1].

Unlike the lacustrine habitats, only a few studies have been conducted on the taxonomy of Ethiopian riverine fish diversity [14–16]. These studies have mostly focused on major rivers. Therefore, it is imperative to look at the geographical patterns of ichthyofaunal variety in Ethiopian rivers. This information can be utilized to support current conservation programs or to implement more effective conservation schemes. Therefore, this study on fish diversity in the less studied water systems of the Alitash National Park (ALNP) will contribute to our understanding of the various components of riverine fish variety. Moreover, the ichthyofaunal richness of the floodplain rivers was also investigated in this study in order to provide baseline data on riverine fish and fisheries for the sustainable utilization of aquatic resources.

The need to protect the ALNP is essential because there are two ecological risks to the park: first, natural processes like drought that could negatively impact the ecosystem's ability to function normally and second human activity, the most dangerous since it is destroying natural habitats and the biota. The anthropogenic activities that are common in the area include poison fishing, seasonal grazing inside parks and along river courses, poaching and encroachment, the rivalry between humans and wildlife for resources and habitat, and water abstraction from rivers for irrigation purposes. As a result, in order to address these issues, it is necessary to investigate the park's biological resources and propose some management strategies for their sustainable utilization.

The local people receive animal protein from the Ayima and Gelegu Rivers in the Abbay Basin and the Shinfa River in the Tekeze Basin, which hou66se a variety of fish species. However, there has not been much research conducted on the variety of fish species found in these rivers. The frequent insecurity or flare-ups near borders and the difficulty in accessing samples are the reasons for the sparse and fragmented knowledge of the fishes of these rivers. As a result, researchers did not precisely know or have access to documentation of the amount of fish diversity in these rivers. Thus, the need for this study was prompted by the dearth of fish and fishery data that hinder management techniques in these rivers. Our goal is to record fish diversity, prepare a checklist of species, and look at the diversity metrics of the rivers under study.

2. Materials and Methods

2.1. Study Area and Sampling Sites. The ALNP is situated at 11° 47′ 4″ to 12° 31′ 36″ N latitude and 35° 15′ 48″ to 35° 48′ 51″ E longitude in northwestern Ethiopia and borders with the Dinder National Park (DNP) of Sudan. The climate of the Alitash and surrounding area is semiarid and characterized by two weather extremes: moist cloudy wet (May to October) and extremely hot dry (December to April). The annual temperature may reach 21–47°C with a mean average air temperature of about 35–41°C [17].

The lower sections of the Abbay Basin's level unending plain (500–900 m.a.s.l.) are where the park is located. The ALNP is drained by the Shinfa River (Tekeze Basin) and the Ayima and Gelegu Rivers (Abbay Basin) (Figure 1). These rivers are floodplains; from January to April, when the weather is dry, they form tiny water pools. Fishermen may get readily access to remnant pools along the rocky river bottoms which keep water until the next rainy season for fishing.

Ayima is the main cardinal tributary in the ALNP with a diverse fish fauna. It is the largest tributary of the Abbay Basin in its lower course. The river has a wide channel width (cf. 225 m during flooding). Dominantly sandy and rarely muddy to rocky substrates are observed along most reaches of the river. The river fits the classic description of a "temporary river" [18]. During the wet season, the entire river network is connected following the natural route, but small stagnant water pools are formed during the dry season (January to April). Small- to medium-sized furrow irrigation schemes abstract water from this river. The Gelegu River is relatively smaller and has a largely eroded gorge with a very narrow channel. This river flows directly into the ALNP. The Shinfa River is perhaps the true lower course of the Tekeze Basin [2]. The area is arid and has a seasonal rainfall of 950 mm, annually which is even shorter than the Abbay Basin and is highly concentrated in July and August.

For this study, fish were sampled from a total of six sites (two sites on each river) (Figure 1). The sampling sites were selected based on fishing accessibility and riverine habitat type. The sampling sites in each river had different habitat characterizations and substrate types. In Ayima, (A1) was characterized by its pool with a muddy substratum, and (A2) with its riffle nature and a sandy bottom. Gelegu River's (G1) was riffle with a rocky bottom, while G2 was a pool with a sandy substratum, and the channel was relatively wider than G1. G1 had a 2 m "water fall" on the upper side that hindered fishes moving to upstream. In Shinfa River, S2 was a riffle with a muddy bottom, while S1 was a pool with a rocky substratum.

2.2. Fish Sampling and Identification. Fish sampling was carried out from April 2018 to November 2019 on a seasonal basis from the Ayima, Gelegu, and Shinfa Rivers.

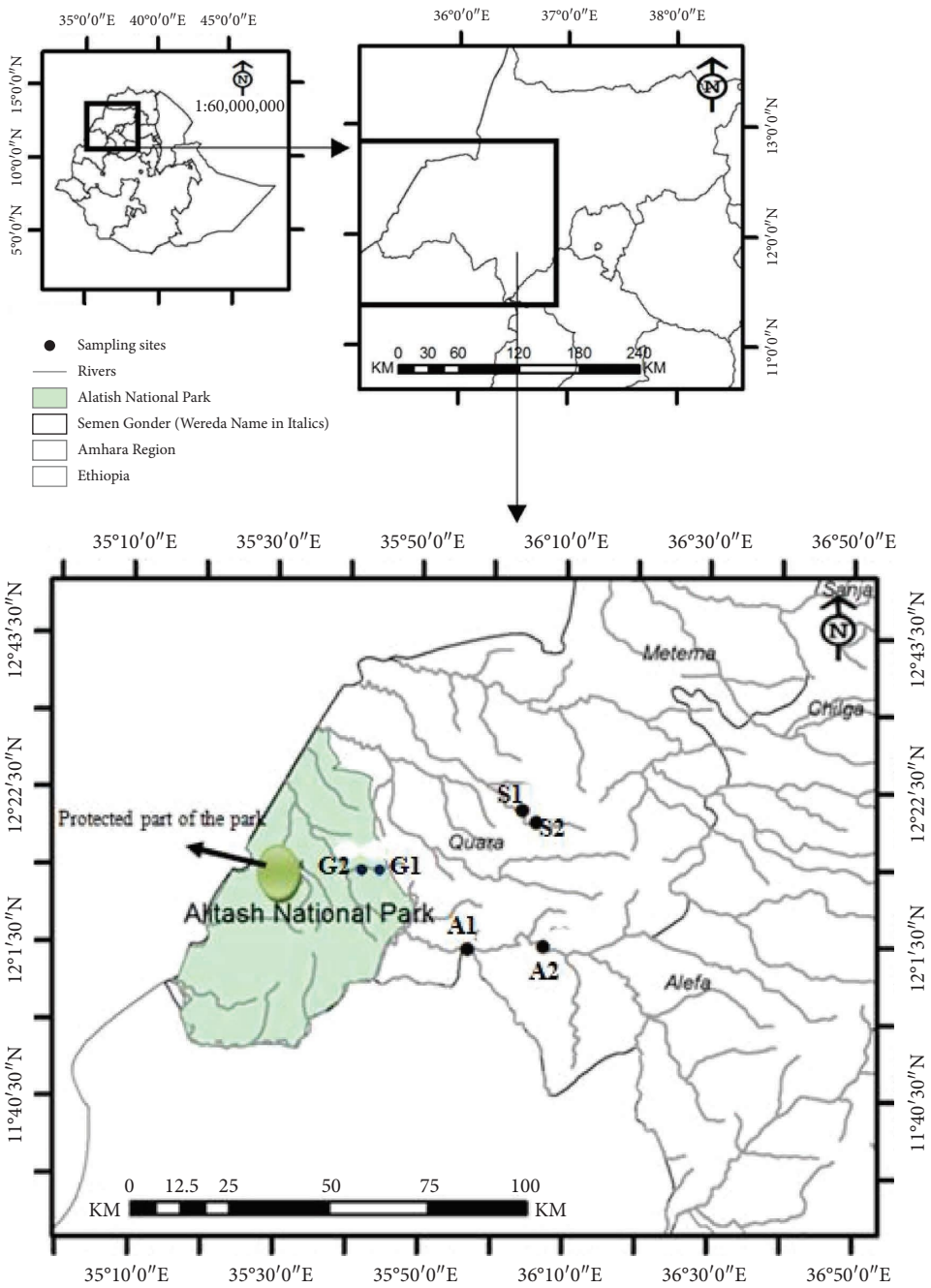

FIGURE 1: Sampling sites for collection of fish samples from Ayima (A1 and A2), Gelegu (G1 and G2), and Shinfa (S1 and S2) rivers, northwestern Ethiopia.

Sampling was performed over a period of two dry and two wet sampling occasions using monofilament and multifilament gillnets with mesh sizes of 4–14 cm and a panel length of 25–75 m. Dry season sampling was conducted during periods of a year when there was no rainfall (March and April) whereas wet season sampling was undertaken following prolonged heavy rainfall (September and October). Four sets of gillnets, two parallel and two perpendicular to the shore, were set at a subsurface level at each sampling site. The gillnets were positioned in the late afternoon (5:00 p.m.) and inspected the next morning (1:30 a.m.). Hooks, cast nets, traps, mosquito nets, and electrofishing supplemented gillnet sampling and used in shore regions. Each site was sampled for three days with a similar fishing effort. Voucher specimens were preserved in 5% formalin and transported to the Addis Ababa University (AAU) Fisheries Laboratory. In the laboratory, voucher specimens were identified based on morphometric and meristic parameters by referring to different identification keys (e.g., [7, 19–24]).

2.3. Taxa Nomenclature. In the present study, for higher taxa, nomenclature (e.g., families) was organized based on Getahun [7]. Fish Base sources were used for the correct spelling of species names. During identification, field tag information (e.g., sampling locality, collection date, and collector name) was carefully observed and cataloged at the Zoological Natural History Museum (ZNHM)–AAU–Ethiopia. The tag used for museum-deposited specimens was ZNHM – FAL – XXX: –ZNHM–Fishes of Alitash (FAL), followed by three identity numerals.

2.4. Data Analysis. Descriptive statistics was used to determine the average values of physicochemical parameters and to evaluate the percentage contribution in terms of the number of each fish species. A multivariate analysis of variance (MANOVA) was used to test for significant spatial differences in the physicochemical parameters between the sampling sites. The Shannon diversity index (H'), Shannon evenness ($e^{H/S}$), and equitability (J') indices were used to evaluate the extent of fish species diversity as a measure of species richness in the rivers [25]: $\mathbf{H}^{'} = -\sum_{\mathbf{i=1}}^{\mathbf{s}} \mathrm{pi} * (\mathbf{ln} \quad \mathrm{pi})$ and $\mathbf{J}^{'} = \mathbf{H}^{'} / \mathbf{Ln\ S}$ where Pi is the relative cover of the ith species, S is species richness, and Pi is the abundance of the ith species in an area. The Whittaker's beta (βw) diversity index was used to evaluate the rate of fish species differentiation between the rivers [9]: $\beta_{\mathbf{w}} = \mathbf{S}/\acute{\alpha} - \mathbf{1}$, where S is the total number of species in the habitat and $\acute{\alpha}$ = average species richness per habitat.

The rank-order abundance plot (Whittaker's plot) was used to evaluate the equitability of species abundance among rivers and was generated as a natural logarithm of relative abundance values (Y-axis) versus the species abundance rank (X-axis). An individual-based rarefaction analysis was performed to standardize diversity comparisons between the rivers [26, 27]. All statistical analyses were performed using PAST version 3.20 [28]. The data obtained during the present study were combined with a thorough review of past ichthyofaunal studies to develop annotated checklists and identification keys for fishes of the entire Abbay and Tekeze Basins.

3. Results

3.1. Environmental Variables of Sampling Sites. Morphometric variables of the sampling sites, site depth (m), river channel diameter (m), and light transparency (Secchi depth (cm)) were measured using PLASTIMO ECHOTEST II-73420, a rope and by a standard 20-cm-diameter Secchi disk, respectively, seasonally on each sample occasion (Table 1). A multimeter probe (Model HQ 40d) was used to measure a few key water physicochemical parameters *in situ* at each sampling site. Only the mean values of dissolved oxygen (DO) differed significantly between the sampling sites (MANOVA, $p < 0.05$). The average EC values varied between 260.06 ± 193.0 and $305.87 \pm 251.4\ \mu\mathrm{scm}^{-1}$, with no discernible variation between the sites ($p = 0.479$). The rivers' pH ranged from 8.08 to 8.39, which is mildly alkaline. The mean values of temperature ranged from 27.32 ± 2.90 to $29.68 \pm 2.0^{\circ}\mathrm{C}$, and there was no significant difference among the sampling stations ($p = 0.108$). The mean level of DO in all sites was 7.26 ± 0.6 to $8.95 \pm 0.7\ \mathrm{mgL}^{-1}$ and significantly different among sites ($p = 0.002$).

3.2. Fish Diversity. A total of 2719 fish individuals were collected and identified into 43, 6, 15, and 25 fish species, orders, families, and genera, respectively, during the entire sampling program (Table 2). The order Siluriformes contained six families, seven genera, and thirteen species, which accounted for 30.2 and 36.4% of the total richness and individuals collected, respectively (Table 2). The Cypriniformes were the second most species-rich order, with ten species covering 23% of the species richness. The order Characiformes, represented by nine species, was among the most dominant and abundant collections. The two other orders (Osteoglossiformes and Perciformes) comprised two families each the former represented by seven species and the latter having three species. The order Polypteriformes was represented by a single species.

During the present study, the highest number of species and specimens were collected from the Gelegu River, followed by the Ayima and Shinfa Rivers (Table 2). About 38 species and 1124 specimens from Gelegu River, 35 species and 1006 individuals from Ayima River, and 25 species and 589 individuals from Shinfa River were collected and identified during this study. Three species (8.6%) which include *Distichodus brevipinnis*, *Raiamas senegalensis,* and *Lates niloticus* were verified from the Ayima River only. The Gelegu River alone contributed eight species, with 196 counted individuals (see Table 2 for the species list). Twenty-one species (48.8%) were common to all rivers considered by this study and contributed 1970 individuals (72.5%) of the total abundance.

3.3. Fish Species Diversity

Order *Polypteriformes*

Polypteridae

Polypterus bichir [29]: Figure 2(1).

Synonym: *Polypterus bichir* [30]: 97—Günther [31]: 218, Sandon [21]: 19, Tedla [22]: 19, Bailey [32]: 940, Golubtsov et al. [23]: 10.

Voucher profile: dorsal fins contained articulated spines; counted lateral line scales (LLS) were 63–70; olive green in color; see Table 2 for locality.

Order *Osteoglossiformes*

Arapaimidae

Heterotis niloticus [33]: Figure 2(2).

Voucher profile: mouth terminal; body slender; scales large and cartilaginous; spins absent on fins; see Table 2 for specific locations.

Mormyridae

Table 1: Summary of sampling sites with a GPS position Ayima (A1/A2), Gelegu (G1/G2), and Shinfa (S1/S2).

Site	Alt. (m)	Site depth (m)		Secchi depth (cm)		Channel diameter (m)		GPS readings	
		Dry	Wet	Dry	Wet	Dry	Wet	N	E
A1	633	3.7	5.0	135	78	28.3	45	12° 0′ 47.03″	35° 56′ 39.18″
A2	689	2.9	4.3	63	43	25.9	38.5	12° 1′ 18.47″	35° 7′ 14.29″
G1	636	2.3	4.6	85.3	39.2	2.8	6.2	12° 8′ 9.88″	35° 30′ 15.16″
G2	627	3.2	3.5	68.6	47.6	3.1	7.0	12° 10′ 6.73″	35° 30′ 26.80″
S1	587	6.1	7.6	41.3	18	3.8	12.5	12° 19′ 47.89″	36° 4′ 12.00″
S2	589	2.0	4.7	34	23.5	5.0	16.5	12° 18′ 4.96″	36° 6′ 6.13″

alt. = altitude (m).

Table 2: Lists of fish species identified from the Ayima (A1/A2) and Gelegu (G1/G2) in the Abbay Basin and the Shinfa (S1/S2) Tekeze Basin.

Order/family/species	A1	A2	G1	G2	S1	S2	Voucher specimen
Polypteriformes							
Polypteridae							
Polypterus bichir (Lacepède, 1803)			x	x			ZNHM-FAL001-2
Osteoglossiformes							
Arapaimidae							
Heterotis niloticus (Cuvier, 1829)	x	x	x	x			ZNHM-FAL003–5
Mormyridae							
**Hyperopisus bebe* (Lacepède, 1803)			x		x		ZNHM-FAL006-7
**Petrocephalus keatingii* (Boulenger, 1901)		x	x				ZNHM-FAL008-9
**Marcusenius cyprinoides* (Linnaeus, 1758)	x	x	x				ZNHM-FAL010
Mormyrus caschive (Linnaeus, 1758)	x	x				x	ZNHM-FAL011-12
Mormyrus kannume (Forsskål, 1775)	x	x	x	x	x	x	ZNHM-FAL013
**Mormyrops anguilloides* (Linnaeus, 1758)				x			ZNHM-FAL014
Characiformes							
Alestidae							
Hydrocynus vittatus (Castelnau, 1861)		x	x	x			ZNHM-FAL015-16
Hydrocynus forskahlii (Cuvier, 1819)	x	x	x				ZNHM-FAL017-18
Alestes baremoze (Joannis, 1835)	x	x	x	x		x	ZNHM-FAL019–21
Brycinus nurse (Rüppell, 1832)	x	x	x	x	x	x	ZNHM-FAL022–24
**Brycinus macrolepidotus* (Valenciennes, 1849)	x		x	x			ZNHM-FAL025–27
Distichodontidae							
**Distichodus brevipinnis* (Günther, 1864)	x		x				ZNHM-FAL028
**Distichodus engycephalus* (Günther, 1864)			x				ZNHM-FAL029
**Distichodus rostratus* (Günther, 1864)		x	x	x			ZNHM-FAL030
Citharinidae							
Citharinus latus (Muller & Troschel, 1845)	x			x			ZNHM-FAL031
Cypriniformes							
Cyprinidae							
Labeobarbus bynni (Forsskål, 1775)	x	x	x	x	x	x	ZNHM-FAL032-33
Labeobarbus crassibarbis (Nagelkerke & Sibbing, 1997)				x	x	x	ZNHM-FAL034-35
Labeobarbus intermedius (Rüppell, 1835)	x	x	x	x	x	x	ZNHM-FAL036-37
Labeobarbus degeni (Boulenger, 1902)	x	x		x	x	x	ZNHM-FAL038
Labeobarbus nedgia (Rüppell, 1836)			x	x	x		ZNHM-FAL039
Labeo cylindricus (Peters, 1852)	x			x	x	x	ZNHM-FAL040-41
Labeo forskahlii (Rüppell, 1835)	x	x	x	x	x	x	ZNHM-FAL042-43
Labeo horie (Heckel, 1846)	x	x	x		x	x	ZNHM-FAL044-45
Labeo niloticus (Linnaeus, 1758)	x	x	x		x		ZNHM-FAL046-47
**Raiamas senegalensis* (Steindachner, 1870)	x	x					ZNHM-FAL048–50
Siluriformes							
Auchenoglanididae							
Auchenoglanis occidentalis (Valenciennes, 1840)	x	x	x	x	x		ZNHM-FAL051–53
Clariidae							
Clarias gariepinus (Burchell, 1822)	x	x	x	x		x	ZNHM-FAL054–56
Heterobranchus longifilis (Valenciennes, 1840)	x	x	x		x	x	ZNHM-FAL057-58

Table 2: Continued.

Order/family/species	A1	A2	G1	G2	S1	S2	Voucher specimen
Bagridae							
Bagrus bajad (Forsskål, 1775)					x	x	ZNHM-FAL059
Bagrus docmak (Forsskål, 1775)	x	x	x		x	x	ZNHM-FAL060
Mochokidae							
**Synodontis clarias* (Linnaeus, 1758)			x				ZNHM-FAL061-62
Synodontis schall (Bloch & Schneider, 1801)	x	x	x	x	x	x	ZNHM-FAL063–65
Synodontis serratus (Rüppell, 1829)	x	x	x	x	x	x	ZNHM-FAL066-67
**Synodontis sorex* (Günther, 1864)			x	x			ZNHM-FAL068-69
Malapteruridae							
**Malapterurus electricus* (Gmelin, 1789)		x	x				ZNHM-FAL070
**Malapterurus minjiriya* (Sagua, 1987)				x			ZNHM-FAL071
Schilbeidae							
**Schilbe mystus* (Linnaeus, 1758)			x				ZNHM-FAL072–74
Schilbe uranoscopus (Rüppell, 1832)			x	x		x	ZNHM-FAL075–77
Perciformes							
Cichlidae							
Oreochromis niloticus (Linnaeus, 1758)	x	x	x	x	x	x	ZNHM-FAL078–80
Coptodon zillii (Gervais, 1848)	x	x		x	x		ZNHM-FAL081-82
Latidae							
Lates niloticus (Linnaeus, 1758)	x	x					ZNHM-FAL083-84

x stands for species-specific occurrence; museum deposited voucher specimens are designated as ZNHM-FAL.

Hyperopisus bebe [29]: Figure 2(5).

Literature support: *Hyperopisus bebe* [29]: 619—Golu btsov et al. [23]: 37, Habteselassie [24]: 66, Boulenger [20]: 170, Eschmeyer et al. [34]; Froese & Pauly [35].

Examined voucher: anal fin is five times more than dorsal fin—against other congers of the genus; possesses terminal mouth; see Table 2 for a specific locality.

Petrocephalus keatingii [36]: Figure 2(8).

Literature support: *Petrocephalus keatingii* [36]: 444—Golubtsov et al. [23]: 39, Habteselassie [24]: 70, Eschmeyer et al. [34].

Voucher profile: possess a strongly compressed silvery body; possess inferior mouth; counted 42-43 LLS; refer Table 2 for specific locality.

Marcusenius cyprinoides [37]: Figure 2(6).

Literature support: *Marcusenius cyprinoides* [37]: 327—Golubtsov et al. [23]: 40, Habteselassie [24]: 66, Eschmeyer et al. [34]; Froese & Pauly [35].

Voucher specimen profile: terminal mouth; 70–86 LLS; dorsal fin originating above anal fin; see Table 2 for locality.

Mormyrus caschive [37]: Figure 2(4).

Literature support: *Mormyrus caschive* [37]: 327—Golu btsov et al. [23]: 38, Bailey [32]: 942, Habteselassie [24]: 64, Eschmeyer et al. [34]; Froese & Pauly [35].

Erroneous citations of original publication year: *Mor myrus caschive* [38]—Sandon [21]:24, *Mormyrus caschive* [39]: 398—Boulenger [40]: 136.

Voucher profile: dorsal fin with 77–90 rays much longer than anal with 18–21 rays; 97–128 LLS; see Table 2 for locality.

Mormyrus kannume [41]: Figure 2(3).

Literature support: *Mormyrus kannume* [41]: 74—San don [21]: 24; Golubtsov et al. [23]: 38, Boulenger [20]: 169, Bailey [32]: 942, Habteselassie [24]: 64, Eschmeyer et al. [34]; Froese & Pauly [35].

Observed voucher profile: snout shorter and less slender against *M. caschive*; 57–75 and 18-2, rays dorsal and anal fin rays; refer to Table 2 for specific locations.

Mormyrops anguilloides [37]: Figure 2(7).

Supporting literature: *Mormyrops anguilloides* [37]: 327—Golubtsov et al. [23]: 38, Habteselassie [24]: 68, Eschmeyer et al. [34]; Froese & Pauly [35].

Erroneous citations of original description year: *Mormyrops anguilloides* [42]—Sandon [21]: 22, erroneous citations of the year of original publication as 1764.

Erroneous naming: *Mormyrops (Mormyrops) anguilloides* [37] —Bailey [32]:943.

Voucher profile: laterally compressed body; nostrils placed distantly; dorsal fin is slightly longer than anal; possesses subinferior mouth; see Table 2 for specific locality.

Order *Characiformes*

Alestidae

Hydrocynus vittatus [43]: Figure 2(10).

Literature support: *Hydrocynus vittatus* [43]: 65—Bai ley [32]: 946, Eschmeyer et al. [34]; Froese & Pauly [35].

Erroneous author placement: *Hydrocynus vittatus* [43]—Habteselassie [24]: 75.

Synonyms: *Hydrocyon lineatus* [44]:125— Boulenger [40]: 182, Boulenger [20]: 176, Tedla [22]: 23, *Hydrocynus lineatus* Bleeker, 1862— Sandon [21]: 27.

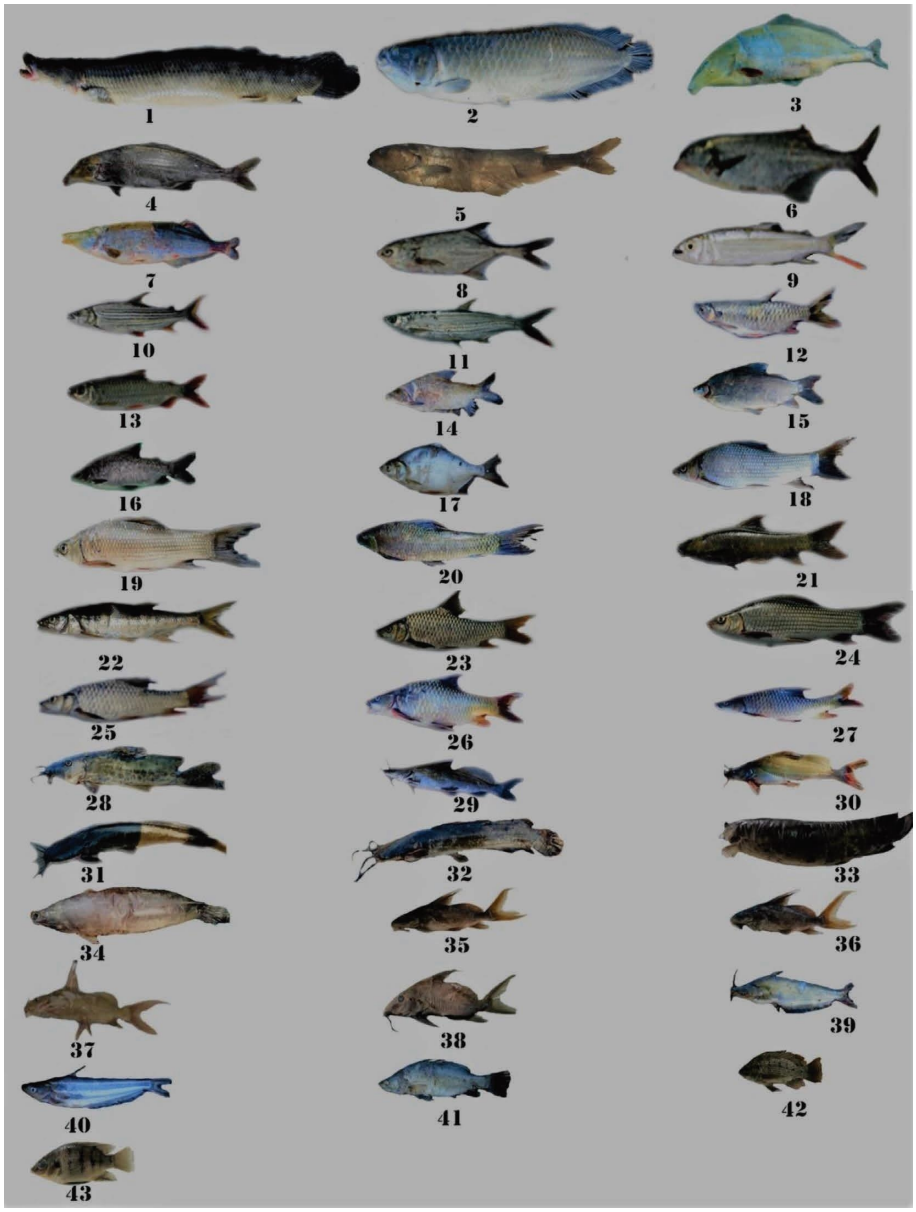

FIGURE 2: Species of fishes of the Alitash National Park floodplain rivers: (1) *P. bichir*, 50.8 cm SL, ZNHM-FAL001-2. (2) *H. niloticus*, 63.5 cm SL, ZNHM-FAL003-5. (3) *M. kannume*, 48.7 cm SL, ZNHM-FAL013. (4) *M. caschive*, 42.7 cm SL, ZNHM-FAL011-12. (5) *H. bebe*, 27.2 cm SL, ZNHM-FAL006-7. (6) *M. cyprinoides*, 34.2 cm SL, ZNHM-FAL010. (7) *M. anguilloides*, 55.3 cm SL, ZNHM-FAL014. (8) *P. keatingii*, 19.3 cm SL, ZNHM-FAL008-9. (9) *H. forskahlii*, 38.6 cm SL, ZNHM-FAL017-18. (10) *H. vittatus*, 37.3 cm SL, ZNHM-FAL015-16. (11) *A. baremoze*, 27.5 cm SL, ZNHM-FAL019-21. (12) *B. macrolepidotus*, 27 cm SL, ZNHM-FAL025-27. (13) *B. nurse*, 24, 16.7 cm SL, ZNHM-FAL022-24. (14) *D. engycephalus*, 41.8 cm SL, ZNHM-FAL029. (15) *D. brevipinnis*, 44.3 cm SL, ZNHM-FAL028. (16) *D. rostratus*, 46.3 cm SL, ZNHM-FAL030. (17) *C. latus*, 33.4 cm SL, ZNHM-FAL031. (18) *L. niloticus*, 31.2 cm SL, ZNHM-FAL046-47. (19) *L. horie*, 25.6 cm SL, ZNHM-FAL044-45. (20) *L. forskahlii*, 23.3 43. (21) *L. cylindricus*, 23.4 cm SL, ZNHM-FAL040-41. (22) *R. senegalensis*, 46.3 cm SL, ZNHM-FAL048-50. (23) *L. bynni*, 23.3 cm SL, ZNHM-FAL042-43. (24) *L. Intermedius*, 32.7 cm SL, ZNHM-FAL036-37. (25) *L. crassibarbis,* 28.9 cm SL, ZNHM-FAL034-35. (26) *L. degeni*, 21.7 cm SL, ZNHM-FAL038. (27) *L. nedgia*, 19.5 cm SL, ZNHM-FAL039. (28) A. occidentalis, 36.8 cm SL, ZNHM-FAL051-53. (29) *B. bajad*, 39.2 cm SL, ZNHM-FAL059. (30) *B. docmak*, 40.7 cm SL, ZNHM-FAL060. (31) *C. gariepinus*, 48.5 cm SL, ZNHM-FAL054-56. (32) *H. longifilis*, 50.6 cm SL, ZNHM-FAL057-58. (33) *M. electricus*, 18.3 cm SL, ZNHM-FAL0070. (34) *M. minjiriya*, 19.7 cm SL, ZNHM-FAL071. (35) *S. clarias*, 23 cm SL, ZNHM-FAL061-62. (36) *S. schall*, 28.2 cm SL, ZNHM-FAL063-65. (37) *S. serratus*, 30.6 cm SL, ZNHM-FAL066-67. (38) *S. sorex*, 26.3 cm SL, ZNHM-FAL068-69. (39) *S. uranoscopus*, 27.8 cm SL, ZNHM-FAL075-77. (40) *S. mystus*, 25.3 cm SL, ZNHM-FAL072-74. (41) *L. niloticus*, 28.5 cm SL, ZNHM-FAL083-84. (42) *O. niloticus*, 26.2 cm SL, ZNHM-FAL078-80. (43) *C. zillii*, 20.8 cm SL, ZNHM-FAL081-82.

Voucher specimen profile: adipose eyelid present; body silvery with slight black stripes; refer to Table 2 for specific locality.

Hydrocynus forskahlii [45]: Figure 2(9).

Literature support: *Hydrocynus forskahlii* [45]: 354—Bailey [32]: 946, Golubtsov et al. [23]: 28, Froese & Pauly [35].

Erroneous author placement: *Hydrocynus forskahlii* Cuvier, 1819—Habteselassie [24]:74, Eschmeyer et al. [34].

Erroneous in spelling: *Hydrocynus forskalii* [45] —Paugy [46]:170.

Synonym: *Hydrocyon forskali* [45] —Tedla [22]:22.

Observed voucher profile: possess small adipose fin; LLS 48–54; see Table 2 for specific locations.

baremoze [47]: Figure 2(11).

Literature support: *Alestes baremoze* [47]: 31—Esch meyer et al. [34]; Froese & Pauly [48].

Eraneous descriptor name: *Alestes baremoze* [49]—Bailey [32]: 947, Golubtsov et al. [23]: 29, Habteselassie [24]: 76.

Eraneous in spelling: *Alestes baremose* [47]—Boulenger [50]: 40, Boulenger [40]: 195, Boulenger [20]: 176, Sandon [21]: 29, Tedla [22]: 24.

Voucher specimen profile: body compressed; possesses adipose eyelid; 44 LLS; see Table 2 for specific locality.

Brycinus nurse [51]: Figure 2(13).

Literature support: *Brycinus nurse* [51]:12—Bailey [32]: 946, Golubtsov et al. [23]: 29, Habteselassie [24]: 77, Froese & Pauly [48].

Synonyms: *Brachyalestes nurse* [51]—Eschmeyer et al. [34] and *Alestes nurse* [51]—Sandon [21]: 29, Boulenger [50]: 40, Boulenger [40]: 205, Boulenger [20]: 179, Tedla [22]: 24.

Voucher profile: single black spot on gill-cover and caudal peduncle; 11–16 branched rays on anal fin; 26–33 LLS; refer to Table 2 for the specific location.

Brycinus macrolepidotus [52]: Figure 2(12).

Literature support: *Brycinus macrolepidotus* [52]: 157—Bailey [32]: 946, Golubtsov et al. [23]: 29, Habteselassie [24]: 76.

Synonym: *Alestes macrolepidotus* [53]—Boulenger [20]: 184, Sandon [21]: 29, Tedla [22]: 25.

Voucher profile: possess flattened head; 12–14 branched rays in anal fin; 22–26 LLS; see Table 2 for specific locality.

Distichodontidae

Distichodus brevipinnis [54]: Figure 2(15).

Literature support: Dichotomous *brevipinnis* [54]: 361—Boulenger [20]: 193, Sandon [21]: 32, Bailey [32]: 948, Golubtsov et al. [23]: 31, Habteselassie [24]: 81, Eschmeyer et al. [34]; Froese & Pauly [35].

Voucher specimen profile: possesses small inferior mouth; scales small and covering the greater part of the caudal and adipose fins; refer to Table 2 for specific locality.

Distichodus engycephalus [54]: Figure 2(14).

Literature support: Dichotomous *engycephalus* [54]: 361—Boulenger [20]: 193, Sandon [21]: 32, Bailey [32]: 948, Golubtsov et al. [23]: 31, Habteselassie [24]: 81, Eschmeyer et al. [34]; Froese & Pauly [35].

Observed voucher characteristics: mouth inferior; nostrils very close to each other; possesses small ctenoid scales; unique narrow head; see Table 2 for a specific locality.

Distichodus rostratus [54]: Figure 2(16).

Literature support: *Dichotomous rostratus* [54]: 360—Boulenger [20]: 194, Sandon [21]: 32, Bailey [32]: 946, Golubtsov et al. [23]: 32, Habteselassie [24]: 82; Eschmeyer et al. [34]; Froese & Pauly [48].

Vouchers' profile: mouth inferior; body covered with small ctenoid scales; 83–90 LLS; juveniles possess black irregular bands on flunk; refer to Table 2 for the specific locality.

Citharinidae

Citharinus latus [55]: Figure 2(17).

Literature support: *Citharinus latus* [55]: 9—Boulenger [20]: 197, Sandon [21]: 31, Bailey [32]: 949, Golubtsov et al. [23]: 28, Habteselassie [24]: 86, Eschmeyer et al. [34]; Froese & Pauly [48].

Examined specimen profile: very deep body covered with cycloid scales; mouth terminal; see Table 2 for the specific locality.

Order *Cypriniformes*

Cyprinidae

Labeobarbus bynni [41]: Figure 2(23).

Literature support: *Labeobarbus bynni* [41]: 71—Habteselassie [24]: 123.

Synonyms: *Barbus bynni* [41]—Boulenger [19]: 26, Sandon [21]: 36, Bailey [32]: 950, Golubtsov et al. [23]: 15, *Barbus ruspolii* [56]: 29—Tedla [22]: 34.

Voucher specimen profile: body deep; inferior mouth equipped with well-developed lips; 28–37 LLS; refer to Table 2 for the specific locality.

Labeobarbus crassibarbis [57]: Figure 2(25).

Literature support: *Labeobarbus crassibarbis* [57]: 131—Getahun & Dejen [58]: 81, Habteselassie [24]: 131.

Synonym: *Barbus crassibarbis* [57]: 131.

Voucher profile: possesses deep body; mouth inferior with well-developed lips; last dorsal ray is ossified and

unbranded; 28–37 LLS; see Table 2 for the specific location.

Labeobarbus intermedius [59]: Figure 2(24).

Literature support: *Labeobarbus intermedius* [59]: 7—Habteselassie [24]: 123, Eschmeyer et al. [34]; Froese & Pauly [35].

Erroneous year of original publication: *Labeobarbus intermedius* [60]—Getahun & Dejen [61]: 91.

Synonym: *Barbus intermedius* [62]—Boulenger [63]: 59; Tedla [22]: 43.

Vouchers' specimen characteristics: mouth terminal equipped with small barbells; possesses cycloid scales; 30–36 SLL; refer to Table 2 for specific collection locality.

Labeobarbus degeni [64]: Figure 2(26).

Literature support: *Labeobarbus degeni* [64]: 435—Getahun & Dejen [61]: 85, Eschmeyer et al. [34]; Froese & Pauly [35]. However, *L. degeni* is missing from Habteselassie's [24] account.

Synonym*: Barbus degeni* Boulenger, 1902—Boulenger [64]: 435, Boulenger [63]: 50.

Examined voucher characteristics: mouth inferior; possesses well-developed lips—lower produced into rounded median lobes; see Table 2 for the specific locality.

Labeobarbus nedgia [60]: Figure 2(27).

Literature support: *Labeobarbus nedgia* [60]: 14—Getahun & Dejen [61]: 98, Habteselassie [24]: 138.

Synonyms: *Barbus nedgia* [60]: 14—Nagelkerke & Sibbing [4]: 210 and *Barbus nedgia* [65]: 104—Boulenger [64]: 426, Boulenger [63]: 51.

Observed voucher profile: inferior mouth with thick lip—lower lip with a fleshy median lobe and upper ones curling back; refer to Table 2 for the specific locality.

Labeo cylindricus [66]: Figure 2(21).

Literature support: *Labeo cylindricus* [66]: 684—Boulenger [20]: 204, Tedla [22]: 29, Golubtsov et al. [23]: 15, Habteselassie [24]: 110.

Voucher characteristics: mouth large, eyes positioned supero-laterally, body elongated and cylindrical; see Table 2 for a particular location.

Labeo forskalii [59]: Figure 2(20).

Labeo forskalii [59]: 18—Boulenger [20]: 205, Sandon [21]: 35, Bailey [32]: 952, Golubtsov et al. [23]: 15, Habteselassie [24]: 108.

Voucher profile: eye positioned dorsally, concave dorsal fin margin ahead; refer to Table 2 for the specific locations.

Labeo horie [67]: Figure 2(19).

Literature support: *Labeo horie* [68]: 304—Boulenger [40]: 306, Sandon [21]: 35, Bailey [32]: 952, Golubtsov et al. [23]: 15, Habteselassie [24]: 109.

Eraneous original year of publication: *Labeo horie* Heckel, 1847—Eschmeyer et al. [34]; Froese & Pauly [35].

Examined specimen profile: strongly compressed body; teeth absent; 11–14 branched rays on dorsal fin; 40–44 LLS; see Table 2 for a particular locality.

Labeo niloticus [37]: Figure 2(18).

Literature support: *Labeo niloticus* [37]: 322—Froese & Pauly [35].

Eraneous first descriptor naming: *Labeo niloticus* [41]: 71; Boulenger [40]: 304 & 316, Sandon [21]: 35, Bailey [32]: 952, Golubtsov et al. [23]: 13, Habteselassie [24]: 107.

Examined voucher profile: inferior mouth, teeth absent, 14–17 branched dorsal rays, 41–45 LLS; see Table 2 for specific locality.

Raiamas senegalensis [69]: Figure 2(22).

Literature support: *Raiamas senegalensis* [69]: 564—Bailey [32]: 953, Habteselassie [24]: 120, Eschmeyer et al. [34]; Froese & Pauly [35].

Erroneous report on first descriptor: *Raiamas loati* [36]: 80, Golubtsov et al. [23]: 12, *Barilius loati* [36]: 80, Sandon [21]: 38, Tedla [22]: 57.

Synonym: *Barilius senegalensis* [69]: 564, Boulenger [19]: 204.

Observed specimen profile: mouth terminal; dorsal III 8 rays; 12–14 black vertical bars on flunk; 50–64 LLS; refer to Table 2 for a particular location.

Order *Siluriformes*

Auchenoglanididae

Auchenoglanis occidentalis [70]: Figure 2(28).

Literature support: *Auchenoglanis occidentalis* [70]: 303—Habteselassie [24]: 141, Eschmeyer et al. [34]; Froese & Pauly [35].

Eraneous in first descriptor placement: *Auchenoglanis occidentalis* [71]—Boulenger [50]: 48, Boulenger [19]: 369, Sandon [21]: 44.

Examined specimen profile: short white-yellow maxillary barbells; moderately sized black spots on body but small caudal; the snout is more pointed against *A. biscutatus*; see Table 2 for a specific locality.

Clariidae

Clarias gariepinus [72]: Figure 2(31).

Literature support: *Clarias gariepinus* [72]: 425—Boulenger [19]: 228, Bailey [32]: 957, Golubtsov et al. [23]: 19, Getahun & Dejen [61]: 114, Habteselassie [24]: 151, Eschmeyer et al. [34]; Froese & Pauly [35].

Synonym: *Clarias lazera* [71]: 372— Boulenger [19]: 232, Sandon [21]: 40, Tedla [22]: 63.

Examined voucher profile: elongated body; mouth subinferior; no adipose fin; caudal fin round; refer to Table 2 for a particular collection area.

Heterobranchus longifilis [70]: Figure 2(32).

Literature support: *Heterobranchus longifilis* [70]: 395, Bouleneger [19]: 274, Bailey [32]: 957, Golubtsov et al. [23]: 20, Habteselassie [24]: 154, Eschmeyer et al. [34]; Froese & Pauly [35].

Synonyms: *Heterobranchus longifilis* [73]: Tedla [22]: 65, *Heterobranchus longifilis* [74]: Sandon [21]: 41, *Heterobranchus laticeps* [66]: 682, Boulenger [36]: 265.

Examined voucher characteristics: longer head; eyes positioned supero-lateral view; feebly serrated spin on pectoral fins; refer to Table 2 for a particular locality.

Bagridae

Bagrus bajad [41]: Figure 2(29).

Literature support: *Bagrus bajad* [41]: 66—Golubtsov et al. [23]: 21, Habteselassie [24]: 142, Eschmeyer et al. [34]; Froese & Pauly [35].

Synonym: *Bagrus bayad* [41]—Boulenger [19]: 305, Sandon [21]: 42.

Examined voucher profile: naked body; long maxillary barbell—reaching ventral fin; caudal fin strongly forked—upper and lower lobes equally extending into long filaments; refer to Table 2 for a particular locality.

Bagrus docmak [41]: Figure 2(30).

Literature support: *Bagrus docmak* [41]: 65, Golubtsov et al. [23]: 2, Habteselassie [24]: 143, Eschmeyer et al. [34]; Froese & Pauly [35].

Synonym: *Bagrus docmac* [41]—Boulenger [75]: 559, Boulenger [19]: 308, Boulenger [20]: 298, Sandon [21]: 42, Tedla [22]: 60.

Examined voucher characteristics: body slightly elongated and naked; caudal fin forked—upper lobe extending into long filament; see Table 2 for a particular locality.

Mochokidae

Synodontis clarias [37]: Figure 2(35).

Literature support: *Synodontis clarias* [37]: 306—Bou lenger [19]: 469, Bailey [32]: 959, Golubtsov et al. [23]: 23, Habteselassie [24]: 165.

Erroneous of original year publication: *Synodontis clarias* [38]—Sandon [21]: 46.

Synonyms: *Synodontis clarias* [76]: 299—*Synodontis callarias* [77]: 379; *Synodontis macrodon* [78]: 295.

Examined voucher profile: naked body; branched maxillary barbells without marginal membrane; pointed humeral process; see Table 2 for the specific locality.

Synodontis schall [77]: Figure 2(36).

Literature support: *Synodontis schall* [77]: 385—Bou lenger [19]: 404, Boulenger [20]: 316, Sandon [21]: 47, Tedla [22]: 66, Bailey [32]: 960, Golubtsov et al. [23]: 26, Habteselassie [24]: 170, Eschmeyer et al. [34]; Froese & Pauly [48].

Examined voucher profile: body naked; maxillary barbells longer but unbranched; dorsal fins feebly serrated behind; humeral process sharply pointed; refer to Table 2 for particular locality.

Synodontis serratus [79]: Figure 2(37).

Literature support: *Synodontis serratus* [79]: 8—Bou lenger [19]: 457, Sandon [21]: 46, Bailey [32]: 960, Golubtsov et al. [23]: 26, Eschmeyer et al. [34]; Froese & Pauly [35].

Synonym: *Synodontis serrata* Rüppell, 1829—Habt eselassie [24]: 168.

Examined voucher profile: dorsal spine—serrated in front; pectoral spine—strongly serrated; maxillary barbell slightly branched; see Table 2 for the specific locality.

Synodontis sorex [54]: Figure 2(38).

Literature support: *Synodontis sorex* [54]: 110— Boulenger [19]: 465, Boulenger [20]: 322, Sandon [21]: 46, Bailey [32]: 959, Golubtsov et al. [23]: 25, Habteselassie [24]: 167, Eschmeyer et al. [34]; Froese & Pauly [48].

Synonym: *Synodontis geledensis* [31]: 56—Tedla [22]: 67, Boulenger [20]: 322.

Examined voucher specimen: broad marginal membrane at maxillary barbels; humeral process flat; caudal fin strongly developed as compared to other congers; dorsal spine strongly serrated in front and coarsely serrated behind; see Table 2 for specific location.

Malapteruridae

Malapterurus electricus [80]: Figure 2(33).

Literature support: *Malapterurus electricus* [80]: 1354—Bailey [32]: 958, Golubtsov et al. [23]: 18, Habteselassie [24]: 155, Eschmeyer et al. [34]; Froese & Pauly [35].

Synonym: *Malapterurus electricus* [41]—Sandon [21]: 50.

Observed vouchers' profile: body naked; caudal fin usually well spotted in adults; anal fin short; no bony head plates; see table for particular collection locality.

Malapterurus minjiriya [81]: Figure 2(34).

Literature support: *Malapterurus minjiriya* [81]: 78—Golubtsov et al. [23]: 18, Habteselassie [24]: 156, Eschmeyer et al. [34]; Froese & Pauly [35].

Examined voucher specimen: naked body; caudal fin round or truncated; large blotch on body and head but concentrated posterior; see Table 2 for a particular locality.

Schilbeidae

Schilbe mystus [37]: Figure 2(40).

Literature support: *Schilbe mystus* [37]: 305—Golubtsov et al. [23]: 20, Habteselassie [24]: 174, Eschmeyer [82].

Synonym: *Schilbe mystus* [38]—Boulenger [20]: 293, Sandon [21]: 49, erroneous citation of year of publication as 1762 in both cases.

Examined voucher specimen characteristics: naked body and compressed; mouth terminal; head region rises gradually to dorsal; anal fin very long; refer to Table 2 for specific collection localities.

Schilbe uranoscopus [51]: Figure 2(39).

Literature support: *Schilbe uranoscopus* [51]: 4—Bou lenger [19]: 296, Sandon [21]: 49, Bailey [32]: 956, Golubtsov et al. [23]: 18, Habteselassie [24]: 174, Eschmeyer et al. [34]; Froese & Pauly [35].

Examined voucher specimen: naked body and strongly compressed; the head profile is nearly horizontal; mouth terminal; see Table 2 for specific locality.

Order *Perciformes*

Cichlidae

Oreochromis niloticus [37]: Figure 2(42).

Literature support: *Oreochromis niloticus* [37]: 290—Golubtsov et al. [23]: 35, Habteselassie [24]: 195, Eschmeyer et al. [34]; Froese & Pauly [48].

Synonyms: *Labrus niloticus* [83]: 346—Günther [31]: 218; *Tilapia nilotica* [39]: 346—Boulenger [84]: 162, *Tilapia nilotica* [39]: Sandon [21]: 56, Tedla [22]: 70 and *Oreochromis niloticus cancellatus* [85]: 2—Trewavas & Teugels [86]: 330.

Examined voucher specimen: dorsal fin XVI-XVIII 11–15 rays; pectoral fin relatively shorter; mouth terminal; dark spots on dorsal and anal fins; see Table 2 for the specific locality.

Coptodon zillii [87]: Figure 2(43).

Literature support: *Coptodon zillii* [87]: 203, a newly revised genus.

Synonym: *Tilapia zillii* [87]—Boulenger [84]: 197, Bailey [32]: 966, Golubtsov et al. [23]: 34, Sandon [21]: 56, Tedla [22]: 70; Habteselassie [24]: 197, Eschmeyer et al. [34]; Froese & Pauly [35].

Observed specimen: upper head profile not convex; orange bands on dorsal and anal fins; "tilapia" spot large and extending to 4^{th} dorsal soft ray; see Table 2 for a particular locality.

Latidae

Lates niloticus [37]: Figure 2(41).

Literature support: *Lates niloticus* [37]: 290, Golubtsov et al. [23]: 32, Habteselassie [24]: 189, Eschmeyer et al. [34]; Froese & Pauly [35].

Synonyms: *Lates nilotica* [38]—Sandon [21]: 53, *Lates niloticus* [38]: 404—Boulenger [84]: 105, *Lates (Lates) niloticus* [37]—Bailey [32]:963.

Examined specimen: a deep body covered with ctenoid scales; mouth terminal; dorsal fin notched into anterior and posterior; caudal fin rounded; see Table 2 for specific locality.

3.4. Fish Diversity Status. Species richness, H', and evenness indices were statistically significant among the rivers ($p < 0.05$) (Table 3). The abundance of collected specimens varied only between the Gelegu and Shinfa Rivers ($p = 0.041$). Fish turnover in the floodplain rivers was implied by the Whittaker beta diversity index, which was determined to be 0.33.

The likely species richness of the Shinfa River (i.e., the smallest sample) rarefied from the Ayima and Gelegu Rivers (i.e., the largest sample), and the expected rarefied species richness of the Shinfa River with a sample size of 534.356 ± 22.91 and a 95% confidence interval (CI) are shown in Figure 3. In ecology, differential sampling sizes were standardized by scaling the bigger sample down to the size of the smaller one through the process of rarefying, or thinning, a reference sample by selecting random subsets of sample populations.

The rank-order abundance plot showed that fish communities in the Gelegu and Shinfa Rivers were more uneven than those in the Ayima River (Figure 4).

4. Discussion

The analysis showed that the Gelegu, followed by the Ayima River, was species-rich. As verified in the present study and previous literature, the basin-wise characterization showed that the rivers of the Abbay Basin are home to diverse ichthyofauna compared to the Tekeze Basin (e.g., [7, 8, 88]). This difference might be attributed to the nature and volume of tributary streams since the Abbay Basin has a greater number of tributaries throughout the entire course of the river basin.

In the entire sampling program, similar fishing efforts and techniques were applied, and this assured that the difference in species diversity and abundance would not result in effort variation [26, 89]. However, in diverse ecological setups where sampling campaigns only cover a small section, collecting biological entities only accustoms the available individuals from the whole assemblage. Thus, the absence of a particular species in a collection can represent its absence or presence but is not verified in a sample [8]. This is related to the fact that biological diversity is often high at all levels and biodiversity sampling is usually biased because of its labor-intensive nature [27]. Accordingly, the intentions referred to in this study need to consider previous studies and the country's fish checklist. This is because fish biological data analysis should include present and past studies to account for the full image of an intended basin ichthyofauna. For example, fish diversity studies intended to cover Abbay and Tekeze Basins need to recognize 77 valid native fish species [6]. Based on these premises, from this study, a dichotomous bracketed key was produced for easy naming of fish that will be collected from the whole Abbay and Tekeze Basins (Appendix 1).

Table 3: Summary of variation in species abundance (n), species richness (S), Shannon diversity index (H'), Shannon evenness index ($e^{H/S}$), and equitability (J') for the Ayima River (AR), Gelegu River (GR), and Shinfa River (SR).

Parameter	AR	GR	SR	F	P
Number of specimens (n)	1006	1124	589	1.642	0.080
Species richness (N)	35	38	25	67.444	0.000*
Shannon diversity index (H')	2.86	3.02	2.95	15.413	0.000*
Shannon evenness index ($e^{H/S}$)	0.51	0.54	0.76	145.865	0.001*
Equitability index (J')	0.81	0.83	0.92	66.618	0.000*

*Significant values, $p < 0.05$.

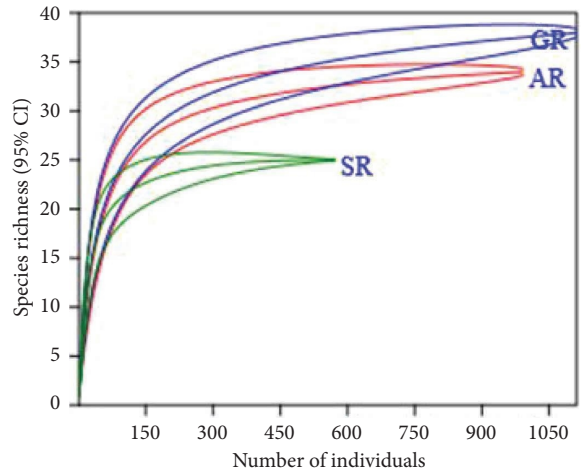

Figure 3: River-wise individual-based rarefaction analysis for SR ($n = 589$) and over the GR ($n = 1124$) for their species abundances; AR: Ayima River; GR: Gelegu River; SR: Shinfa River.

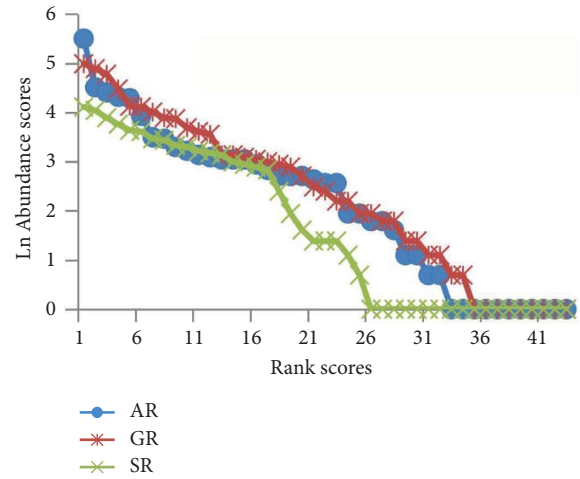

Figure 4: Whittaker plot for fish communities of the rivers in the Abbay and Tekeze Basins, see Figure 3 for abbreviations.

In the present study, Cyprinidae was the most dominant family, represented by 10 species in the two basins. By considering the "species flocks" of the Lake Tana subbasin, species of the cyprinids composed 50% of the ichthyofaunal accounts of the Abbay Basin [2, 6]. In the present study, 23.3 and 36% of the Abbay and Tekeze Basins, respectively, were accounted for by cyprinid species. In agreement with the present finding, the study intended to compare the fish faunal diversities in the Abbay and White Nile Basins and reported the dominance of cyprinids in the former basin [6]. This is associated with the fact that the resilient nature of cyprinids led them to adapt to seasonally inundated but productive floodplain habitats in the Abbay Basin [2]. The dominance of cyprinid species in both tropical and temperate rivers has also been reported (e.g., [14, 15, 90, 91]).

The other dominant families identified from ALNP were Alestidae (five species) and Mockokidae (four species) (Table 2). According to Lèvèque et al. [92], fish species

belonging to these families are primarily distributed in African freshwater systems. In the Abbay Basin within the Ethiopian territory, the Mormyridae and Mockokidae families were more representative of rivers [2]. In the present study, families were represented by nearly equal numbers of species in the three rivers. According to Greenwood [93], Mormyridae, Cyprinidae, Alestidae, Auchenoglanididae, Bagridae, Clariidae, and Cichlidae together accounted for half of the fish species diversity in the Nile.

In the present study, some families were represented only by a single species, including Polypteridae, Arapaimidae, Citharinidae, Auchenoglanididae, and Latidae (Table 2). Except for the individuals sampled from the Arapaimidae and Auchenoglanididae families, the number of individuals belonging to these families was also too small. In agreement with the present report, these "peripheral freshwater fish families" were poorly represented in many African inland waters [92].

Compared to the DNP (Sudan), the faunal diversity of ALNP was much higher [8, 94]. The two parks share similar ecological biomes and are isolated by shared boundaries. The River Ayima (Ethiopia), named Dinder (in Sudan), with highland stream tributaries, is the only perennial river flowing into the two parks. The number of fish identified from the Ethiopian Ayima was 35 (present study), while Khalid et al. [94] identified 31 fish from the Dinder River (Sudan). The differences in fish species diversity in the river might be associated with the seasonal nature of the river, which hinders fish movement while disconnected from the main channel during the extended dry season.

Getahun [7] reported the occurrence of 62 species in the whole Abbay Basin. Accordingly, the collection made in the ALNP in the present study represented 69.35% of the basin's fish. On the other hand, the Tekeze Basin was recognized as home to 35 species [7], and the River Shinfa alone contributed 71.43% of the total. The presence of more diverse ichthyofauna in the floodplain rivers of the ALNP is attributed to the lower altitude ranges of the areas since biological diversity increases as altitude decreases [88].

The present study revealed the presence of 15 and 4 newly recorded species from the Ayima and Shinfa Rivers, respectively, based on the available literature [15, 58] (Table 2*). Among others, this study reported the presence of the genera *Marcusenius* and *Hyperopisus* in the Shinfa River of the Tekeze Basin. The discovery of these two mormyrid genera in the Shinfa River for the first time may be attributed to our exhaustive sampling strategy. The collection we obtained from the Gelegu River cannot be compared with the available literature. This is because, to the best of our knowledge, there is no available data pertaining to fish diversity studies on the Gelegu River. In this context, we performed a basin-wise comparison. Based on this analysis, *P. bichir*, *H. bebe*, *M. cyprinoides, P. keatingii*, *M. anguilloides*, *D. rostratus*, *S. clarias*, *S. sorex*, *M. electricus,* and *M. minjiriya* were identified in the Gelegu River (Table 2*).

The identification of the above-mentioned species from the Abbay Basin had not been previously reported. For example, *M. cyprinoides* was found only in the basins of the White Nile, Omo-Turkana, and southern Ethiopian rift valley lakes [6]. In Ethiopia, *P. keatingii* had been only reported in the White Nile [88]. However, the present collection from the Gelegu River confirmed the presence of *P. keatingii*. Known as the "lowland nilotic fish fauna" [92], the presence of *P. bichir* in the Gelegu River was considerably a new record for the Abbay Basin in this study. Other species discovered as new records in the Abbay Basin were *D. engycephalus*, *D. rostratus*, *C. latus,* and *S. mystus*. In the present investigation, diversity and the number of collected individuals differed between the sampling sites.

The most varied (35) and abundant fish fauna were found at sampling site G1, with H′, evenness, and equitability indices of 2.98, 0.56, and 0.84, respectively. *C. gariepinus*, *S. schall*, *S. mystus*, *S. serratus*, and *H. niloticus* all made significant numerical contributions at this location. In terms of both diversity and richness, the other location found on Gelegu River (G2) came in second. High species variety and abundance in the Gelegu River may be ascribed to low human disturbance and low fishing pressure. Furthermore, compared to Ayima and Shinfa Rivers, Gelegu has a smaller water volume and is shallower, which may make it easier for us to gather more species and individuals.

The number of individuals collected did not differ among the rivers ($p > 0.05$). However, there was a statistically significant difference between the individuals sampled from G1 and S1 ($p = 0.042$) and G1 vs. S2 ($p = 0.039$). As was compared with the H′ and the Whitaker plots in this study, the species abundance distribution was more even for the Gelegu River [9]. This might be due to the rocky gorges that contribute to sheltering the fish species from predators in this river [8]. The Ayima River, with several small to medium tributary streams, is attributed to the occurrence of considerable fish species diversity. This notation is in line with the reports of Tewabe [15] who reported higher fish diversity in the Ayima River than in the Guang and Gendawuha Rivers in Ethiopia.

5. Conclusion

Many seasonally inundated (floodplain) rivers drain along the ALNP. These rivers are made of considerable fish species diversity and belong to the lower reach tributaries of the Abbay and Tekeze Basins. In the current study, the rivers of the ALNP were acknowledged as being home to a diversified ichthyofauna when compared to other comparable water bodies in Ethiopia [95].

Generally,

(a) The endemic species in ALNP were significantly less diversified than the native "Nilo-Sudanic" affinities.

(b) In both basins, the rivers evaluated for this study had the highest diversity of fish species.

(c) Certain areas within the ALNP were experiencing complex ecological problems, and in order to preserve park resources, suitable conservation actions need to be pursued.

(d) It is anticipated that the identification key and annotated checklist created for this study will address taxonomic issues with fish species identification in these two basins. Moreover, the outcomes of this research will serve as baseline data for researchers and policymakers in the future.

Data Availability

All datasets and the materials used in the preparation of this manuscript are available from the corresponding author and will be shared upon reasonable request.

Ethical Approval

This study was approved by the Addis Ababa University (Ethiopia) Ethical Review Committee (Ref No. VM/ERC/07/05/12/2017).

Consent

Written informed consent was obtained from the Local Governor of the Quara Woreda officials for this study.

Disclosure

This study is a part of a Ph.D. work.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Authors' Contributions

Alamrew Eyayu conceptualized the study, collected and analyzed data, wrote the first draft, and edited the manuscript. Abebe Getahun supervised and edited the manuscript. All authors have reviewed the manuscript.

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Supplementary Materials

In the present, a dichotomous bracketed identification key was prepared for the fish species occurring in the Ethiopian Abbay and Tekeze Basins. This identification was prepared based on measured morphometric and counted meristic parameters. In the preparation of this identification key, in addition to current collections, we also consulted previously published materials pertaining to fishes of both basins. (*Supplementary Materials*)

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