

## Status of knowledge of the Ichthyofauna of Lake Ndjale in Kibombo Territory, Maniema Province, DR Congo

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### ABSTRACT

Our survey on the Ichthyofauna of Lake Ndjale in Maniema, shows that this lake contains 4 orders, 15 families, 20 genera and 20 species, among which the most abundant in terms of decreasing number are: Mormyridae represented by (*Marcusenius morii* and *Gnatonemus sp*); Mockokidae represented by (*Synodontis sp*), Claroteidae (*Chrysichthys nigrodigitatus*), Clariidae (*Clarias gariepinus*), Cichlidae (*Hemichromis elongatus* and *Tilapia sp*) and Channidae (*Parachanna obscura*). The specific richness is 20 species recorded, the inter-station equitability is 0.69 for Dongo against 0.74 in Gabon. These results, taken as a whole, confirm that the biodiversity of Lake Ndjale is high and rich in species. A total of 41825 individuals were caught in two selected stations, 41.9% in Dongo and 58.1% in Gabon. The rainy season appears to be more favourable to catching and has more fish caught than the dry season for all species combined respectively 63% against 37% of the total population. The weights vary from 5grs to 1950grs, but the average is in the range of 7 to 1650 grs. The species with the highest weights are in descending order: *Chrysichthys nigrodigitatus* (1650 grs), *Citharinus gibbosus* (900grs), *Heterotis niloticus* (890 grs), *Mormyrops deliciosus* (640grs), *Parachanna obscura* (600grs), *Polypterus sp* and *Malapterirus electricus* (460grs) each and *Distichodus fasciolatus* (415grs). All the others have the lowest weights below 200 g despite their high numbers in both stations and in all seasons. Size: the variation ranges from 35 to 670 mm and the average size values are between 46mm and 435mm overall. *Chrysichthys* has the biggest size (435mm) followed by *Polypterus sp* (360mm), *Malapterirus electricus* (345mm), *Parachanna obscura* (260mm), *Mormyrops deliciosus* (232mm), *Hepsetus adoe* (210mm) and *Citharinus gibbosus* (206mm). The others have shown small sizes despite their very large numbers. When comparing weight and height, it appears that these two factors are not proportional for all species. Concerning the spatial and temporal distribution, species are present all year in both stations, but at very different frequencies according to the months of the year. The rarest species are: *Mormyrops deliciosus*, during all the months of the year, and absent in December; *Parauchenoglamus punctatus*: also rare during several months of the year, especially at Dongo station. *Heterotis niloticus*, is less present all year at Gabon station than at Dongo station; *Polypterus sp* is rare and sometimes absent during certain months of the year (January, February and March) especially at the Gabon station; *Malapterirus electricus* very rare in Dongo but more frequent at Gabon station; *Distichodus fasciolatus*, present all year round but less represented in terms of numbers; and *Schilbe sp*: absent all year round at Dongo but rarely present at Gabon station and represents the lowest number of all species recorded in Lake Ndjale.

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### 1. Introduction

Maniema province is one of the major aquatic faunal centres in the DRC with a very large hydrographic network and its great diversity of fish species (OMASOMBO et al, 2009).

It hosts several less exploited streams, including Lomami, Kasuku, Lowa, Ulindi, Musukuyu, Kunda, Lowe, Lufuba, Lweki, Elila (OMASOMBO et al, 2009).

However, apart from these streams, we can also mention Lake Ndjale, a vast and magnificent body of water in the

heart of the valley that derives its specificity from the break-up of Kasuku in Kibombo territory, which is also less well known nationally, but which has attracted our attention for this survey.

Although this lake has great fishing potential for the population of Maniema in general and the population of Kindu city and its surroundings in particular, its fish biodiversity remains undocumented; hence the need for both quantitative and qualitative studies of the fish biodiversity of

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Lake Ndjale and many other streams of Maniema are almost non-existent. This justifies our interest in conducting this study in order to contribute to the knowledge of this ecosystem and its biodiversity.

In addition, this study will permit to suggest a policy for the sustainable management of the fishing potential but also of the species that can be used in fish farming in order to improve the nutritional conditions and income of the populations of the concerned region.

Indeed, the increasing anthropogenic pressure on this aquatic ecosystem can lead to enormous ecological problems, which justifies the development of a coherent strategy adapted to an economic and sustainable development programme. In this respect, our contribution to the study of the Ichthyological biodiversity of Lake Ndjale could constitute a database on ichthyological fauna in order to enable the indigenous population to adopt the mechanisms (strategies) for its rational and sustainable use.

The need for knowledge of fish biodiversity and Lake Ndjale prompts our reflection while focusing on the following question: "Is the ichthyological biodiversity of Lake Ndjale high or low? What are the dominant families, and are there any similarities with the surrounding water bodies?"

### 1.1. Hypotheses

Our study aims at testing the following hypothesis:

The ichthyological biodiversity of Lake Ndjale is high and dominated by: *Mormyridae*, *Claroteidae*, *Mochokidae*, *Clariidae*, *Cichlidae* and would have similarities with other surrounding streams.

### 1.2. Objectives

#### 1.2.1. General objective

The general objective of this study is to provide a database on Ichthyological biodiversity in order to contribute to its rational exploitation and to combat protein malnutrition, especially that of animal origin, as well as unemployment, which is increasing.

#### 1.2.2. Specific objectives

- To determine the level of Ichthyological biodiversity of Lake Ndjale and specify the families of the dominant species;
- To determine the indices of ichthyological biodiversity and their evolution over time and space.

## 2. Study area, materials and method

### 2.1 Study area

Lake Ndjale is located in the Matapa chiefdom 42 km Kindu city, Kibombo road via the secondary road 18km away. It is located at an altitude of 472m at a position of 35M 0357259 and UTM: 9640173.

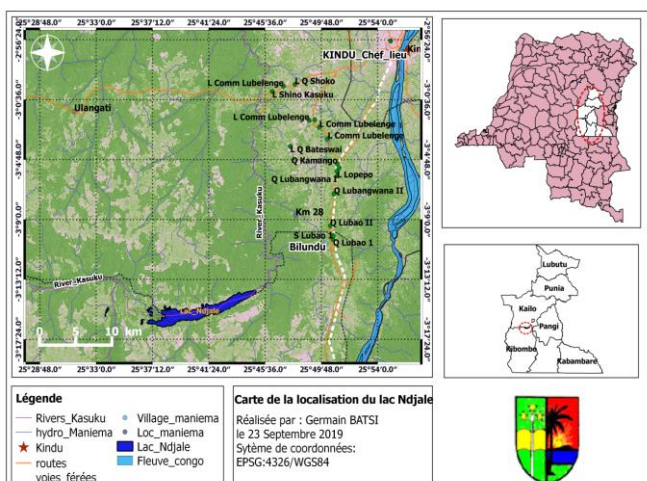


Figure 1. Location of Lake Ndjale in Maniema province, Kibombo territory

### 2.2. Material

During this study we used two types of materials: technical and biological.

Technical equipment consists of nets, canoes, hooks and longlines used by fishermen to catch fish.

Biological material consists of all the specimens caught during fishing for one year by fishermen of Lake Ndjale for a systematic identification of the species either on site after capture or kept in 4% formaldehyde to be identified in the laboratory using different fish species determination keys.

### 2.3. Method

In the field, fish sampling was carried out during the period from April 2018 to March 2019, i.e. one year. Field trips were made twice a month, in the first week and last week of each month. As for the fish sample, the collection of the sampling consisted first of separating the caught species into different groups according to the species, their counting (actual), these samples grouped on the basis of morphological characteristics which, we weighed using a precision balance of brand Q-H limited to 5000 grams maximum; the measurements taken were the average weight in (gram) and the standard length in (mm).

Fishing was carried out in two different sites on the same lake (Dongo and Gabon) with 20 fishermen per site, however, each should have a card to indicate the vernacular name of the fish caught and the number of copies for each species. The unknown species of fishermen are kept in 4% formaldehyde for later identification in the laboratory.

To motivate fishermen selected for this task, all the fish caught belonged to the fishermen selected each in relation to their catch capacity, except for the few samples of species that caused problems during their identification.

In the laboratory, specimens were identified using the identification keys of Boulanger (1901), Poll (1953, 1957, 1986), Matthes (1964), Gosse (1968), Robert and Stewart (1976), Banister and Bailey (1979), Teugels (1982b), Poll and Gosse (1995), Tschibwabwa (1997), Shumway et al (2002) Mbenga and Teugels (2003), Skelton (2004), Stiassny et al (2007a and b), AMNH lower Congo Keys, Fish Base (2016), Sullivan et al (2013).

Three fishing techniques were used in Lake Ndjale to catch fish, namely:

#### 1. Net fishing

Fishing in Lake Ndjale with fixed gillnets. These are nylon sheets with a length of 50m and about 1m in height and mesh sizes of 1.5cm, 2cm, 2.5cm and 3cm, 5cm and even more than 5cm. These nets are placed in the water in the evening and then lifted the next day before noon for a catch effort of about 12 hours... The technique consists of storing fishing nets in different parts of the station's water body.

#### 2. Gun fishing

It consists of attaching the hooks to a 30m nylon line baited with earthworms. These are lines with many baited hooks resting on the bottom and held in place by large stones (placed at the ends and connected to the float on the upper luff tape to separate them... The hooks are about 60cm apart and the variable number is between 25 and 75 numbers: 8, 10, 12, 14, 16, 18, 20.

#### 3. Longline fishing

This practice is also often used and consists in attaching the hooks to the 2.5 to 3m long nylon wire on the lower end while being baited and on the other end a piece of lightweight cut wood is fixed so as to place it horizontally on the surface of the water body, thus playing the role of a float.

3. Results and discussions

3.1. Presentation of the results of different specimens according to their Orders, families, genera and species

From the reading of this table, it can be seen that in Lake Ndjale as a whole 4 orders, 16 families, 20 genera and 20 species of fish were recorded; except for the family of Schilbeidae which was not present in the Dongo site during the whole duration of our investigations.

3.2 Variation of middleweights (grams) of the species in the two sites (Dongo and Gabon)

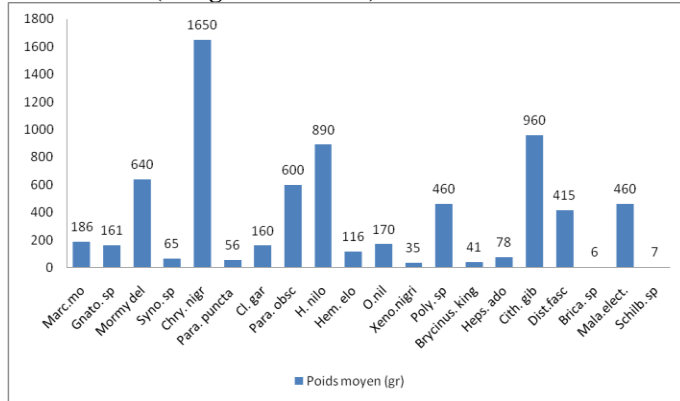


Figure 2. Evolution of average weight of specimens caught in the two stations of Lake Ndjale

The observation in Figure 1 shows that overall, and in descending order, *Chrysichtys nigrodigitatus* has the highest weight (1650grs) followed by *Citharinus gibbosus* (960grs), *Heterotis niloticus* (890 grs), *Mormyrops deliciosus* (640grs), *Parachanna obscura* (600 grs), *Polypterus sp* and *Malapterurus* (460 grs) for each, and *Distichodus fasciolatus* (415 grs) ; all other species recorded had weights below 200 grams, despite their higher numbers.

3.3. Variation in the average sizes (mm.Ls) of the species recorded in the two sites (Dongo and Gabon)

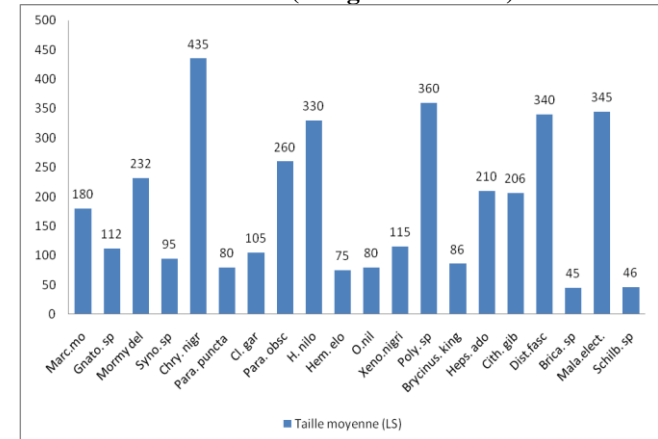


Figure 3. Variation of the middle size of the species counted in the two stations of capture (Dongo and Gabon)

It appears from Figure 16 above that the size in all species caught in both sites varies from 35mm to 670mm and the average values are between 46mm and 435mm. In decreasing order of size we have *Chrysichtys nigrodigitatus* (435mm), *Polypterus sp* (360mm), *Malapterurus electricus* (345mm), *Distichodus fasciolatus* (340mm), *Parachanna obscura* (260mm), *Mormyrops deliciosus* (232mm), *Hepsetus adoe* (210mm), and *Citharinus gibbosus* (206mm). However, the comparison of height versus weight shows that the weights of individuals are not proportional to their height.

3.4 Spatio-temporal distribution of biodiversity

The Figure below present the yearly distribution of the species captured

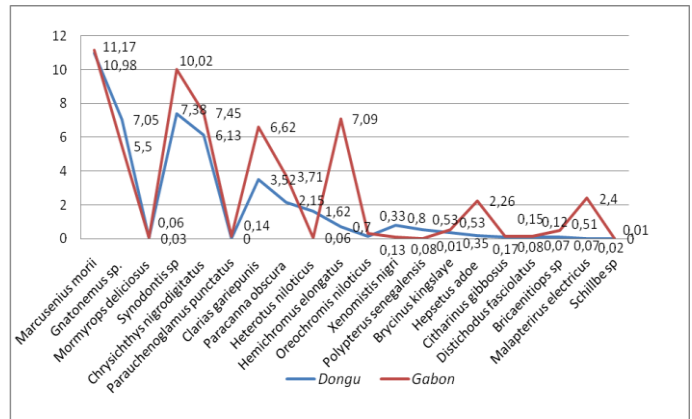


Figure4. Spatial distribution of the species captured in the two stations during the year of fishing in season of rain

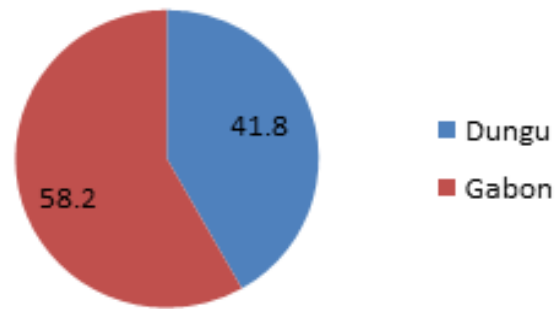


Figure 5. The spatial distribution of species caught according to percentage in the rainy season  
It can be seen from the figure above that Gabon station recorded 58.2% of the total workforce compared to 41.8% for Dongo station.

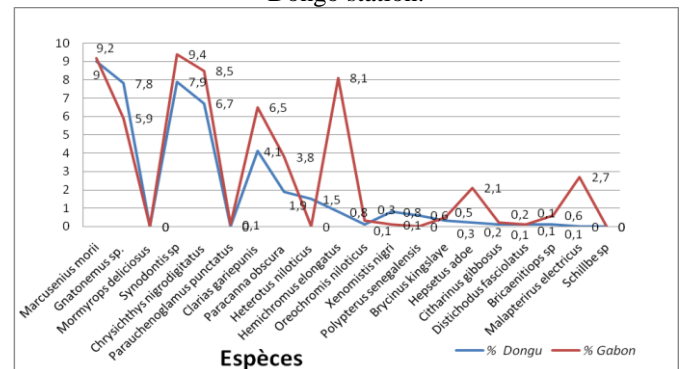


Figure 6. The spatial distribution of species caught in the dry season in the two stations

It can be seen from this figure that for the dry season, the most represented species are similar to those found in the dry season but with differences in terms of percentages of representativeness.

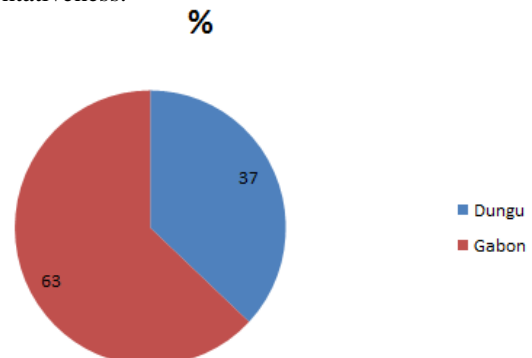


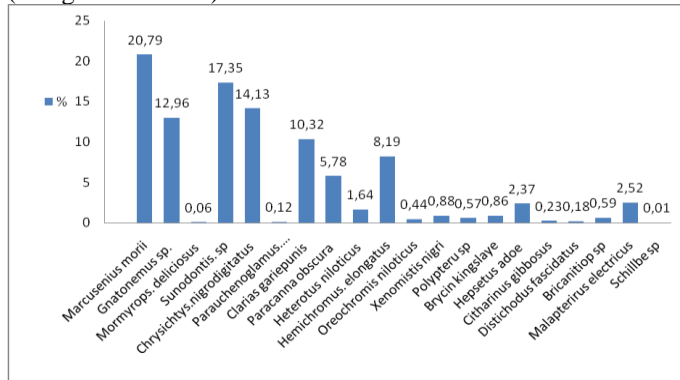
Figure7. Spatial distribution (%) of species in the dry season.



It can be seen from this figure that Gabon has 63% of the catch population in the dry season compared to 37% for Dongo.

**3.5. Biodiversity indices used for Lake Ndjale**

**3.5.1. Relative abundance of species in the two stations (Dongo and Gabon)**



**Figure 8. Relative abundance of species at all two fishing stations on Lake Ndjale**

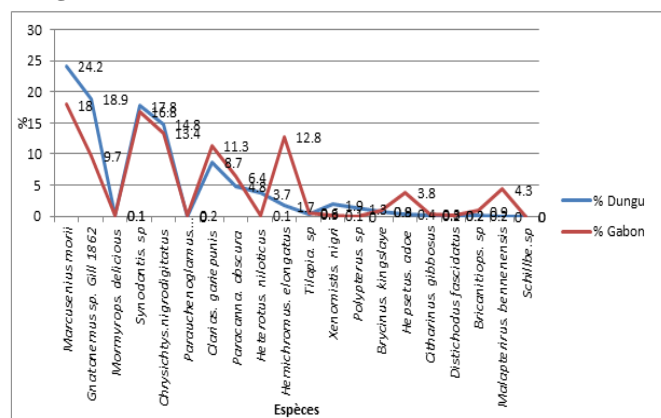
It can be seen from the figure above that, *Mormyridae* are the most represented in the two stations are respectively: (*Marcusenius morii* with 20.8% and *Gnatonemus sp* 13%), *Mockokidae* represented by (*Synodontis sp* with 17%), *Claroteidae* (*chrysiichthys nigrodigitatus* 14.1%), *Clariidae* (*Clarias gariepinus* 10.3%) ,followed by *Cichlidae* (*Hemichromis elongatus* 8.2%) and *Cannidae* (*Paracanna obscura* 5.8%); the others represent the lowest percentage although they are present in the different stations considered.

**3.5.1. Inter-site species diversity index**

**Table 2. Indication Dongo Station and Gabon Station**

Indice	Station Dongo	Station Gabon
Efficient	17509	24318
Specific wealth	19	20
Indication of simpson 1-D	0,84	0,87
Indication of shannon-hs	2,056	2,227
Equitability_J	0,6982	0,7432
Fisher alpha	2,105	2,142

**3.6. Distribution of species in the two fishing stations (Dongo and Gabon)**



**Figure 9. Distribution of species caught according to their capture station**

It can be seen from this figure that the most abundant species were distributed almost equally between the two sites, with the exception of *Schilbe sp*, which was not caught at Dongo station during the fishing period.

The table shows that the largest number of individuals for the whole year comes from the Gabon station with a total number of 24318 individuals representing 58.1%, distributed in 20 species distributed, 15 families against 17507 individuals at the Dongo site which represent 41.9% distributed in 19 species and 14 families.

**4. Results and discussions**

At the end of our survey on the Ichtyofauna of Lake Ndjale in Maniema, it emerges that this lake contains 4 orders, 15 families, 20 genera and 20 species, the most abundant in terms of numbers in decreasing order are: *Mormyridae* represented by (*Marcusenius morii*; and *Gnatonemus sp*); *Mockokidae* represented by (*Synodontis sp*), *Claroteidae* (*Chrysiichthys nigrodigitatus*), *Clariidae* (*Clarias gariepinus*), *Cichlidae* (*Hemichromis elongatus* and *Tilapia sp*) and *Channidae* (*Parachanna obscura*).

Moreover, the results obtained in Mali at the Baoulé River, the ichthyological communities are rich, they represent 58% of all the species of the Niger Basin in Mali; of which the Ichtyofaune is estimated at 130 species (Quensière, J.,1994).

Most of the freshwater families of the entire Niger Basin are represented; the Niger Basin is rich in 36 families and 243 species including marine and brackish water species (Leveque.C ,and Paugy.D : 2006).

*Mormyridae*, *Cyhlidae*, *Alestidae*, and some families of Siluriformes (*Bagridae*, *Claroteidae*, *Clariidae*,) constitute the main part of the ichthyological fauna encountered in perfect agreement with the results of other authors (Kantoussan. J., 2007; Kuela.,2002 ; Montchowu., iyonkuru ,2007).

For the composition and distribution of the ichthyological fauna of African rivers; these results of the specific richness encountered is similar to that of Lake Sankarani on the Sankarani River in the same Niger River basin. The specific richness encountered is lower than that of the Sankarani River in the Niger Basin, which contains 75 species.

For Baoulé stream, the specific richness is greater than that of other rivers in the Senegal River basin in Mali, whose ichthyological investigations present 41 species (Sanogo.,et al:2010) and 51 species for a basin of 65000km2 (Paugy. : 1994). Hlan stream in Benin with 43 species (Levèque. and Paugy.: 1999) and the Camoe (Burkinabe part) with 40 species (Kuela: 2002).

While *Mormyridae*, *Cyprinidae* and *Alestidae* are the most important families in terms of number of species, this order does not seem to be maintained for all rivers. Indeed, in the Baoulé River of the Senegal Basin in Mali, it is the *Cyprinidae* followed by *Characidae* and *Mormyridae* and then *Mockokidae*, which are the most represented (Paugy, 1994).

In the dam lake of Sankarani and Monantali in Mali, it is rather *Cichlidae* followed by *Mockokidae*, *Mormyridae* and *Alestidae* that are most represented. (Kantoussan, 2007). Comparing the results of Lake Ndjale with those of the Sankarani River, it can be seen that the latter has more species than Lake Ndjale.

In other basins, particularly in the Hlan stream in Benin, *Mormyridae* and *Claroteidae* are the most common in catches (Montchowu et al 2007. p 173-176). In Camoe (Burkinabe part) (Kuela, 2002), *Mormyridae*, *Caracidae*, and *Cyprinidae* are in decreasing order of importance the most frequent. However, in Lake Ndjale the most represented are: *Mormyridae*, *Mockokidae*, *Claroteidae*, *Clariidae*, *Cannidae*, *Osteoglossidae* and *Cichlidae*, but with a total absence of *Cyprinidae* unlike other rivers and lakes, in the same order of decreasing importance.

The significant specific richness of African rivers can be explained by a diversity of habitats in terms of indices of the diversification and adaptation of many fish species to environmental conditions. In fact, the ichthyological communities of African rivers are very rich, as many species adapt to poor conditions. With regard to biodiversity indices, it can be said that specific richness and specific diversity can vary from one river, from one aquatic ecosystem to another,

and even within a river it can vary from the upper, middle or lower river and vice versa.

In the Malian part of the Baoulé River, for example, the upper reaches of the river seem to be in a state of equilibrium (with an equity index of 0.99 or 99% compared to the average and lower reaches which are slightly disturbed with respective indices of 0.74 or (74%) and 0.77 or (77%). The biodiversity indices found are more important than those found in the Baoulé River of the Senegal River in Mali: 5.21 against 3.8 for specific diversity and 0.84 against 0.7 for equitability (Sanogo et al: 2010), while for Lake Ndjale in Maniema (D.R. Congo) these indices are respectively: 0.64 and 0.72 respectively for the equitability of the Dongo and Gabon stations. This difference could be due to the climatic situation of each area; and therefore it is necessary to confirm that Lake Ndjale has such a high biodiversity at the time: *Mormyridae*, *Claroteidae*, *Mockokidae*, *Clariidae*, *Cannidae*, *Osteoglossidae*, *Cichlidae*, *Notopteridae*, *Polypteridae*, *Alestidae*, *Hepsetidae*, *Citharinidae*; *Distichodontidae*, *Malapteruridae* and *Schilbeidae*. These results of the investigations of Lake Ndjale will serve as Ichthyofauna databases to enrich the provincial directory of Maniema province.

The results of the study carried out by Kankonda et al (2016) on the 13 rivers in the southern part of the Lomami National Park revealed the presence of 129 species of fish, 54 genera, divided into 20 families and 7 orders. The Mormyridae family dominates the collection with 30 species followed by the Alestidae with 23 species. *Clarias spp*, *Chrysichthys spp*, *Auchenoglamus occidentalis*, *Polypterus spp*, *Hydrocynus spp*, *Alestes spp*, *Parachanna spp* and *Mormyridae* are species of high economic value. These species are almost the same species found in Lake Ndjale.

### Conclusion

With regard to ichthyofauna, we have identified Lake Ndjale as a whole in 4 orders, 15 families, 20 genera distributed in 20 species as reported above);

A total of 41825 individuals were caught in the two selected stations, 41.9% in Dongo and 58.1% in Gabon;

- The rainy season appears to be more favourable to catching and has more fish caught than the dry season for all species combined 63% compared to 37% of the total population;

- Weights vary from one species to another from *Heterotis niloticus* 5grs to 1950grs, but the average is in the range of 7 to 1650 grs,

- The species with the highest weights are in descending order: *Chrysichthys nigrodigitatus* (1650 grs), *Citharinus gibbosus* (900grs), (890 grs), *Mormyrops deliciosus* (640grs), *Parachanna obscura* (600grs), *Polypterus spp* and *Malapterirus electricus* (460grs) each and *Distichodus fasciolatus* (415grs). All the others have the lowest weights below 200 g despite their high numbers in both stations and in all seasons.

- Size: the variation ranges from 35 to 670 mm and the average size values are between 46mm and 435mm overall. *Chrysichthys* has the highest size (435mm) followed by *Polypterus sp* (360mm), *Malapterirus bennenensis* (345mm), *Parachanna obscura* (260mm), *Mormyrops deliciosus* (232mm), *Hepsetus adoe* (210mm) and *Citharinus gibbosus* (206mm). The others have also shown very large sizes despite their numbers. By comparing weight and height, it can be seen that these two factors are not proportional for all species caught.

- Concerning the spatial and temporal distribution, it emerges that species are present all year round in both stations, but at very different frequencies depending on the months of the year; and the rarest species are:

*Mormyrops deliciosus*, during all the months of the year, and absent in December;

*Auchenoglamus punctatus*: also rare during several months of the year, especially at Dongo station;

- *Heterotis niloticus*, is less present all year round at Gabon station than at Dongo station;

- *Polypterus sp*: is rare and sometimes absent during certain months of the year (January, February and March) especially at the Gabon station;

- *Malapterirus electricus* very rare in Dongo but more frequent at Gabon station;

- *Distichodus fasciolatus*, present all year round but less represented in terms of numbers; and *Schilbe sp*: absent all year round at Dongo but rarely present at Gabon station and represents the lowest number of all species recorded at Lake Ndjale.

In short, the rainy season appears to be more favourable for fishing at Lake Ndjale and offers the highest number of catches than the dry season.

- The most abundant or abundant species are respectively the families of *Mormyridae*, *Mackokidae*, *Claroteidae*, *Clariidae*, *Cichlidae* and *Channidae* and the same representativeness can be observed at both stations.

- The specific richness is 20 species recorded, the inter-station equitability is 0.69 for Dongo against 0.74 in Gabon.

These results, taken as a whole, confirm that the biodiversity of Lake Ndjale is high and rich in species of families of *Mormyridae*, *Mockokidae*, *Clariidae*, *Claroteidea* and *Cichlidae*.

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