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Bio-ecology of *Ctenopoma kingsleyae* Günther in the Kogon and Tinguilinta rivers in the Republic of Guinea

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Abstract

Bio-ecology of *Ctenopoma kingsleyae* Günther in the Kogon and Tinguilinta rivers in the Republic of Guinea was studied through growth type and diet. Sampling was carried out from the series of experimental fisheries from October to December 2013. The experimental fisheries were conducted by gillnets of 10 to 40 mm mesh size. The Length-Weight relationship allowed the determination of the growth type. For diet, the mixed feeding index (MFI) was used. The results have shown that the growth of *Ctenopoma kingsleyae* in the Kogon and Tinguilinta rivers is positive allometry. In addition, the diet of this fish species is invertivorous.

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Introduction

Aquatic environments constitute a reservoir of great biodiversity and also play a very important bioecological role (Ismaïla *et al.*, 2011). The characterization of the ichthyological fauna hosted by these hydrosystems is both a scientific and ecological issue because it allows identifying the influence of disturbances on biological systems at the population and community levels (Ahouanssou, 2011). However, anthropogenic activities likely to endanger or at least modify the biological diversity of ichthyofauna have been increasing over the last two decades in tropical Africa.

Guinea is a country whose economy is based primarily on agriculture and mining resources. The Compagnie de Bauxite de Guinée (CBG), one of the most important companies operating in the bauxite sector in Guinea, plans to increase its production in the coming years. In this context, it is necessary to take stock of the aquatic fauna of the waterways likely to be influenced by the activities of the expansion project of the Compagnie de Bauxite de Guinée (CBG), in order to take appropriate conservation measures. These measures, to be effective, require a good knowledge of the species and the relationships that link them to their environment (FAO, 2008). Indeed, knowledge on the bio-ecology of fish, particularly on growth and feeding habits, is important for efficient decision-making in the preservation and conservation of the biodiversity of this fauna (Boussou, 2013). With this in mind, the fish fauna of the watersheds of the Kogon and Tinguilinta hydrosystems in the Republic of Guinea was studied (Edia *et al.*, 2014).

The species *Ctenopoma kingsleyae* is among the most encountered ichthyological species (Edia *et al.*, 2014). This species is a benthopelagic fish capable of disturbing the sediment while searching for its food, thus allowing the resolution of nutrients (Lévêque, 1994). Thus, the study aims to contribute to the knowledge of the bio-ecology of *Ctenopoma kingsleyae* in the Kogon and Tinguilinta rivers in the Republic of Guinea.

Materials and methods

Study area

The present work took place in the Kogon and Tinguilinta rivers in the Republic of Guinea located between longitudes 6°12 and 6°36 and latitudes 12°16 and 12°36 (Fig. 1).

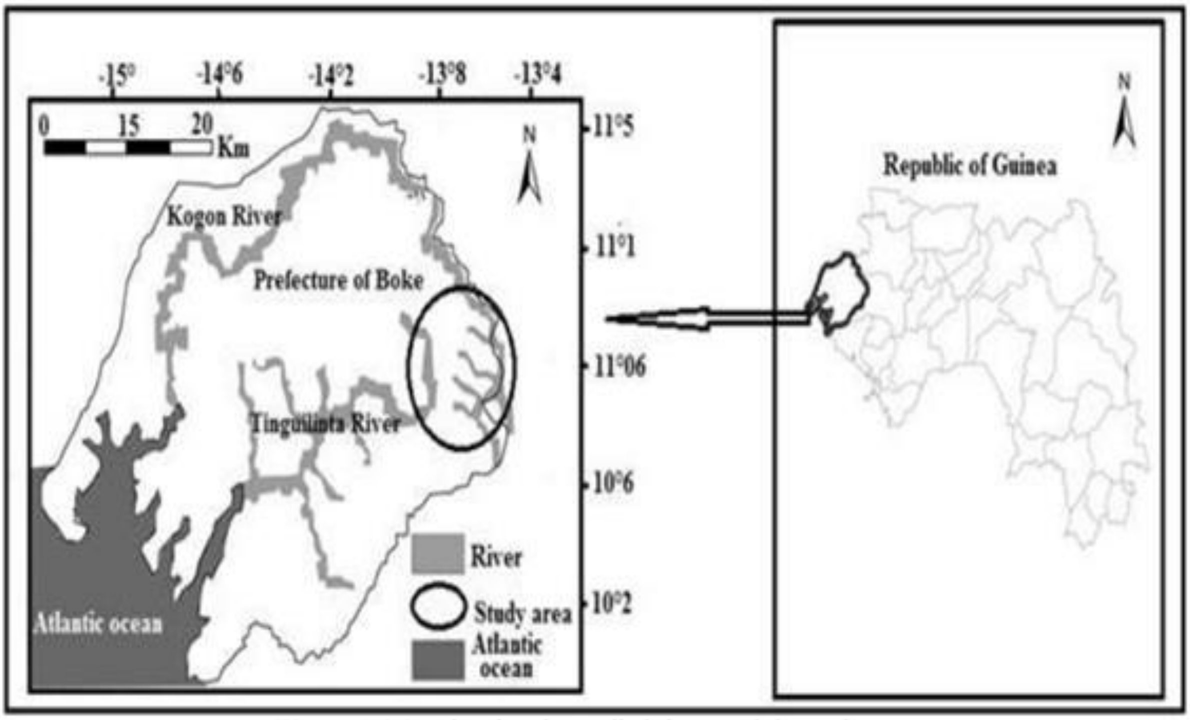

Fig. 1. Location of study area (Aliko *et al.*, 2018).

The Kogon River has a watershed area of 7,288 km² with a length of 379 km (Diallo *et al.*, 2009). The Kogon River flows in a northwest direction towards the border of Guinea Bissau. The Tinguilinta River drains an area of 4,858 km² and is 160 km long (Barry, 2009; Diallo *et al.*, 2009). This river flows from southwest to north.

Sampling and identification of fish

The sampling of fish fauna took place from October to December 2013 as part of the experimental fishing series. The mesh size of the gillnets used varied from 10 to 40 mm mesh size. Fish specimens were identified using the keys proposed by Paugy *et al.* (2003 a and b), Sonnenberg and Busch (2009), Froese and Pauly (2014).

Data collection and analysis

On each fish specimen, the weight (in grams) and total length (in millimeters) were determined. The length and weight data allowed the determination of the growth type through the length-weight relationship. This relation is established according to the following formula:

$W = a \times SL^b$ (Lévêque, 2006);

where W *is the weight of the fish in g; SL, the standard length in mm; a, a constant and b, the allometry coefficient*

To determine the type of growth (isometric, positive or negative allometry), Student's t-test was used to compare the different coefficients b of the length-weight relationships to the value 3 at the 5% significance level (Konan *et al.*, 2007). Thus, when the value of b is equal to 3, the growth is said to be isometric. When it is less than 3, the growth of the fish is negative allometric. When it is greater than 3, the growth of the fish is said to be positive allometric (Morey *et al.*, 2003).

In the laboratory, each specimen was dissected and the stomach contents were observed to identify the prey items contained in each stomach. Indices were calculated to determine the diet of *Ctenopoma kingsleyae*

Occurrence frequency (%F) $\%F = (n / N) \times 100$; (González *et al.*, 2006)

Where n was the number of individuals with stomach content and N was the total number of individuals sampled.

The importance of prey items was evaluated using numerical methods such as percent of number (%N) and percent of weight (%W) reported by Hyslop (1980). The results derived from these two methods were conjugated in order to determine the contribution of each prey category in the fish diet.

Hence, the MFI (Main Food Index) was determined using the combination of the three previously calculated indices (Zander, 1982):

$$MFI = ((N + F) \times W/2)^{1/2}$$

Then the MFI of the item i was expressed as a percentage of the total MFI. Then, according to the MFI values, preys were classified as: primary food (MFI > 75), main food (50 < MFI ≤ 75), secondary food (25 < MFI ≤ 50) and insignificant food (MFI ≤ 25).

The feeding strategy was assessed using the Costello (1990) method with modifications by Amundsen *et al.* (1996); where the Prey Specific Abundance (Pi) was plotted against Frequency of Occurrence (%F) to generate a prey distribution plot defining the feeding strategy of the species (Figure 2).

Results

Size variation

In this study, 17 and 29 individuals of *Ctenopoma kingsleyae* were analyzed in the Kogon and Tinguilinta rivers, respectively. In the Kogon River, the dominant size range of the catches oscillated from 33 to 96 mm TL, while in Tinguilinta the dominant range was between 46 and 106 mm TL (Fig. 3).

Table 1. Diet composition of *Ctenopoma kingsleyae* in the Kogon and Tinguilinta Rivers of the Republic of Guinea and percentage of the food indices.

	Kogon River				Tinguilinta River			
Food	%F	%N	%W	MFI	%F	%N	%W	MFI
Insects								
Odonata	6.66	1.12	0.02	0.27				
Trichoptera	6.66	1.12	0.02	0.27				
Hemiptera	6.66	12.35	0.42	1.99	5.88	1.26	0.22	0.85
Coleoptera	6.66	2.24	0.08	0.59	17.64	24.05	1.04	4.66
Hymenoptera					5.88	1.26	0.13	0.68
Insect larvae	13.33	4.49	6.19	7.42	41.17	13.92	12.02	18.2
Insect remains	93.33	15.75	57.6	56.04	88.23	18.98	26.68	37.82
Arachnids								
Spiders	6.66	1.12	1.37	2.3				
Fish					11.76	5.53	2.42	4.16
Arthropods					5.88	1.26	0.34	1.1
Crustaceans								
Shrimp					5.88	2.53	0.2	0.92
Sediment								
Pebbles	6.66	1.12	1.37	2.3	5.88	6.32	6.29	6.19
Sludge	6.66	1.12	5.03	4.42	23.52	5.06	17.5	15.81
Plants								
Fruits	13.33	49.43	0.47	3.84	23.52	26.58	4.76	10.92
Plant debris	60	10.11	24.93	29.56	41.17	8.86	28.33	26.62
Summary								
Insects	93.33	37.05	64.33	66.62	88.23	59.47	40.09	62.24
Arachnids	6.66	1.12	1.37	2.3				
Fish					11.76	5.53	2.42	4.16
Arthropods					5.88	1.26	0.34	1.1
Crustaceans					5.88	2.53	0.2	0.92
Sediment	13.32	2.24	8.83	8.26	23.52	11.38	23.79	22
Plants	66.67	59.54	25.4	33.4	52.94	35.44	33.09	37.54

The total length recorded at Kogon ranged from 33.74 mm to 137.14 mm with an average value of 76.65±6.86 mm. At Tinguilinta River, the total length of individuals fluctuated between 45.57 mm and 131.37 mm, with a mean value of 79.75±4.58 mm.

The mean size of *Ctenopoma kingsleyae* specimens did not vary significantly between rivers (Student's t-test ; $p > 0.05$).

Growth typology

At the Kogon River, the coefficient b evaluated by the total length-weight relationship of *Ctenopoma kingsleyae* specimens is 3.29 (Fig. 4). This value of b significantly greater than 3 (Student's t-test ; $p < 0.05$) indicates that *Ctenopoma kingsleyae* has a positive allometric type growth. Similarly, in the Tinguilinta River, the b coefficient of this species is equal to 3.26. This value is significantly higher than 3 (Student's t-test ; $p < 0.05$) translates into major allometry of *Ctenopoma kingsleyae*.

Mean intestinal coefficient and vacuity coefficient

The value of the mean intestinal coefficient (MIC) calculated for *Ctenopoma kingsleyae* in the Kogon River is 1.01 and that obtained for the Tinguilinta River is 1.

The analysis of the fullness of the stomach showed a variation of this parameter according to the places where the fish were caught. Indeed, in the Kogon River, 04 fish out of 17 had empty stomachs, i.e., a vacuity coefficient of 23.52%. While in the Tinguilinta River, out of 29 fish, there were no empty stomachs.

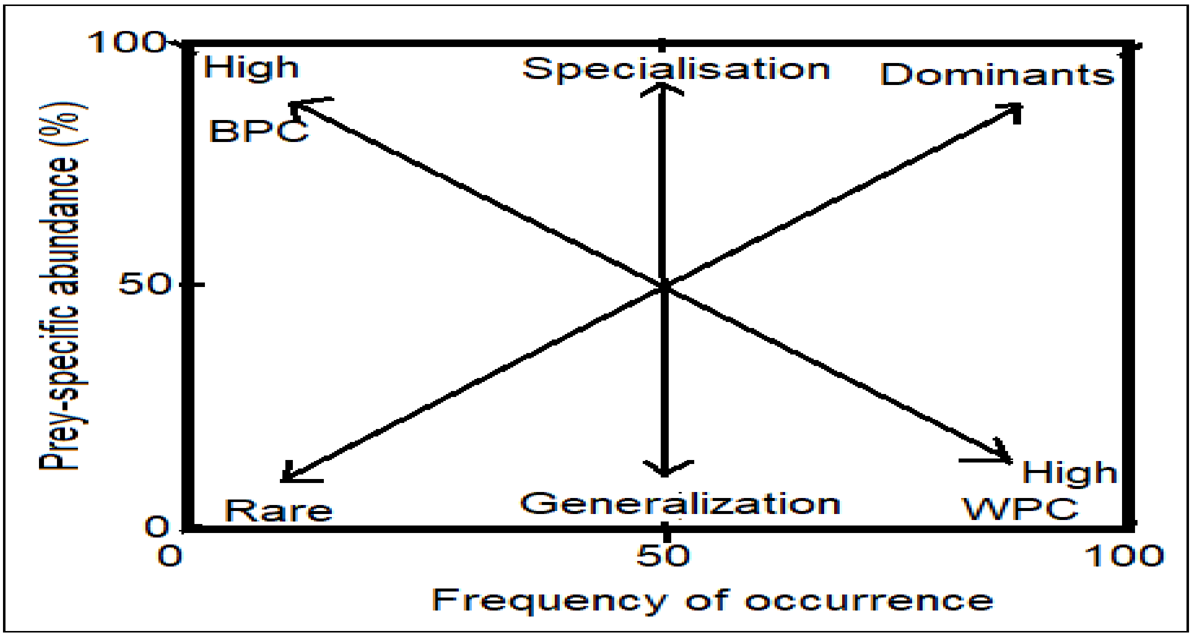

Fig. 2. Modified Costello graph showing explanatory axes (Modified from Amundsen *et al.* (1996) and its interpretation to indicate feeding strategy; BPC: between-phenotype component; WPC: within-phenotype component.

Diet composition

Analysis of the stomach contents of *Ctenopoma kingsleyae* captured in the Kogon River revealed 11 food items divided into 4 groups (Table 1). On the basis of frequency of occurrence, the most regular prey items in the stomach contents of the species are: insect remains (%F = 93.33) and plant debris (%F = 60). Numerically, the most important items in the stomach contents are fruits (%N = 49.43) and insect remains (%N = 15.73). On the other hand, when considering the weight of prey taxa, insect remains with a percentage of 57.60 are the most important in the diet. The analysis of the proportions of the items based on their values of the main food index shows that insects are consumed mainly (MFI = 66.62) in the diet of *Ctenopoma kingsleyae*.

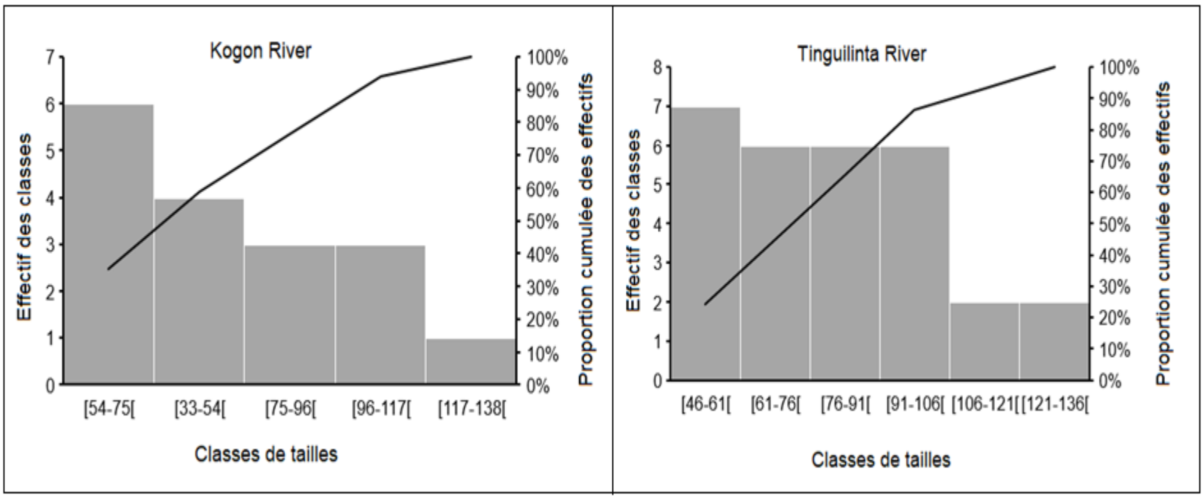

Fig. 3. Size class of *Ctenopoma kingsleyae*.

At the Tinguilinta River, stomach content analysis identified 12 food items. This food spectrum is grouped into 6 prey categories: insects, fish, arthropods, crustaceans, sediments and plants. Based on the frequency of occurrence, insect remains (%F = 88.23), insect larvae and plant debris (%F = 41.17) were the most regular prey items in stomach contents. Numerically, the most important items in stomach contents were: fruits (%N = 26.58) and Coleoptera (%N = 24.05). In reference, considering the weight, plant debris (%N = 28.33) and insect remains (%N = 26.68) are the most preponderant. Based on the MFI values, insects are the main prey (MFI = 62.24).

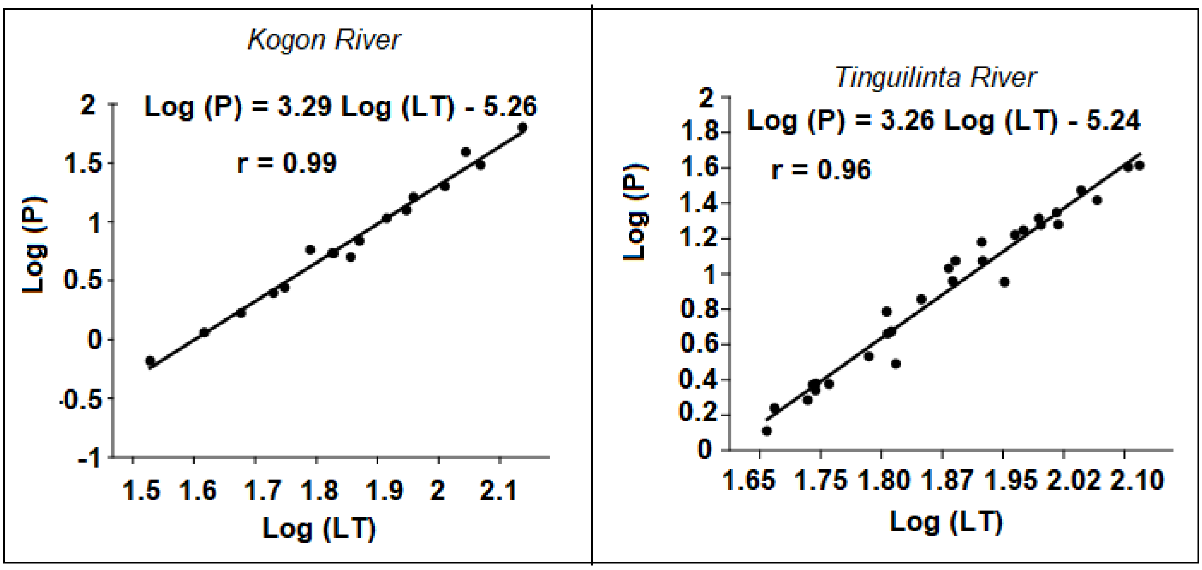

Fig. 4. Logarithmic regression curves of weight versus total length of *Ctenopoma kingsleyae* sampled in the Kongon and Tinguilinta rivers in the Republic of Guinea.

Food strategy

The Costello diagram modified by Amundsen shows that there is great variability in the use of resources by individuals. In both hydrosystems, *Ctenopoma kingsleyae* population is subdivided into four subpopulations, each specialized in the use of a well-defined resource (Figure 5). In case (a), several bangs of the population each specialize on different prey. In case (b), the whole population specializes in a reduced number of preys. In case (c), all individuals in the population show a generalist diet on that prey. Case (c) represents rarely encountered prey.

Discussion

Size spectrum analysis indicated that the maximum sizes of *Ctenopoma kingsleyae* (T max = 137.14mm TL for Kogon and T max = 131.37mm TL for Tinguilinta) are smaller than those observed by Daget (2003) and Ezenwaji (2004) in the Ogooué Basin in Gabon (T max = 245mm TL) and in the Anambra River in Nigeria (T max = 217mm TL) respectively. According to Boussou (2013), the maximum size for a given taxon may experience spatial disparities attributable to environmental, ecological conditions.

The regressions between height and weight in this study were highly significant ($0.97 < r < 0.98$). This reflects that the increase in height induces the increase in weight in *C. kingsleyae* (Ikomi and Sikoki, 2001). The allometry coefficient b provides information on the growth type of the fish (Montcho *et al.*, 2009). The values of b obtained (b = 3.26 and 3.29) are consistent with those reported in the literature. Indeed, Montchowui *et al.* (2009) place the values of the allometry coefficient between 2 and 4. Furthermore, the values of b are greater than 3 (Student's t-test ; $p < 0.05$) indicating a positive allometric type of growth for *C. kingsleyae* in the Kogon and Tinguilinta Rivers. In both river, during growth, this anabantidae gains more weight than length. In contrast, negative allometric growth (b = 2.16) was reported for the same species in the Anambra River in Nigeria (Ezenwaji, 2004).

This difference in growth pattern could be attributed to age, sex, the fecundity of the fish, sampling methods and sample sizes, as well as the prevailing ecological conditions in the water body at different times (Adaka *et al.,* 2015).

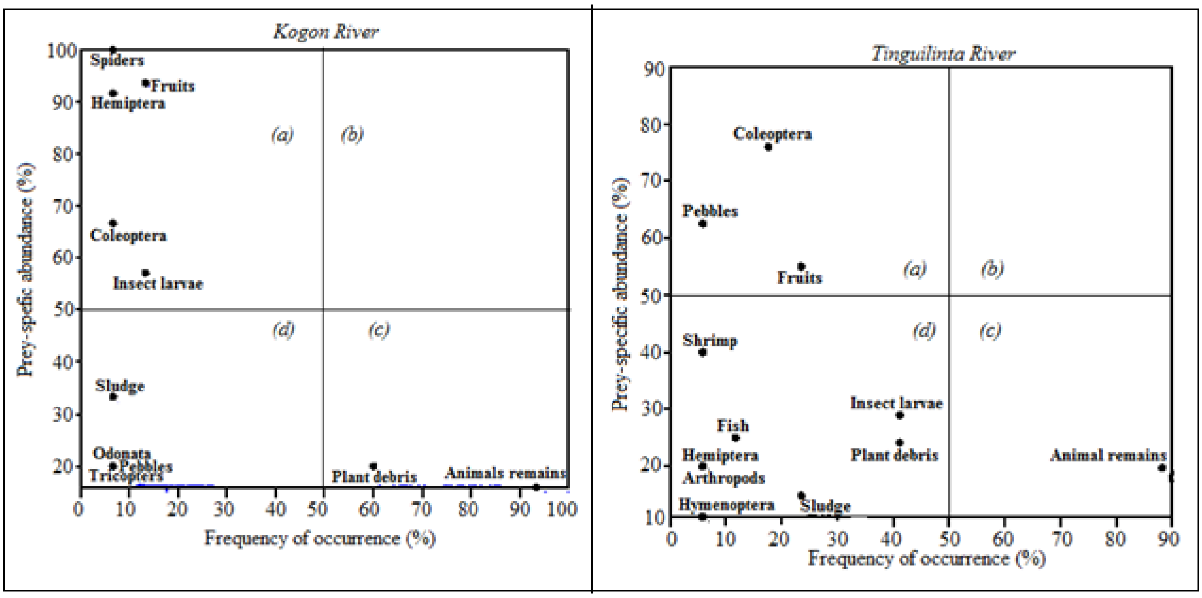

Fig. 5. Costello diagram showing the feeding strategy of *Ctenopoma kingsleyae* in the Kogon and Tinguilinta rivers in the Republic of Guinea.

Food vacuity results during the study period show that the trophic activity of *C. kingsleyae* is more intense in the Tinguilinta River (CV = 0%) than in the Kogon River (CV = 23.52%.). The food spectrum of *C. kingsleyae* is made up of prey of relatively diverse origins including animal, plant and sediment prey. This result confers to this species an omnivorous diet with a tendency to insectivore (MFI = 65.86) insects. Analysis of the stomach contents of *C. kingsleyae* in both rivers revealed similar preferred prey in these environments, although their proportions differed slightly between the two environments. The significant presence of insect debris in the stomach contents of *C. kingsleyae* could likely result from insects consumed whole but found partially digested (Boussou, 2013). The presence of mud and pebbles in most of the digestive tracts examined suggests that this fish tends to forage in the mud during feeding. In terms of feeding strategy, the results showed that *Ctenopoma kingsleyae* applies a generalist type strategy on insect remains and on much rare prey occasionally consumed in the studied habitats. However, there are some intentions of specialization for some individuals on Spiders, fruits, hemipterans, beetles and rocks. These results are consistent with those of Da Costa and Louis Tito (2007), who reported a generalist diet of *Ctenopoma kingsleyae* on insects in small dams in Côte d'Ivoire. A generalist strategy limits intraspecific competition over available food resources (Lamesa *et al.*, 2008).

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