Fish diversity of four waterways of left bank of Alima River in Boundji district, Congo Brazzaville

Isabelle Mady-Goma Dirat, Anthelme Tsoumou, Louis Regis Dossou-Yovo, Léon Akoua, Marceline Mikia, Durelle Brith C, Olabi-Obath and Joseph Vouidibio

Abstract

The inventory of the ichthyofauna of the Alima watershed was carried out in four rivers of Boundji district (Angouewe River, Engondo River, Andouwou River and Amejni River). Fishes were captured with cast nets, gill nets, rotenone and drain fishing shows a species richness of 52 species, belonging to 36 genus, 21 families and 10 orders. Three orders were more represented in all rivers: Siluriformes (31%), Osteoglossiformes (28%) and Characiformes (11.32%). Mormyridae (20.75%), Cichlidae (9.48%) and Claroteidae (9.44%) were the most common families. The Mormyridae was the most diversified with 11 species, Angouewe, Amejni and Engondo have the most diversified and balanced populations with diversity index values between 3.24 and 3.96 and equitability between 0.71 and 0.81. Andouwou on the other hand, was the least diversified with 2.97 and an equitability of 0.66. The presence of species such as Polliamyntus sp., Raïamas chrysti, Raïamas buchholzi, Mastacembelus sp. more oxygen consumers, proves that the waters of these courses are still of good quality. The fish inventories must continue on the middle and upper courses of the Alima River.

Keywords: Boundji district, Congo basin, biodiversity, Shannon index, equitability, ichthyofauna, species richness.

1. Introduction

An astonishing diversity of freshwater fish species is found in Africa, however, 21% of continental African freshwater species are threatened with extinction [1]. The ichthyofauna of the right bank of the Congo Basin is poorly known. The Congo basin is the subject of very few studies, especially on its right bank. Indeed, poorly known Congoese aquatic ecosystems are threatened by population growth and deforestation [2]. Also, intensive fisheries and other natural disturbances (drought and silting) or anthropogenic (erosion of dams, pollution, reduction of habitat). In Congo, the potential for inland fisheries has been estimated at more than 100,000 tons per year [3]. The quantity of freshwater fish caught in the Cuvette Department is about 13,000 tons [3]. These scarce studies, prove that the ichthyofauna of the tributaries of the right bank of the Congo basin must be better investigated to help better management. The information available is the extensive systematic work [4, 5]. A few partial studies, mostly old, were carried out on Alima River, Sangha River [6, 7] and the right bank of Middle Congo [8]. Later, later, preliminary observations have been made in some rivers on the right bank of Congo basin: in Likouala aux Herbes River and Lake Tele [9]; in Mambil River in Ozala National Park [10]; on the lower course of Alima River [11]; in Likouala aux Herbes [12], in Lefini River [13]; in Djiri River [14]; in Tsieme River [15]; in the right bank of Malebo Pool [2, 16]; in Mfilou River and the Djoue River [17, 18]; in Komo River [19]; in Dzoumouna River and Loua River [20, 21]. Therefore, the present study has conducted to know ichthyoecological diversity of the Alima watershed of four rivers in Boundji district. Moreover, the species richness was determined according to different fishing techniques used development, status of digestion ability is a mystery. Therefore, a good understanding of fish.

2. Materials and Methods

2.1 Presentation of the study environment

The district of Boundji is located in the Cuvette Department. Its area is 2600 km² for a population of 11695 inhabitants; a density of 4.41 inhabitants / km² (Anonymous, 1980).
It is limited to the northwest by Owando District, to the east by Ewo District, to the south by Okoyo District and to the west by Abala District. Boundji District is located about 120 km southwest of Owando and 50 km west of the National Road Number 2 connecting Brazzaville to Ouesso, as shown in Figure 1. The waterways explored in this study are the tributaries of the Alima basin. They flow through the forest, their dimensions including width and depth are variable, depending on the season. The average width does not exceed ten (10) meters. The depth varies between sixty 0.6 meters in the dry season and 1.20 meters in the rainy season. These four rivers (Angouewele, Engondo, Andouwou, and Amegni) were selected according to their accessibility. The fishing site on Angouewele River (Station 1) is located just outside the town of Boundji, going on the Okoyo road. This fishing site on this waterway is located at 15° 20.299 East and 01° 03.309 South, this point located next to the bridge, as shown in Figure 3. Engondo is a small village located at 15 Km from Boundji on the Okoyo road, the fishing site on Engondo River (Station 2) is located two kilometres from the village: 015° 17.487 East and 01° 03.637 South. The fishing site on Andouwou River (station 3) is located one kilometre from the village Odikango, 15° 15.936 East and 1° 04.903 South, between Odikango village and Engondo village, which are separated by 10 kilometers. Like other rivers, Andouwou fishing site serves both as a place for retting cassava and bathing. It flows through a ridiculous forest. The last fishing site is on Amegni River (station 4), 10 kilometers from Odikango village, has not been georeferenced.

2.2 Physico-chemical parameters
Four physico-chemical parameters of surface water (pH, temperature, conductivity and TDS) were measured using a multiparameter brand Combo.

2.3 Sampling and fish conservation
Fishes caught using cash nets, gillnets, rotenone and drain fishing, were fixed with formalin 10% and then stored in formalin 5% or alcohol 70%. The fish identification was made using the keys determination proposed by different authors [22, 23, 24, 25, 26, 27, 28, 29, 30].

2.4 Diversity indexes
The species richness study has made it possible to calculate the diversity of the populations of fishes caught [31]. For this, we used the Shannon-Weaver index (H').

\[
H' = - \sum_{i=1}^{S} \frac{N_i}{N} \log_2 \frac{N_i}{N}
\]

Where:
- \(N_i\) is the number of individuals of species \(i\);
- \(N\) is the total number of individuals.

2.5 Similarity index
Duellman's similarity index allows us to say whether the ichthyofaunics groupings of the four waterways studied belong to the same animal community. This is the measure of the degree of similarity of the different waterways. It is given by the formula:

\[
E = \frac{H'}{H_{max}}
\]

Where:
- \(H_{max}\) is the maximum diversity;
- \(H'\) is the real diversity.

2.2 Physico-chemical parameters
Fig 1: Representative map of the study area (Kempena, 2019)
2.6 Statistical analysis
A Cluster analysis based on Euclidean distance is performed from the species richness - rivers matrix to identify similarities between the different rivers.

3. Results and discussion
3.1 Physico-chemical parameters of surface water
Some physico-chemical parameters of surface water were recorded (Table 1).

Table 1: Physico-chemical parameters of surface water

<table>
<thead>
<tr>
<th>Waterway</th>
<th>Dry season</th>
<th>Rainy season</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>T °C</td>
<td>pH</td>
</tr>
<tr>
<td>Angouewele</td>
<td>26.6</td>
<td>5.97</td>
</tr>
<tr>
<td>Engondo</td>
<td>26.6</td>
<td>5.5</td>
</tr>
<tr>
<td>Andouwou</td>
<td>25.6</td>
<td>5.60</td>
</tr>
<tr>
<td>Amegni</td>
<td>25.8</td>
<td>5.65</td>
</tr>
</tbody>
</table>

The temperature of the surface water varies according to the seasons, the low temperatures are observed in dry season where the temperature varies between 25, 8 °C and 26.6 °C. They vary between 27.5 °C and 28.5 °C in the rainy season. The pH is slightly more acidic in the dry season than in the rainy season. In all rivers, the pH values vary between 5.5 in the dry season and 6.2 in the rainy season. The TDS values are very low (Angouewe: 0.66 NTU and Andouwou: 0.66 NTU). The same is true of the conductivity which is equal to 1.8 μS/cm at Angouewe and 0 μS/cm at Andouwou, which indicates a low mineralization of the soils of the study area. Low values of pH, conductivity and TDS were also found in several tributaries of the right bank of the Congo basin.

3.2 Species composition
The study of the fish biodiversity of Fours Rivers of Alima watershed allowed identification of 52 species, 36 genus, 21 families, and 10 orders. Each species is designated by its local name in Mbochi language (Table 2).

Table 2: List of species of the four rivers

<table>
<thead>
<tr>
<th>Ordres</th>
<th>Families</th>
<th>Species</th>
<th>Local name in Mbochi</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lepidosireniformes</td>
<td>Propterusidae</td>
<td>1-Propterus dolloi Boulenger, 1900</td>
<td>Niombo</td>
</tr>
<tr>
<td>Polypteryiformes</td>
<td>Polypterusidae</td>
<td>2-Polypterus retropinnus Boulenger, 1911</td>
<td>Konga</td>
</tr>
<tr>
<td>Pantodontidae</td>
<td>3-Polypterus weeksi Boulenger, 1898</td>
<td>Konga</td>
<td></td>
</tr>
<tr>
<td>Notopteridae</td>
<td>4-Pantodon buchholzi Peters, 1877</td>
<td>Itatsa</td>
<td></td>
</tr>
<tr>
<td>Mormyridae</td>
<td>5-Xenonyxus nigri Günther, 1868</td>
<td>Lepé</td>
<td></td>
</tr>
<tr>
<td>Osteoglossiformes</td>
<td>Mormyridae</td>
<td>6-Gnathonemus petersii Günther, 1862</td>
<td>Lébouwè</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7-Marcusenius kutaensis (Boulenger,1899)</td>
<td>Lébouwè</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8-Marcusenius moorii (Günther, 1867)</td>
<td>Lébouwè</td>
</tr>
<tr>
<td></td>
<td></td>
<td>9-Mormyrops nigricans Boulenger, 1899</td>
<td>Lébouwè</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10-Mormyrops sanchirostris (Günther,1867)</td>
<td>Lébouwè</td>
</tr>
<tr>
<td></td>
<td></td>
<td>11-Mormyrops sirenoides Boulenger, 1898</td>
<td>Lébouwè</td>
</tr>
<tr>
<td></td>
<td></td>
<td>12-Petrocephalus ballaiy Sauvage, 1883</td>
<td>Lébouwè</td>
</tr>
<tr>
<td></td>
<td></td>
<td>13-Petrocephalus sp</td>
<td>Lébouwè</td>
</tr>
<tr>
<td></td>
<td></td>
<td>14-Petrocephalus christyi Boulenger, 1920</td>
<td>Lébouwè</td>
</tr>
<tr>
<td></td>
<td></td>
<td>15-Stomacorhinus sp</td>
<td>Lébouwè</td>
</tr>
<tr>
<td></td>
<td></td>
<td>16-Polliymyrus sp</td>
<td>Lébouwè</td>
</tr>
<tr>
<td>Cypriniformes</td>
<td>Cyprinidae</td>
<td>17-Phractolaemus ansorguini Boulenger, 1901</td>
<td>Okissi</td>
</tr>
<tr>
<td></td>
<td></td>
<td>18-Raimas chrysti Boulenger, 1920</td>
<td>Elô</td>
</tr>
<tr>
<td></td>
<td></td>
<td>19-Barbus sp cf holotaenia (Boulenger,1904)</td>
<td>Elôy'ombossi</td>
</tr>
<tr>
<td></td>
<td></td>
<td>20-Raimas buchholzi (Peters, 1877)</td>
<td>Elô</td>
</tr>
<tr>
<td>Characiformes</td>
<td>Alestidae</td>
<td>21-Hepsetus odor (Bloch, 1794)</td>
<td>Mouenguè</td>
</tr>
<tr>
<td></td>
<td></td>
<td>22-Alestes liebrechtsii Boulenger, 1898</td>
<td>Okobi</td>
</tr>
<tr>
<td></td>
<td></td>
<td>23-Brycinus imberi Peters, 1852</td>
<td>Engondokorò</td>
</tr>
<tr>
<td></td>
<td></td>
<td>24-Bryconaeothius bulegleri Pellegrin, 1900</td>
<td>Letsuèlé</td>
</tr>
<tr>
<td></td>
<td></td>
<td>25-Phenacogrammus interruptus (Boulenger,1899)</td>
<td>Lendzâ</td>
</tr>
<tr>
<td>Distichodontidae</td>
<td>26-Xenocharax spilurus Günther, 1867</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Siluriformes</td>
<td>Claroteidae</td>
<td>27-Auchenoglanis sp</td>
<td>Mboka</td>
</tr>
<tr>
<td></td>
<td></td>
<td>28-Chrysolichthys punctatus Boulenger, 1899</td>
<td>Ibarabara</td>
</tr>
<tr>
<td></td>
<td></td>
<td>29-Chrysolichthys thomneri Steindachner, 1912</td>
<td>Ibarabara</td>
</tr>
<tr>
<td></td>
<td></td>
<td>30-Parauchenoglanis punctatus (Sauvage, 1879)</td>
<td>Ikagna</td>
</tr>
<tr>
<td></td>
<td></td>
<td>31-Parauchenoglanis sp</td>
<td>Ikagna</td>
</tr>
<tr>
<td></td>
<td>Schilbeidae</td>
<td>32-Schilbe yangambianus</td>
<td>Ihelélé</td>
</tr>
<tr>
<td></td>
<td></td>
<td>33-Schilbe marmonanthus Boulenger, 1911</td>
<td>Ilangwa</td>
</tr>
<tr>
<td></td>
<td>Amphiliidae</td>
<td>34-Phractura lindica Boulenger, 1902</td>
<td></td>
</tr>
</tbody>
</table>
Siluriformes (31%) is the most represented, followed by Osteoglossiformes (27%), Characiformes (11%), Labriformes (7%), Cypriniformes (6%), Polypteriformes and Anabantiformes (4%). Lepidosireniformes, Cyprinodontiformes and Synbranchiformes (2%) were the least represented. The Mormyridae (22%) is the most representative family, followed by Claroteidae (10%), Alestidae, Claridae and Cichlidae (8%). The other families had proportions between 6% and 2%. The specific distribution of fishes in each river is shown in Table 3. The same orders and families were also identified by many authors in different proportion in the main tributaries of the Congo basin [22, 23, 33, 50, 11, 2, 16, 19, 13, 14, 15, 17, 18, 34, 35].

### Table 3: Fish species distribution according to the river

<table>
<thead>
<tr>
<th>Orders</th>
<th>Families</th>
<th>Species</th>
<th>R1</th>
<th>R2</th>
<th>R3</th>
<th>R4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lepidosireniformes</td>
<td>Protopterida</td>
<td><em>Proptépères dolloi</em> Boulenger, 1900</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td></td>
<td>Polypterida</td>
<td><em>Polyptéretes retropinnus</em> Boulenger, 1911</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>Polyptéretes weeksi</em> Boulenger, 1898</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Pantodontidae</td>
<td><em>Pantodon buchholzi</em> Peters, 1877</td>
<td>++</td>
<td>-</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td></td>
<td>Notopterida</td>
<td><em>Xenomyxustus nigri</em> Günther, 1868</td>
<td>+</td>
<td>+</td>
<td>++</td>
<td>+</td>
</tr>
<tr>
<td>Osteoglossiformes</td>
<td>Mormyridae</td>
<td><em>Gnathomynus petrii</em> Günther, 1862</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>Marcusius kutuensis</em> Boulenger, 1899</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>Marcusius mooli</em> Günther, 1867</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>Mormyres nigricans</em> Boulenger, 1899</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>Mormyrops sironoides</em> Boulenger, 1898</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>Mormyrops zancloostris</em> Günther, 1867</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>Petrocephalus ballasi</em> Sauvage, 1883</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>Petrocephalus chirist</em> Boulenger, 1920</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>Petrocephalus sp</em> Marcusen, 1854</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>Polymerus sp</em> Traverne, 1971</td>
<td>+++</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>Stomacorhinus sp.</em></td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Phractolaemidae</td>
<td><em>Phractolaemus ansorgii</em> Boulenger, 1901</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

---

Fig 2a: Species richness of orders  
Fig 2b: Species richness of families
The Angouewe River had the highest species richness with 35 species, followed by Amegni River (22 species) and Andouwou River (21 species). Engondo River is the least rich of the four rivers with 18 species. The different fishing techniques practiced in each waterway partly explains these results. Indeed, in addition gillnet and cash net were used more much in Angouewe River. This waterway is the deepest and widest of all rivers.

### 3.4 Distribution of fish species by waterway according to fishing technique

The fish surveyed were divided by waterway and fishing technique (Table 4). Cash net and rotenone fisheries had captured more species than drain fishing and gillnets (Figure 3). However, there are species caught with the four techniques: Hemichromis elongatus, Pantodon buchholzi, Xenomystus nigri, Mormyrops zanclirostris, Raimas buchholzi, Parauchenoglanis punctatus, Clarias buthupogon, and Clenopoma nanum. In addition, table 3 shows that some species were more easily captured by drain fishing or rotenone, these are Mastacembelus sp, Clarias sp and Chanallabes apus.

<table>
<thead>
<tr>
<th>Species</th>
<th>Angouewe</th>
<th>Engondo</th>
<th>Andouwou</th>
<th>Amegni</th>
</tr>
</thead>
<tbody>
<tr>
<td>FD</td>
<td>FE</td>
<td>Vd</td>
<td>RT</td>
<td>Vd</td>
</tr>
<tr>
<td>---------------------------------------------------------------</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Proteotus dolloi, Bouleguer, 1900</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Polypterus retropinnus, Bouleguer, 1911</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Polypterus weeksi, Bouleguer, 1898</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Pantodon buchholzi, Peters, 1877</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Xenomystus nigri, Günther, 1868</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Gymnophorus petersii, Günther, 1862</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Marcusenius kutensis, Bouleguer, 1899</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Marcusenius moorii, Günther, 1867</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Mormyrops nigricans, Bouleguer, 1899</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>Mormyrops sirenoides</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Mormyrops zanclirostris, Günther, 1867</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>-</td>
</tr>
</tbody>
</table>

**Table 4:** Fish species caught according to fishing technique
Species richness

<table>
<thead>
<tr>
<th>Fishing techniques</th>
<th>Angouewele</th>
<th>Engondo</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gillnet</td>
<td>15</td>
<td>16</td>
</tr>
<tr>
<td>Cash net</td>
<td>16</td>
<td>10</td>
</tr>
<tr>
<td>Drain fishing</td>
<td>10</td>
<td>4</td>
</tr>
<tr>
<td>Drain fishing</td>
<td>16</td>
<td>12</td>
</tr>
<tr>
<td>Total</td>
<td>52</td>
<td></td>
</tr>
</tbody>
</table>

FD = gillnet; FE = cash net; Vd = drain fishing; RT = rotenone
3.5 Species richness of orders in the four rivers

The species richness according to orders is represented by Figure 4. In Angouewele River, Osteoglossiformes and Siluriformes (25%) dominated, followed by Characiformes (17%), labriformes (11%) and Cypriniformes (8%). Synbranchiformes are poorly represented with 5%. The, Cyprinodontiformes, Polypteriformes and Lepidosireniformes were the least represented with 3%. The species richness of orders in Engondo River, which had only six orders, showing that the Osteoglossiformes (41%) are the most represented. They are followed by Siluriformes (23%), Cypriniformes and Synbranchiformes (12%). The least represented orders were the Labriformes and the Anabantiformes (6%). Andouwou River has 7 orders among which the order of Siluriformes is the most represented, with 45%. It is followed by Osteoglossiformes (20%) and Synbranchiformes (15%). The least represented orders are Labriformes, Cyprinodontiformes, Cypriniformes and Anabantiformes, each of which is 5%. In Amegni River, Osteoglossiformes (36%) represent the richest order in species, followed by the Siluriformes (27%), Anabantiformes (9%), Labriformes, Cypriniformes, Synbranchiformes, Polypteriformes, Lepidosireniformes and Cyprinodontiformes are the least represented (5%). In the Congo basin, Teugels and Guegan (1994) found the same orders in varying proportions: Siluriformes (23.5%), Perciformes (18.7%), Osteoglossiformes (16.5%), Cypriniformes (16.3%), Characiformes (14.3%), in Mambili River [10]; in Likouala aux Herbes River [12]; in Djiri River [14]; in Alima River [11]; in Malebo Pool (Congo River) [2,16] showed the predominance of the same orders in a specific distribution in each river.
3.6 Species richness of families according to the waterway

The Figure 5 shows the proportional distribution of species richness of families in Angouewe River, Engondo River, Andouwou River and Amegni River. Four families were dominant in Angouewe River: Mormyridae (17%), Alestidae, Cichlidae and Claroteidae (11%). They are followed by Cyprinidae (8%), Claridae and Mastacembelidae (6%). The rest of the families represent only 3%. In Engondo River, Mormyridae were the most represented (33%). This family is followed by Cyprinidae and Mastacembelidae (11%). Other families are less represented (5.6%). Claridae are the most represented at 20%, followed by the families Mormyridae, Claroteidae and Mastacembelidae (15%). The other seven families were poorly represented, with 5% each.

In Amegni River, the Mormyridae family (29%) is by far the most representative. The other families are poorly represented at 5%. Family-specific wealth in Angouewe, Engondo, and Amegni ranks Mormyridae at 28.57%, 27.28%, and 43.75% respectively. In Andouwou however, Claridae dominated with 18.28%. The family Mormyridae is almost the most represented in these rivers. These results are consistent with those found in the Congo basin [5] which showed that Mormyridae were in the lead with 16.2%, followed by Cichlidae 13.1%. The same families were found in the tributaries of the right bank of the Congo River: in Mambili River [10], in Likouala River [12], in Djiri River [14], in Alima River [11], in the Malebo Pool [2, 16].

![Fig 5: Proportional distribution of species richness of families in each river](image)

3.7 Diversity indexes

The diversity indexes make it possible to compare the structure of several populations and to see how they vary in space. Figure 6 illustrates the values of these indexes by waterways. The Shannon indices of Angouewe River, Engondo River, Andouwou River and Amegni River were all greater than 1. These rivers are very rich and diversified. The strongest index was found in the Amegni River with 3.96, followed by that of the Angouewe River which is 3.57. The lowest index was observed in the Andouwou River, with 2.97. Species diversity has been found to increase from pole to equator [36], high Shannon diversity index values in these four rivers are explained by the proximity of the equator. Angouewe River, Engondo River and Amegni River have equitabilities greater than 0.7, the fish populations of these waterways are therefore balanced (Figure 6). However, Andouwou River has an equitability of 0.66, this value less than 0.7, indicating a slight population imbalance [31].
Duellman's similarity index allowed us to determine the similarity coefficient between waterways as shown in Figure 7. Strong similarities were observed between Engondo River and Amegni River, Andouwou River and Amegni River, Engondo River and Andouwou River with respectively 66.66%, 60.46% and 55.55%. The similarities between Angouewele River and Engondo River or between Angouewele River and Andouwou River were low (34.61% and 32.14%). The lowest similarity (17.54%) was observed between Angouewele River and Amegni River. These results showed that Angouewele River fish community is different of the three others. The hierarchical classification including the specific richness of four rivers, showed some differences between the data stemming from various sampled stations. The affinity dendrogram of species richness shows different degree of affinity between different waterways (Figure 8). At 60%, three groups can be discriminated, the first group is Angouewele River, the second group is composed of Engodo River and Amegni River. The third group is represented by Andouwou River.

4. Conclusion
The inventory of ichthyofauna of the four rivers of Alima basin of Boundji District, shows a predominance of three major orders (Siluriformes, Osteoglossiformes and Characiformes) and of one family (Mormyridae) which are the most represented of Congo basin. The fish population of these waterways present a very great diversity and its distribution is balanced. The presence of required oxygen species such as *Pollymyrus sp*, *Raïamas chrystii*, *Raïmas buchholzi*, *Mastacembelus sp.*, proves that waters of these
rivers are still of the good quality. This sampling, which completes scares ichthyologic studies carried out in the Alima basin, should be continued on the middle and upper course of the Alima River for a better knowledge of its ichthyofauna.

5. Acknowledgement
The authors are grateful to Mr. Kempena Adolphe, Assistant Master of Geomatics, Faculty of Sciences and Techniques, University Marine Ngouabi for the realization of the study area map.

6. Références


