The fish fauna of
Akagera National Park, Rwanda

Report
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During this summer school, we - a team of six ichthyologists – successfully sampled 23 localities using a) monofilament gill nets (mesh sizes 8 mm, 10 mm, 12 mm, 15 mm, 20 mm, 30 mm and 40 mm); b) a scoop net; and c) an electro fisher. Over 3000 fish samples were collected, of which roughly 1500 were examined in the lab at the RBINS (Royal Belgian Institute of Natural Sciences, Brussels, Belgium). As not all samples have yet been identified, this document provides a preliminary report of the mission. So far, 32 species have been recovered (See table 1, figure 1). Besides giving an overview of the collection, it will also give a description of the habitats and some guidelines for conservation.

The Middle Akagera and connected lakes.

The Akagera National Park lies at the eastern border of Rwanda. It has a north-south orientation and lies between the Akagera River in the east, and an escarpment in the west. The whole of the National Park is part of the Middle Akagera, i.e., the stretch of the River between the Rusimo falls and the Rwanda-Uganda-Tanzania tripoint, which contains 55 fish species (table 1), representing the most species-rich part of Rwanda in terms of fishes.

Besides forming the eastern park boundary, the Middle Akagera River also forms the boundary between Rwanda and Tanzania. Associated to this river are a series of lakes. Some of these are fully connected to the river, whereas others are connected through papyrus swamps. During this summer school, four of these lakes were sampled. These four lakes: Ihema, Shakani, Rwanyakizinga and Mihindi were selected to have an overview of the different environmental conditions in this part of the national park. The river proper was also sampled at three different locations.

Lake Ihema is the largest and southernmost lake within the national park. It is connected to the river proper at its north-eastern edge. This is also the only lake where a semi-commercial fishery is currently operating. The smaller Lake Shakani lies to the west of Lake Ihema. It is an isolated lake that is not (permanently) connected to the river or to the other lakes, although a 500 m wide papyrus swamp could allow for some ichthyofaunal connection with Lake Ihema.

We visited the fishery at Lake Ihema and found it to be dominated by *Oreochromis* spp., all of which are introduced. Native species, such as *Clarias gariepinus*, *Protopterus aethiopicus*, *Mormyrus kannumae* and (potentially) *Bagrus docmak* only formed a small part of the catch. A review of the literature revealed that the fishery has been like this for decades. However, a

riverine fishery, focusing on more rheophilic species was also known from the Akagera River. Target species of this fishery were *Labeo victorianus*, *Labeobarbus* spp., *Synodontis* spp. and *Clarias gariepinus*. Only the latter species was retrieved from the commercial catches from the Lake. When sampling the Akagera river near the outlets of Lakes Ihema and Mihindi, we did retrieve *Synodontis* spp. in great numbers. Some specimens of *Labeo victorianus* were collected, whereas *Labeobarbus* spp. was absent from the catches.

Rheophilic cyprinids, such as *Labeobarbus* and *Labeo* have more stringent habitat requirements than catfishes belonging to *Synodontis, Clarias* and *Schilbe.* We observed a high sediment load in the Akagera River, and this could have been responsible for the decline (or even disappearance) of these species. Additionally, these species undergo spawning migrations, and the constructions of dams would have restricted their access to these sites. Human activities upstream of the Middle Akagera, an area that covers 70% of Rwanda, might be responsible for the high sediment load, as well as for the destruction of spawning sites. Hence, in order to conserve the native fishes of the Middle Akagera, the whole of the catchment needs to be taken into account.

The effect of the Akagera could best be seen by comparing our catches on Lakes Rwanyakizinga and Mihindi. In the former lake, we performed day catches at the shoreline and in the middle of the lake. Here, our catches were high in biomass and in diversity. Not a single fish was collected during a night catch in Lake Mihindi as our gill nets sank in the deep layer of mud that seemed to form the lake's bottom. At least some fishes were present as indicated by a single *Brycinus* specimen that swam into the nets when hauling them in. Representatives of *Brycinus* (most likely *B. jacksonii*) were abundant in all lake catches. Mormyrids were rarely collected, except for our catch near the outlet of Lake Ihema during a rain shower. Here, relatively large numbers of *Cyphomyrus*, *Gnathonemus*, and *Marcusenius* were collected.

In Lakes Ihema, Shakani, and Rwanyakizinga, at least five undescribed species of *Haplochromis* were collected. Previous genomic analyses as well as morphological pilot studies revealed these to form an independent adaptive radiation that is closely related to that of Lake Victoria. This radiation was eco-morphologically diverse and includes a species of piscivore, zooplanktivore, benthic insectivore, and lobed-lipped insectivore. We found no indication that the different lakes contain different species. Morphologically generalized species were regularly collected in littoral habitats together with the probably introduced *Astatotilapia burtoni*.

Conservation recommendations on for the Akagera lakes

The protection of the endemic species of *Haplochromis*, as well as the (re)creating of favorable conditions for rheophilic species, should be considered a priority. As the species of *Haplochromis* are too small to be targeted by the commercial fishery, and as this fishery mostly targets introduced species, we see no problem with the exploitation of Lake Ihema under the current guidelines and restrictions. However, the low number of *Bagrus docmak* in the catches, as well as the low abundance of *Labeo* and the absence of *Labeobarbus*, was worrying. We hence suggest reporting the occurrence of species belonging to these genera at the landing site. As catches are reported per species by the landing site chairman, obtaining this data should be possible.

During the fieldwork, we encountered traces of illegal fishing inside of the national park. We observed piles of confiscated nets (at ranger posts), and gill nets positioned in the water. Remarkably, we observed gill nets at the eastern side of Lake Rwanyakizinga, indicating that fishermen cross the extensive papyrus swamps between the river and the lake in order to fish.

The policing of this illegal activity would allow a permanent boat on this lake. Currently, patrol boats need to be transported between lakes, which hinders a fast response to a sign of illegal fisheries.

Wetlands at the park boundaries

Besides sampling the Akagera River proper and its associated lakes, we also conducted explorative sampling at wetlands near the northern and southern gates of the park, at the shorelines of sampled lakes, and at ponds on the escarpment.

No fishes were found along the escarpment.

At the Southern gate, we sampled both outside: near the Akagera Community Centre and inside of the park. Near the community centre, we encountered a high abundance of invasive and ecologically tolerant species, with more introduced than native species, both in terms of abundance as in terms of species numbers. This shows the disturbed nature of the area, which is dominated by canals, fish ponds, and agricultural fields. Within the park, but still in the same wetland, we found only one invasive species (*Oreochromis leucosticus*), and a larger diversity of native species. This indicates how a more natural fauna is already found at the edge of a protected area. We also sampled at a wetland that is crossed with the park boundary, at the northern gate of the park. Here, only native species were encountered.

At the shorelines of the lakes of the Middle Akagera, both native and introduced species were encountered. However, the invasive *Poecilia reticulata,* was much more abundant than the native killifish *Lacustricola centralis.* This latter species was, however, common in the wetlands at the southern gate and was also retrieved within the papyrus shorelines of Lake Rwanyakizinga. Given the altered state of the Middle Akagera lakes, and the dominance of non-native species in some niches (*Oreochromis spp.* and *Poecila reticulata*), the importance of smaller, somewhat isolated waterbodies should not be neglected for the protection of native fishes.

Wetlands and lake shorelines as well as the Akagera River throughout the study area were inhabited by several native species of small barbs of the genus *Enteromius*. The identification of these species needs to be confirmed. Strangely, *E. apleurogramma*, a species that occur in marshy areas throughout East Africa, was not found. Neither were Ctenopomidae, also a group adapted to low oxygen conditions. This shows how some ecological niches are vacant in the system, explaining the establishment of several invasive species.

Table 1. Fish species of the Middle Akagera (i.e., Rwandese waters of the Akagera system below the Rusumo Falls). I, introduced; X, native; *probably collected.

Order	Species	De Vos *et al.* 2001	Summer School 2023
Ceratodontiformes	*Protopterus aethiopicus*		I
Characiformes	*Brycinus jacksonii*	X	X
Characiformes	*Brycinus sadleri*	X	X*
Cichliformes	*Astatoreochromis alluaudi*	X	X
Cichliformes	*Astatotilapia burtoni*	Present, might be introduced	Present, probably introduced
Cichliformes	*Coptodon rendalli*	I	
Cichliformes	*Haplochromis* sp. 'Ihema red flank'	X (as *H. Haplochromis* sp. 1)	X (probably polyspecific)
Cichliformes	*Haplochromis* sp. 'Ihema thicklip'	X (as *H. Paralabidochromis* sp.)	X
Cichliformes	*Haplochromis* sp. 'Ihema planktivore'	X (as *H. Haplochromis* sp. 2)	X
Cichliformes	*Haplochromis* sp. 'Ihema insectivore'	X (as *H. Gaurochromis* sp.)	X
Cichliformes	*Haplochromis* sp. 'Ihema piscivore'	X (as *H. Harpagochromis* sp.)	X
Cichliformes	*Oreochromis leucostictus*	I	I
Cichliformes	*Oreochromis macrochir*	I	I
Cichliformes	*Oreochromis niloticus*	I	I
Cichliformes	*Oreochromis variabilis*		X*
Cichliformes	*Pseudocrenilabrus multicolor*	X	X
Cypriniformes	*Cyprinus carpio*	I	
Cypriniformes	*Enteromius alberti*	X (as *E. cercops*)	X
Cypriniformes	*Enteromius apleurogramma*	X	
Cypriniformes	*Enteromius kerstenii*	X	X
Cypriniformes	*Enteromius neumayeri*		X*
Cypriniformes	*Enteromius nyanzae*	X	
Cypriniformes	*Enteromius paludinosus*	X	X
Cypriniformes	*Labeo victorianus*	X	X
Cypriniformes	*Labeobarbus acuticeps*	X	
Cypriniformes	*Labeobarbus altianalis*	X	
Cypriniformes	*Labeobarbus somereni*	X	
Cyprinodontiformes	*Lacustricola centralis*	X	X
Cyprinodontiformes	*Poecilia reticulata*		I
Osteoglossiformes	*Cyphomyrus grahami*	X	X
Osteoglossiformes	*Gnathonemus longibarbis*	X	X
Osteoglossiformes	*Marcusenius victoriae*	X	X
Osteoglossiformes	*Mormyrus kannume*	X	X
Osteoglossiformes	*Petrocephalus catostoma*	X	
Osteoglossiformes	*Pollimyrus nigricans*	X	X
Siluriformes	*Amphilius jacksonii*	X*	
Siluriformes	*Bagrus docmak*		Reported by fishermen
Siluriformes	*Clarias gariepinus*	X	X
Siluriformes	*Clarias liocephalus*	X	X
Siluriformes	*Synodontis afrofischeri*	X	X
Siluriformes	*Synodontis ruandae*	X	X
Siluriformes	*Schilbe intermedius*	X	X
Synbranchiformes	*Mastacembelus frenatus*	X	

Figure 1. Map of the Middle Akagera (i.e., Rwandese waters of the Akagera system below the Rusumo Falls) with catch localities where fishes were collected during the Summer School 2023.

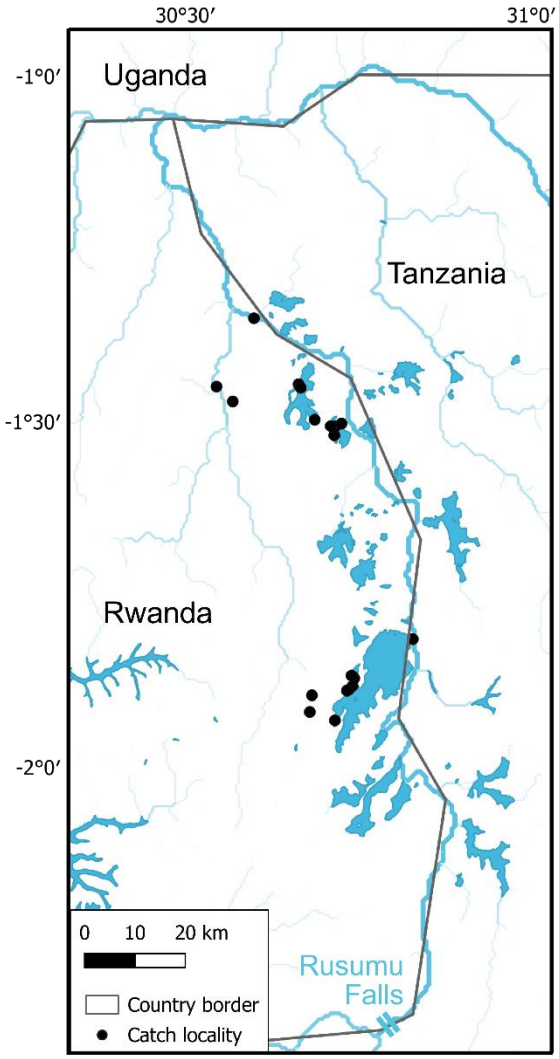

Figure 2. Photographs of fish species of the Middle Akagera (i.e., Rwandese waters of the Akagera system below the Rusumo Falls) collected during the Summer School 2023. *identification uncertain

Protopterus aethiopicus

*Brycinus jacksonii**

Astatoreochromis alluaudi

Astatotilapia burtoni

Haplochromis sp. ‘Ihema red flank’

Haplochromis sp. ‘Ihema thicklip’

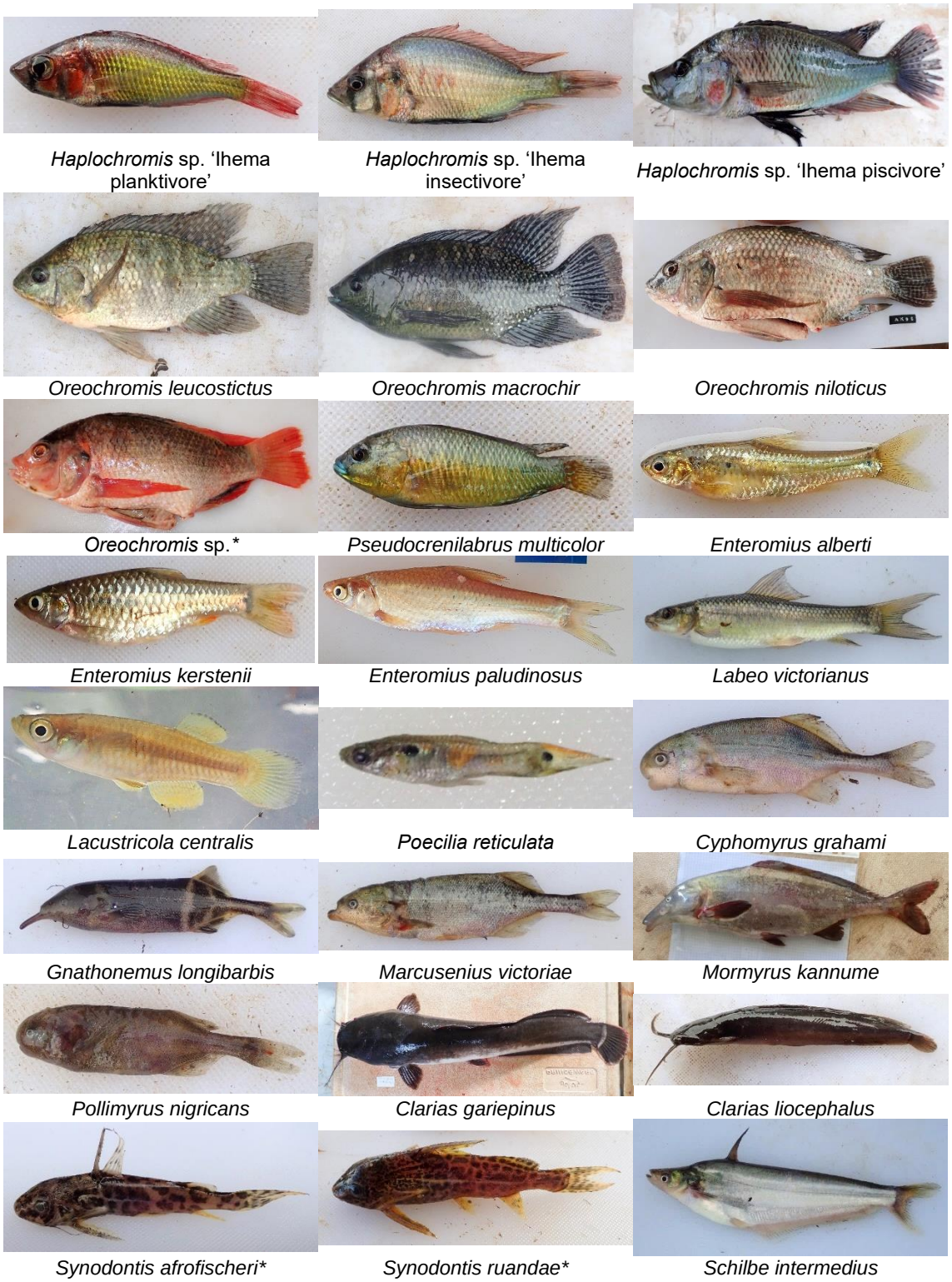

Figure 3. Localities in the Middle Akagera (i.e., Rwandese waters of the Akagera system below the Rusumo Falls) where fishes were collected during the Summer School 2023.

No photograph available

25/10/2023
Wetlands at agricultural site, Nyankora River, near Akagera Community Centre
01°55'12.3"S 30°40'47.8"E

26/10/2023
Lake Ihema, sublittoral, near fish landing site
01°53'15.2"S 30°44'12.0"E

26/10/2023
Lake Ihema, shoreline
01°52'56.3"S 30°44'30.4"E

26/10/2023
Lake Ihema, sublittoral
01°55'56.1"S 30°42'58.6"E

27/10/2023
Lake Ihema, near shore

27/10/2023
Outlet Lake Ihema, Akagera River
01°48'52.7"S 30°49'43.9"E

28/10/2023
Lake Shakani, open water
01°52'09.9"S 30°44'34.9"E

28/10/2023
Lake Shakani, rocky shoreline, 20 cm deep
01°52'16.8"S 30°44'39.8"E

28/10/2023
Lake Shakani, sublittoral
01°52'02.4"S 30°44'25.3"E

No photograph available

29/10/2023
Nyankora River, wetland and small streams, near South Gate of Akagera National Park
01°53'45.2"S 30°40'58.9"E

30/10/2023
Nyankora River, wetland and small streams, near North Gate of Akagera National Park
01°26'56.4"S 30°32'42.2"E

30/10/2023
Shallow pools beside road 33-34 of Akagera National Park
01°28'14.1"S 30°34'06.8"E

31/10/2023
Lake Rwanyakizinga, shallow shoreline
01°29'49.1"S 30°41'13.8"E

31/10/2023
Lake Rwanyakizinga, papyrus shoreline
01°26'43.6"S 30°39'49.8"E

01/11/2023
Lake Rwanyakizinga, papyrus shoreline
01°26'45.2"S 30°39'49.8"E

01/11/2023
Lake Rwanyakizinga, open water
01°27'02.1"S 30°40'00.5"E

01/11/2023
Lake Mihindi, shoreline
01°30'22.9"S 30°43'01.6"E

02/11/2023
Lake Mihindi, open water
01°31'10.2"S 30°42'55.6"E

No photograph available

02/11/2023
Wetlands peninsula between Lakes Mihindi and Rwanyakizinga
01°30'22.3"S 30°42'37.3"E

02/11/2023
Lake Mihindi outlet, Akagera River
01°30'09.0"S 30°43'33.1"E

03/11/2023
Akagera River, Northern part Akagera national Park
01°21'00.1"S 30°35'57.2"E