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Qualitative diet of *Schilbe grenfelli* Boulenger, 1900 (*Siluriformes, Schilbeidae*) caught in the Malebo Pool (Congo River) (Kinshasa, DR Congo)

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Abstract

The Congo River abounds in a multitude of osteichthyan fish, notably *Schilbe grenfelli* Boulenger, 1900 (*Siluriformes, Schilbeidae*), commonly known in Kinshasa as "Lilangwa" in Lingala, one of the national languages of the Democratic Republic of Congo. The species is caught in artisanal fisheries, and its flesh is highly prized for its meat. The aim of the present study was to investigate the diet of *S. grenfelli*, caught in the Kinshasa section of the Malebo Pool (Congo River) in the Democratic Republic of Congo. Fish specimens were collected over an eight (8), month period between february 15 and september 20, 2019. These fish were caught through artisanal fishing using bottom drift gillnets. The study of the diet was based on the qualitative aspect linked to the trophic level of the fish species under study by determining the intestinal coefficient. Trophic level results showed that *S. grenfelli* has a short intestine (intestinal coefficient equal to 1.89±0.12) and is considered a carnivorous fish, feeding either on zooplankton, aquatic and terrestrial invertebrates or fish present in its environment. The preliminary information provided in the present study is of great importance in that it gives indications of the trophic level of *S. grenfelli* fish in the Malebo Pool. This information is of great importance for knowledge of the dietary requirements of this fish for rational exploitation, but above all for fish farming, where this fish species can be domesticated to diversify Congolese fish farming.

Keywords: *Schilbe grenfelli*; Diet; Trophic level; Malebo Pool; Congo River; Kinshasa

1. Introduction

The biologically rich Congo River is a focus of both scientific and socio-economic interest. Its geomorphological features and endemic fish fauna have attracted many researchers. Fishing in the fluvial zone provides income for the people living along the Congo River. The biological diversity of the littoral fauna is currently the subject of a number of research studies, particularly with regard to the food preferences of fish [1].

The study of feeding ecology through the analysis of fish stomach contents is one way of approaching knowledge on the presence, abundance and availability of food potential in aquatic environments [2]. Food is an important ecological factor which, depending on its quality and abundance, affects fecundity, longevity, development speed and mortality. As diet is an important parameter for the success of any breeding operation, it is necessary to initiate investigations in order to identify the factors controlling the proliferation of certain species. It constitutes a basic element for judging a species' ability to adapt to domestication changes in breeding [2].

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The diversity of food guilds, habitats and rhythms of trophic activity are the key factors in understanding the coexistence of species in a given ecosystem [3, 4]. Furthermore, species of the same guild have similar ecological requirements. Consequently, competition for the acquisition of the critical resource should be expected. This allows us to deal with problems of membership within a taxonomic group and also to classify the species in the food chains of a given community [5].

The massive and uncoordinated artisanal exploitation of fish in the Malebo Pool ecoregion of the Congo River has become widespread, leading to the capture of fish of all sizes and dimensions [6, 7, 8, 9]. This practice spares no fish family, given the demand for fresh fish on the local market [9].

Knowledge of the behavior and feeding habits of a wild species in its natural environment is of great importance for its domestication. Hence, the economic and scientific interest aroused by several Malebo Pool fish, which could be adopted as candidates Knowledge of the behafor responsible fish farming with a view to diversifying Congolese aquaculture and offering the population a varied range of fish to consume [10]. To the best of our knowledge, research on the diet of Malebo Pool fish is fragmentary and concerns a very small number of species. Indeed, there is almost no information on how *Schilbe grenfelli* Boulenger, 1900 exploits food resources in Malebo Pool. However, *S. grenfelli* is one of the fish species most commonly caught in artisanal fisheries in Malebo Pool (Congo River) [9], sold in Kinshasa markets and appreciated by the Kinshasa population [11, 12].

It is in this context that the present study is devoted to the analysis of the diet of *Schilbe grenfelli* Boulenger, 1900 (*Siluriformes, Schilbeidae*) caught in the Kinshasa section of the Malebo Pool (Congo River) in the Democratic Republic of Congo.

2. Materials and methods

2.1. Study environment

This study took place in Malebo Pool (Congo River), at two sites, namely, Japon (latitude = 04° 18' 08,7'' South; longitude = 015° 30' 21,9'' East and altitude = 271 meters) and Mipongo (latitude = 04° 16' 45,0'' South ; longitude = 015° 30' 20.3'' East and altitude = 268 meters), at the Kinkole fishing station (figure 1), located in the provincial city of Kinshasa, commune of N'sele in the Kinkole pêcheur district.

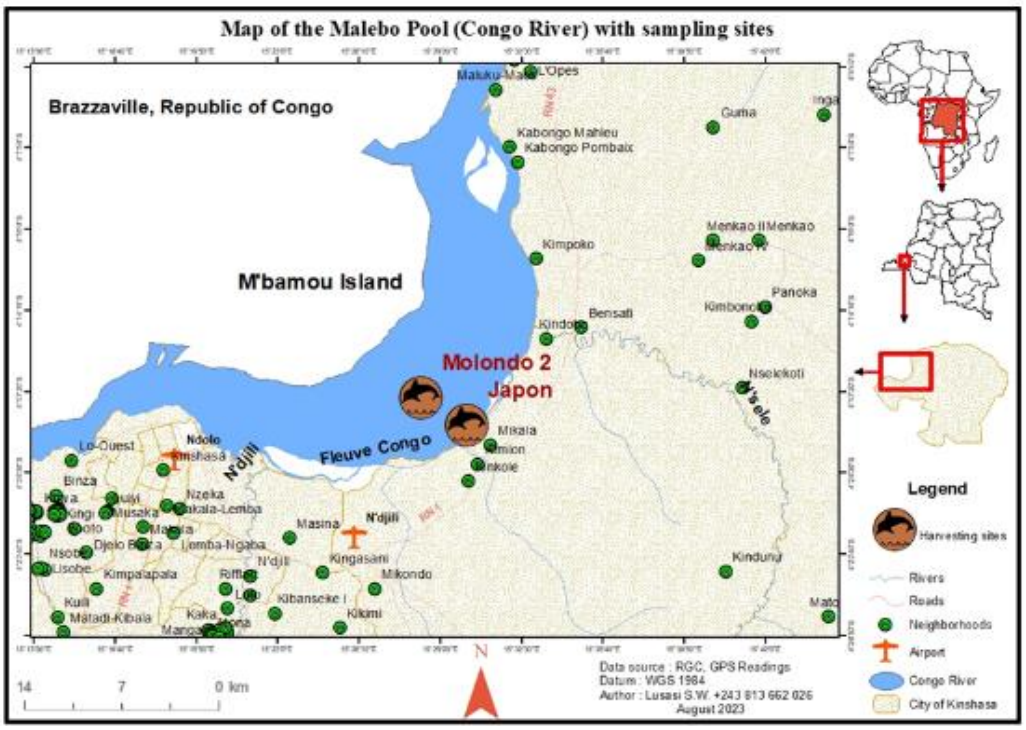

Figure 1 Map of the city of Kinshasa, including the Kinkole fishing station

Malebo Pool is a lake formed by the Congo River and its middle course, drained by major permanent streams (the N'djili, Kalamu, N'sele, Bitshaku-tshaku rivers, etc.) [13]. It is formed by a widening of the Congo River, 35 km long and 25 km wide. It has a surface area of 500 km^2 and is located between the D.R.C. (city-province of Kinshasa) and the Republic of Congo (prefecture of Brazzaville) [9]. The Pool is located at 4° 5' to 4° 20' South and 15° 19' to 15° 30' East, at an altitude of 275m. It occupies the bottom of a basin surrounded by hills often exceeding 500 m [14]. The central part of the Malebo Pool is occupied by M'bamou Island in the Republic of Congo and several groups of small islands, one of which is an archipelago at the mouth of the N'djili River. It enjoys a humid tropical climate of AW_4 type according to Köppen's classification. The climate of this region is characterized by two main seasons: four dry months (may, june, july and august) and eight rainy months (september to april), with a short dry season between january and february [9].

2.2. Biological material

The biological material for this study consists of fifty (50) specimens of *Schilbe grenfelli* Boulenger, 1900 (figure 2) of different sizes and weights caught in the Malebo Pool (Congo River).

Figure 2 Specimens of the fish *Schilbe grenfelli* Boulenger, 1900 studied (Lusasi, 2019)

2.3. Methodology

2.3.1. Ichthyological sampling

Sampling of specimens of the fish studied was carried out over eight (8) months, i.e. from february 15 to september 20, 2019). These fish were caught during artisanal fisheries using drift gillnets (mesh size between 4 and 70 mm) 50 to 200 m long and at least 2 m high for each category. Fish of all sizes were targeted for analysis.

2.3.2. Fish preservation

After capture, fish specimens were fixed directly in a 10% formalin solution in plastic jars. The place and date of harvesting were marked on the jars. The samples were then sent to the Limnology, Hydrobiology and Aquaculture Laboratory, Life Sciences Department, Faculty of Science and Technology, University of Kinshasa for analysis as part of the study.

2.3.3. Fish handling in the laboratory

In the laboratory, the systematic position of the fish specimens studied was verified using several identification keys proposed by Lévêque et al. [15]; Mbega and Teugels [16]. Morphometric parameters (total and standard lengths, body height and gut length) were taken from the various specimens following Lévêque et al. [15] using an electronic ichthyometer (Digital Caliper 200 mm-8 brand). Fish weights were also taken to the nearest gram using an electronic balance (Salter brand, precision 0.1 g).

2.3.4. Size class and fish weight

The size and weight classes of the Schilbe mystus fish specimens studied, were established according to Sturge's rule [17] : N.C.= 1+ (3.3logN), where N.C = number of classes and N = total number of specimens examined.

The total length-standard length relationship is used to convert data in order to retrieve the maximum amount of information on a species' living condition. This relationship is linear, with the mathematical formula: Lt = a+bLs where, Lt is the total length (mm); Ls is the standard length (mm); a is the y-intercept and b is the slope of the regression line [18].

2.3.5. Relationship between total weight and total length

The weight-length relationship is the first parameter taken into account in any study of fish growth [19]. Generally speaking, this relationship is of dual interest, serving both as a prediction and a description. It is of the power type, whose mathematical formula is: Pt = a.Ltb where, Pt = total weight (g); Lt = total length (mm); a = constant and b = the allometry rate [20].

In practice, the logarithmic transformation is generally used, with the power relation giving a linear form of the type : LogPt = log a + b logLt. Logarithmic transformation also reduces variability and homogenizes the two variables P and Lt.

The allometry rate b varies from 2 to 4, but is most often close to 3.

- When b = 3, the (weight-length) relationship is said to be isometric, meaning that there is no change in the shape and proportion of the various body parts during growth;
- When b < 3, the (weight-length) relationship is said to be minorizing allometry, meaning that the fish's weight increases less rapidly in relation to its size;
- When b > 3, the (weight-length) relationship is said to be majoring allometry, fish weight increases faster in relation to its length [19].

2.3.6. Intestinal coefficient

The overall qualitative analysis of the diet is based on the determination of the intestinal coefficient (IC). The intestinal coefficient is defined as the ratio between the length of the intestine (Li in mm) and the standard length (Ls in mm) of the fish. Its mathematical formula is: CI = Li/Ls.

The intestinal coefficient values observed were compared with those proposed by Paugy and Roberts [21], who state that an average CI < 0.85 corresponds to a piscivorous diet; an average CI < 2.18 corresponds to an invertivorous diet; an average CI < 3.01 corresponds to an omnivorous diet; an average CI < 6.78 corresponds to a phytophagous diet; and a CI between 10 and 17 corresponds to a limivorous diet.

2.3.7. Data processing and statistical analysis

The values obtained from the various analyses were entered into Excel 2013. Correlations were established at the 95% confidence level using Origin software version 6.1. The results obtained were expressed in the form of tables and graphs to facilitate their interpretation. Mapping of the study site was based on geograpic coordinates (longitude and latitude) recorded using a Garmin Etrex 64s GPS.

3. Results

3.1. Fish size classes

The size classes of the various *Schilbe grenfelli* Boulenger, 1900 specimens studied are recorded in Table 1 below, according to Sturge's rule.

Table 1 Size classes of *Schilbe grenfelli* specimens (N = number of individuals)

Size classes	Size range (mm)	Number of specimens
I	[91 ; 107[	9
II	[108 ; 124[	7
III	[125 ; 141[	5
IV	[142 ; 158[	8
V	[159 ; 175[	9
VI	[176 ; 192[	12
Total		50

The results in Table 1 above show that 50 *Schilbe grenfelli* specimens are grouped into 6 size classes. The sixth class is the one with the most individuals (12 fish), followed by the first and fifth size classes (with 9 specimens respectively). The minimum size is 91 mm and the maximum is 192 mm.

3.2. Fish weight classes

According to figure 3 below, 50 *Schilbe grenfelli* specimens are grouped into 7 weight classes. The seventh class is the one with the most individuals (10 fish), followed by the second and sixth weight classes (with 8 specimens respectively). The minimum weight observed is 8.5 g and the maximum 41.4 g.

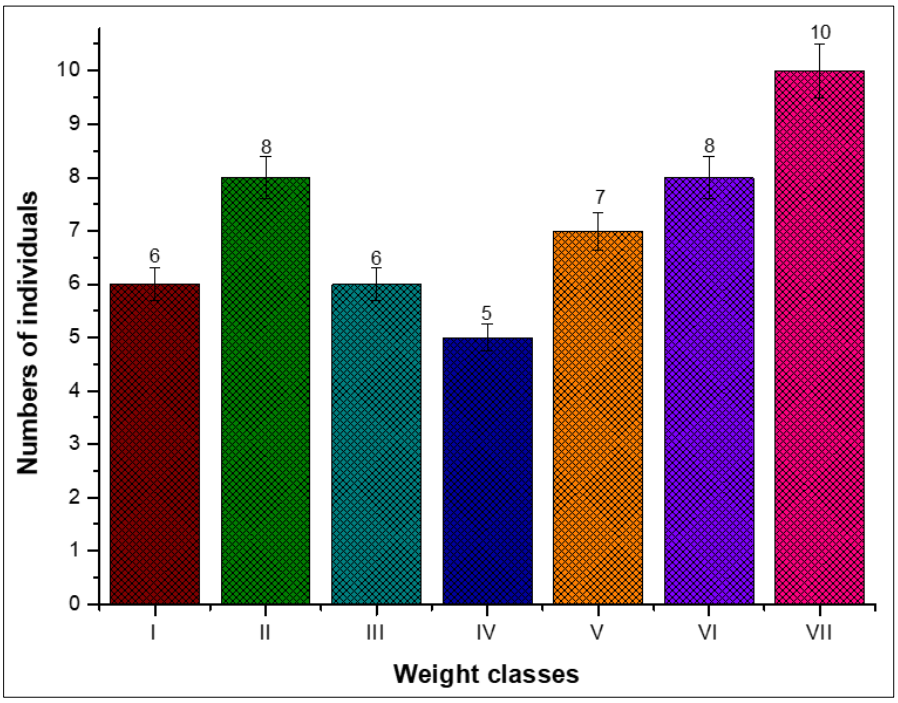

Figure 3 Different weight classes of *Schilbe grenfelli* specimens studied

3.3. Relationship between total length and standard length

The relationship between total and standard lengths of *Schilbe grenfelli* in the diagram in figure 4 below shows that the linear regression between these two parameters is positive (r = 0.9777). It can be seen that the total length of the fish increases at the same time as their standard length.

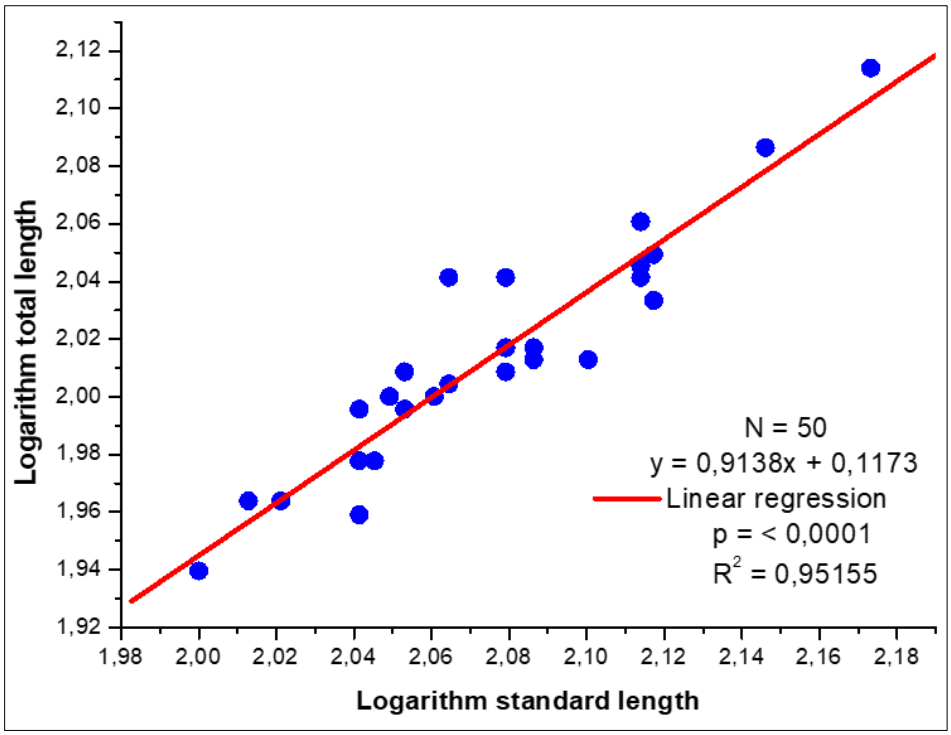

Figure 4 Correlation diagram between total and standard lengths of *Schilbe grenfelli* studied

3.4. Relationship between total weight and total length

The correlation between total weight and total length of *Schilbe grenfelli* is positive. The linear regression diagram (figure 5) shows that the fish studied do not undergo the same type of weight and linear growth. The slope of the regression line (b) of this equation is less than 3 (b = 0.312), demonstrating that during growth, the total weight of *S. grenfelli* increases less rapidly than its total length.

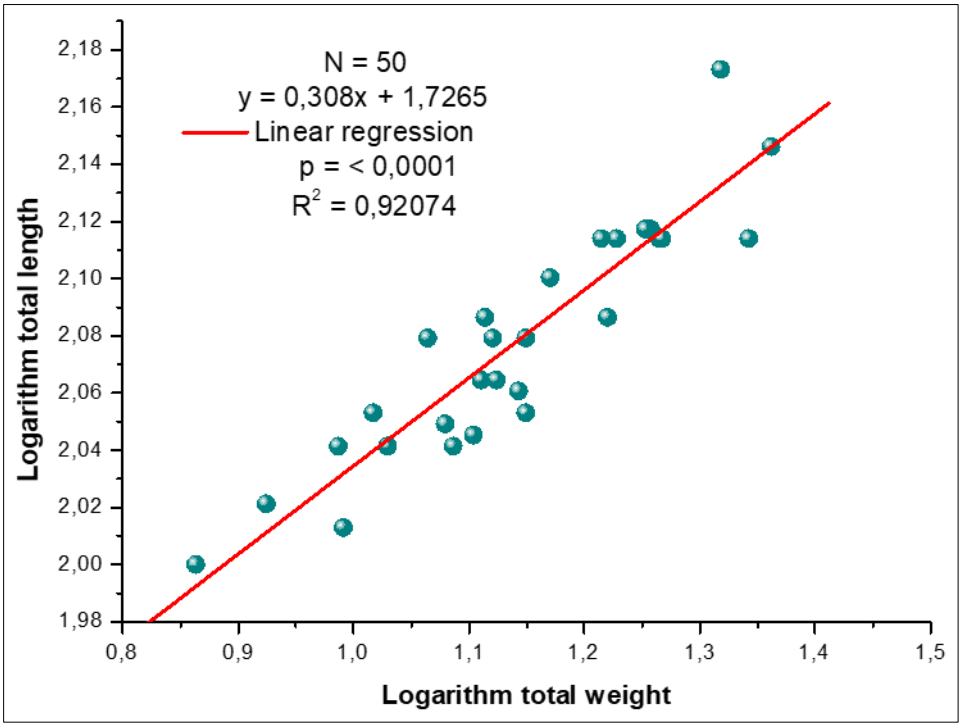

Figure 5 Diagram showing the relationship between total weight and total length of *Schilbe grenfelli* studied.

3.5. Intestinal coefficient

Analysis of the intestinal coefficient (IC) of the 50 *Schilbe grenfelli* specimens shows that the relationship between intestinal length and total length of this fish is positive (r = 0.8363). The mean IC of all specimens analyzed was 1.89±0.12. This simply means that the intestine of the fish species studied is short. This intestinal length indicates that *S. grenfelli* has a carnivorous diet, consuming zooplankton, aquatic invertebrates and fish (figure 6).

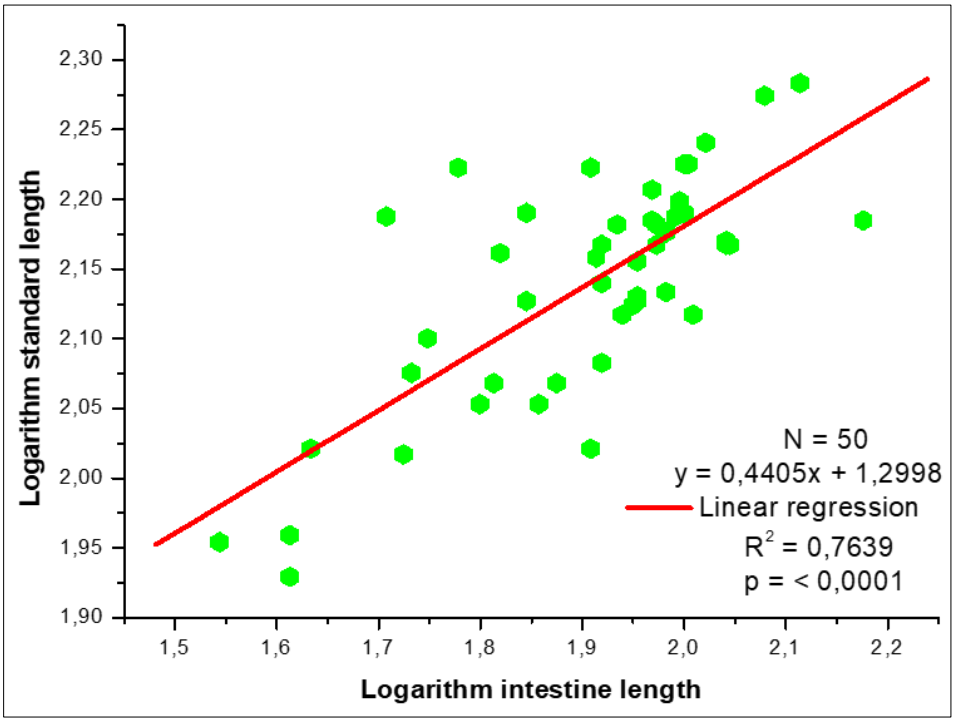

Figure 6 Correlation diagram between intestinal and standard lengths of *Schilbe grenfelli*

4. Discussion

After analysis and processing of the data, the results obtained showed that *Schilbe grenfelli* exhibits weight growth that is less than linear growth; the relationship (weight-length) is of the minorizing allometry type [20] given that the slope of the regression line (b) is less than 3 (b = 0.312). These observations are in harmony with those reported by Diayeno [22], who indicate a minorizing allometry in two species of *Synodontis* fish (*S. acantomias* and *S. greshoffi*) from the Malebo Pool. The same observation was made by Otshinga [23] (2019) in his study on the morphometric analysis of two species of *Cichlidae* (*Oreochromis niloticus* Linnaeus, 1759 and *Tylochromis lateralis* Boulenger, 1920) in relation to their diet, in Malebo Pool.

Determination of the trophic level of *Schilbe grenfelli* was made possible by the relationship between gut length and standard length. The results of this relationship show that the regression is positive (r = 0.8363) and the mean intestinal coefficient (IC) of the fish studied is 1.89±0.12. These observations infer that the digestive tracts of this fish are short; in other words, this species has a carnivorous diet [24] feeding on either zooplankton, aquatic invertebrates or fish [17]. These results are in line with the guidelines set out by Paugy and Roberts [21] in a study on the ecology of fish in the upper Senegal basin. The two aforementioned authors defined the following norms for trophic level: average CI ≤ 0.85 corresponds to a piscivorous diet; average CI ≤ 2.18 determines an insectivorous diet; average CI ≤ 3.01 translates an omnivorous diet; CI between 4.71 and 6.78 corresponds to a phytophagous diet and an average CI between 9 and 17 translates limivorous diet. In addition, Akenze *et al.* [25] report through quantitative analysis of the diet using the preponderance index (PI) that 56.681% of the diet of *Schilbe grenfelli* is composed of prey fish. It is therefore a piscivorous species, mainly consuming one species of *Mormyridae*, in this case the genus *Petrocephalus*, which has the highest preponderance index value. Lauzanne [26] observed similar behavior in specimens of *Hydrocynus forskalii* in the Chari, which has a piscivorous diet from 300 mm total length. Insects constitute food resources for *S. grenfelli* and, represent secondary prey, while other taxonomic groups and notably macrophytes and indeterminate prey present the lowest preponderance index values, they represent negligible prey [25].

5. Conclusion

The present study is a preliminary contribution to the biology and feeding ecology of *Schilbe grenfelli* Boulenger, 1900 (*Siluriformes, Schilbeidae*) from the Malebo Pool (Congo River) in the Kinoise part of the Democratic Republic of Congo. The overall aim was to carry out a preliminary study of the diet of *S. grenfelli* fish caught in this part of the river.

With regard to the type of growth undergone by the species under this study, the results showed that *Schilbe grenfelli* undergoes weight growth inferior to linear growth, and the weight-length relationship was judged to be of the minorizing allometry type (b = 0.312). With regard to trophic level, preliminary results showed that *S. grenfelli* has a short intestine (intestinal coefficient equal to 1.89±0.12) and is considered to be a carnivorous fish, feeding either on zooplankton, aquatic and terrestrial invertebrates or fish present in its habitat. For a better exploitation of *S. grenfelli* in the Malebo Pool, this study deserves to be deepened in order to give precision on the indications of trophic level raised above by focusing on the analysis of stomach contents to characterize the specific diet of this fish species. This will also enable fish farming entrepreneurs to have precise knowledge of the dietary requirements of this fish in order to better cultivate it.

Compliance with ethical standards

Acknowledgments

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Disclosure of conflict of interest

No conflict of interest to be disclosed.

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