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Study of an Edible Frog of Brazzaville: *Hoplobatrachus occipitalis: Ranidae (Günther, 1858)*

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Abstract

The study of the morphometry and the dietary habits of an edible frog, hoplobatrachus occipitalis was carried out in three sites of Brazzaville: congo river (Mbamou island), Ngamboulou river (tests garden of Marien Ngouabi University) and Djoué river (Mafouta district). The frogs were fished with the line. The meaning size of these frogs varied according to the site, the body length of specimens of the Congo River (10.05 cm) was higher than those of specimens of Ngamboulou river (9.27 cm) and Djoué River (6.18 cm). Arthropods represent the most consumed preys with a preference for the coleopters.

Keywords: *Hoplobatrachus occipitalis,* Brazzaville, morphometry, dietary habits.

Introduction

The man's activity is the origin of the destruction of many natural environments, which involves the disappearance of thousands of species, among which frogs. Indeed, the batrachians, important link of the food chain of vertebrate are threatened of extinction, because of over exploitation and pollution[1]. Extreme sensitivity of their skin to environmental changes, makes them better indicators of the health of our environment.

In Europe, the edible frogs are generally taken from natural stocks, but these stocks are diminishing since the eighties[2,3], under the combined influence of regression of favorable habitats and the increase in human activities[4]. This reduction in natural stocks has involved the development of raniculture. Thus, several commercial firms of Asian countries export the frozen frog legs towards Europe.

In sub-Saharian Africa, the raniculture is not popularized, consumed frogs come from the wild captures[2]. In Congo Brazzaville, the principal edible frogs belong to the following families: ranidae (*Ptychadena*, *Hoplobatrachus*) pipidae (*Xenopus*), and phrynomeridae (*Phrynomerus*). No bioecologic characterization of these species was carried out, except very few partial inventories carried out in certain areas of Congo Brazzaville[5,6,7,8]. That is why, we undertook the preliminary study of a very widespread edible frog, *Hoplobatrachus occipitalis*.

Material and Methods

The frogs were fished with the line in three prospection sites of the urban area of Brazzaville (figure 1): the Djoué River (Mafouta district), the Ngamboulou River (tests garden of Marien Ngouabi University) and the Congo River (Mbamou island). 129 specimens of frogs were captured in March and August, 2005 : 50 specimens of the Congo River (Co River) ; 42 specimens of the Djoué River (Dj River) ; 37 specimens of the Ngamboulou river (Ng River).

Physicochemistry of surface water was determined using multiparameter Hanna for pH, electric conductivity (EC) and total dissolved solid (TDS), oxymeter Hanna for dissolved oxygen (DO), turbimeter for turbidity (Turb). The frogs fixed in formol 10% were preserved in alcohol 70°; some specimens were photographed alive. The beforehand weighed frogs with Ohaus electronic balance (0.01 precision), were measured using a slide caliper[9]. The digestive tracts were taken then preserved in formol 5% for a further study of the dietary habit under binocular microscope. The frogs were divided into size classes according to Sturge rule[10].

NC = 1+ (1.3/ ln N), NC = number of classes, N = Total number of examined specimens.

$$I = \frac{L\ max - L\ min}{NC} \quad (1)$$

L max : maximal length, L min : minimal length, I : Interval of class

Median length of frogs specimens were compared between the three rivers at the interval confidence of ± 0.95. Some characteristic index were also calculated, such as sex ratio, preys occurrence and vacuity coefficient. The sex ratio corresponds to male-female ratio. Sex ratio = M / F (2)

Where M : male number; F : female number.

The preys' occurrence (%O.C) were calculated by the following formula:

$$\%O.C = \frac{\text{Number of digestive tracts containing item i}}{\text{Number of total full digestive tracts}} \times 100 \quad (3)$$

The vacuity coefficient (%V) is the ratio of number of empty digestive tracts and total number of digestive tracts were also calculated:

$$\%V = \frac{\text{Number of empty digestive tracts}}{\text{Total number of digestive tracts}} \times 100 \quad (4)$$

Cluster analysis was applied in this study. Cluster analysis (CA) is a multivariate technique, the primary purpose is to classify the objects of the system into categories or clusters based on their similarities. The objective is to find an optimal grouping for which the observations or objects within each cluster are similar, but the clusters are dissimilar to each other. Hierarchical clustering is the most common approach in which clusters are formed sequentially. The most similar object is first grouped, and these initial groups are merged according to their similarities. Eventually as the similarities decrease all subgroups are fused into a single cluster. CA was applied to preys consumed in diet data using a single linkage method. In the single linkage method, the distances or similarities between two clusters A and B are defined as the minimum distance between a point in A and a point in B:

$$(A,B) = \min \{d(y_i,y_j), \text{ for } y_i \text{ in A and } y_j \text{ in B}\} \quad (5)$$

Where $d(y_i,y_j)$ is the euclidean distance in equation 5. At the first step the distance is found for every pair of clusters and the two clusters with the smallest distance (largest similarity) are merged. After two clusters are merged the procedure is repeated for the next step: the distance between all pairs of clusters is calculated again, and the pair with minimum distance is merged into a single cluster. The result of hierarchical clustering procedure can be displayed graphically using a tree diagram, also known as a dendrogram, which shows all the steps in the hierarchical procedure [11,12].

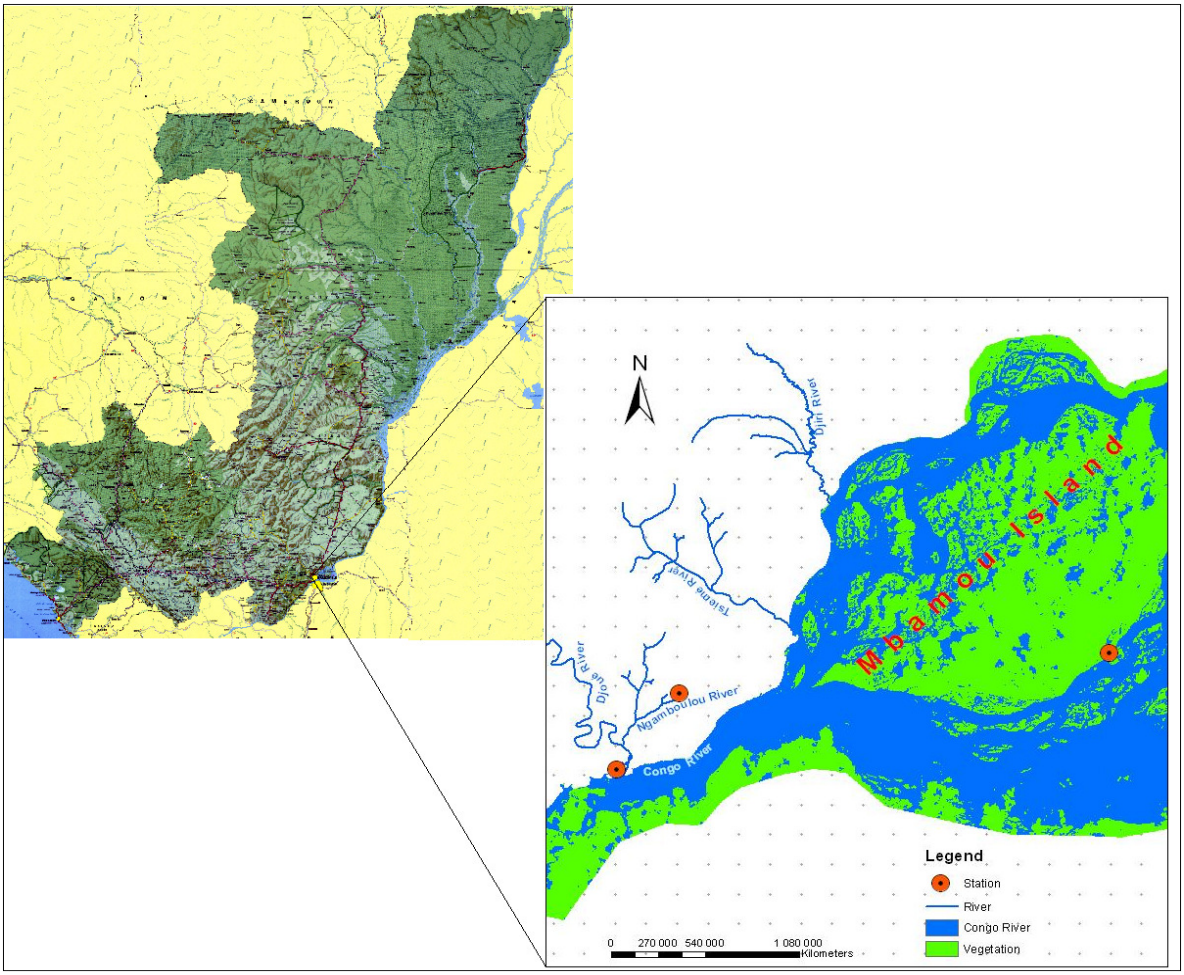


Figure-1
Localization of stations

Results and Discussion

Physico chemistry of surface water: The pH is close to the neutrality: 7.53 in Djoué River, 7.03 in Ngamboulou River and 6.83 with the Congo River. Electrical conductivity on the other hand shows a big difference between the sampling sites: 27µS/cm in the Congo River and 16µS/cm in Djoué River and in Ngamboulou River (table 1). Electrical conductivity values show a weak mineralization of these surface waters. Congo River is more oxygenated (12mg/l) than the two others (5.33mg/l in Djoué River and 5.43mg/l in Ngamboulou River. The value of TDS of Ngamboulou River (11.4ppm) is slightly smaller than those of Djoué River (16.33ppm) and Congo River (15ppm). A difference was observed between water turbidity of Ngamboulou River (9.3NTU) and the one of Djoué River (18.6NTU) and Congo River (24.6NTU).

Table-1
Physico chemistry of surface water

	pH	EC (µS/cm)	DO (mg/l)	TDS (ppm)	Turb (NTU)
Congo River	6.83	27	12	15	24.6
Ngamboulou River	7.03	16	5.43	11.4	9.3
Djoue River	7.53	16	5.33	16.33	18.6

Sex ratio and morphometry: The sex ratio is equal to 1.03 in the Congo River, 2.23 in Djoué River and 1.50 in Ngamboulou River. The meaning size of frogs of the Congo River is highest with 10.05 cm compared to with 6.18 cm in Djoué River, the meaning size of frogs of Ngamboulou River lies between the two preceding values, 9.27cm (table 2) on one hand. Frogs of the Congo River had the largest minimal and maximal sizes, 7.84cm and 14.54cm, respectively. On the other hand, the smallest frog specimens were observed in Ngamboulou River (4.12cm) and Djoué River (4.11cm).

Table-2
Descriptive statistics of body length of frogs

	Min (cm)	Max (cm)	Mean ±SD	Median	n
Congo River	7.84	14.54	10.05±1.43	10.12	50
Ngamboulou River	4.12	11.65	9.27±2.33	7.82	37
Djoue River	4.11	9.92	6.18±1.25	6.33	42

SD : Standard Deviation

The use of the Student test for the comparison of average lengths of frogs of Ngamboulou River and the Congo River, Ngamboulou River and Djoué River, like those of the Congo River and Djoué River, shows that the value of t calculated is always higher than t observed in all cases, which well denotes the difference of the body length between frogs of the various prospected rivers (table 3).

Table-3
Difference between the body lengths of frogs (T-test)

	Ng River / Dj River		Co River / Ng River		Co River/ Dj River	
Mean	7.62	6.39	9.99	7.62	9.99	6.39
SD	2.33	1.25	1.41	2.33	1.41	1.25
n	27	42	37	50	50	42
t calculated	2.932		5.470		12.663	
t observed	1,294		1,293		1,292	
Result	S		S		S	

S: Significant

The most important difference in the average length was observed between frogs of the Congo River and of Djoué River, followed by those of the Ngamboulou River and Djoué River. Whereas, the smallest difference in the mean length is observed between frogs of Ngamboulou River and those of Djoué River. This difference is also well observed by taking in account the median length values (figure 2).

Frogs distribution by size classes in the three sites: The frogs of each river were divided according to size classes. Figure 3 shows the distribution of frogs by size class in the three sites. The frogs of the Congo River were divided in 7 size classes (Figure 3), with prevalence of class 3 (32.72%), followed by class 1 (25%), then class 2 (21.18%), class 4 (12.72%), class 5 (3,6%), and classes 6 and 7 (1.81%). The frogs of Djoué River were divided into 6 classes of size (figure 3), classes 1 and 2 account for 26.19%, followed by class 3 (23.80%), class 4 (16.66%), class 5 (4.76%) and class 6 (2.38%). The frogs of Ngamboulou River were also divided into 6 size classes (figure 3), the most representative of which is class 4 (22.85%), followed by classes 1 and 6 (20%), class 5 (14.28%) and classes 2 and 3 (11.42%).

Dietary habit: The vacuity coefficient of frogs of the Congo River is highest with 18.18%, against 4.76% for frogs from Djoué River and 5.71% in frogs of Ngamboulou River. The insects are the most consumed preys. The food spectrum of frogs varies according to the site of prospection (figure 4).

The dietary habit of frogs of the Congo River is dominated by the coleopters 35.5% followed by the caterpillars (17.77%), the spiders (17.77%), the remains vegetable (17.77%), 6.66%, the fishes (8.88%), the crabs (8.88%), the ants (6.66%), the locusts, the crickets (4.44%), the dragonflies (4.44%), the frogs (4.44%), the molluscs (4.44%), the lizards (2.22%), and the mice (2.22%). Cannibalism was observed in 3 female frogs.

The food mode of frogs of Djoué River is marked by a prevalence of the vegetable remains (55%), molluscs (50%) and coleopters (45%), the remainder is represented by the ants (25%), the sandstones of Inkisi (22.5%), the caterpillars (20%), the locusts (15%), the dragonflies (12.5%), the crickets (10%), the dipterous larvae (10%), the spiders (7.5%), the butterflies (5%), the wasps (5%), and the frogs (5%).

The dietary habit of frogs of Ngamboulou River is dominated by the dragonflies (27.27%), the coleopters (21.21%) and the caterpillars (21.21%), followed by the spiders (18.18%), the molluscs (18.18%), the crabs (18.18%), the remains vegetable (18.18%), the locusts (15.15%), the ants (12.12%), the dipterous larvae (12.12%), and the sachets (3.03%).

Cluster analysis: The dendrogram realised starting from the preys introduced by frogs of the three sites shows that frogs of the Congo River and Ngamboulou River have a similar dietary habit, which was different from frogs of Djoué River (figure 5).

Occurrence of preys groups: The arthropods represent the most preys group consumed by frogs in spite of the variations observed according to the river (figure 6). In the Congo River, the arthropods represent the preferential preys group with 80% of occurrence. The vertebrate and the caterpillars accounts for 22.22% and 17.17% respectively are occasional preys and the molluscs constitute accidental preys with 4.4%. In Djoué River, the arthropods also set up a group of preferential preys with 100% of occurrence, followed by the molluscs (50%). The small vertebrate (32.5%) and the caterpillars (20%) are groups of occasional preys. In Ngamboulou River, the arthropods are the preferential preys with an occurrence of 100%, followed by not identified preys which account for 57.57%. The occasional preys are represented by the caterpillars (21.21%), molluscs (18.18%) and small vertebrate (15.15%).

The occurrence of the preys groups consumed varies according to the sex of the frogs (figure 7). On one hand, the consumption of the arthropods by the males is more important in Ngamboulou River and Djoué River. On the other hand in the Congo River, the consumption of the arthropods is slightly more important among females. The molluscs and the caterpillars are consumed by the males in Djoué River, the tendency is reversed slightly in Ngamboulou River with a consumption of caterpillars less higher among females.

The occurrence of the preys groups consumed varies according to the size class of the frogs (figure 8). The consumption of arthropods and vertebrate increase according to the size class in the Congo River. It is the same in Djoué River where the consumption of the arthropods and molluscs increases with the size of individuals. In Ngamboulou River, the same tendency is observed for the consumption of the arthropods and the molluscs.

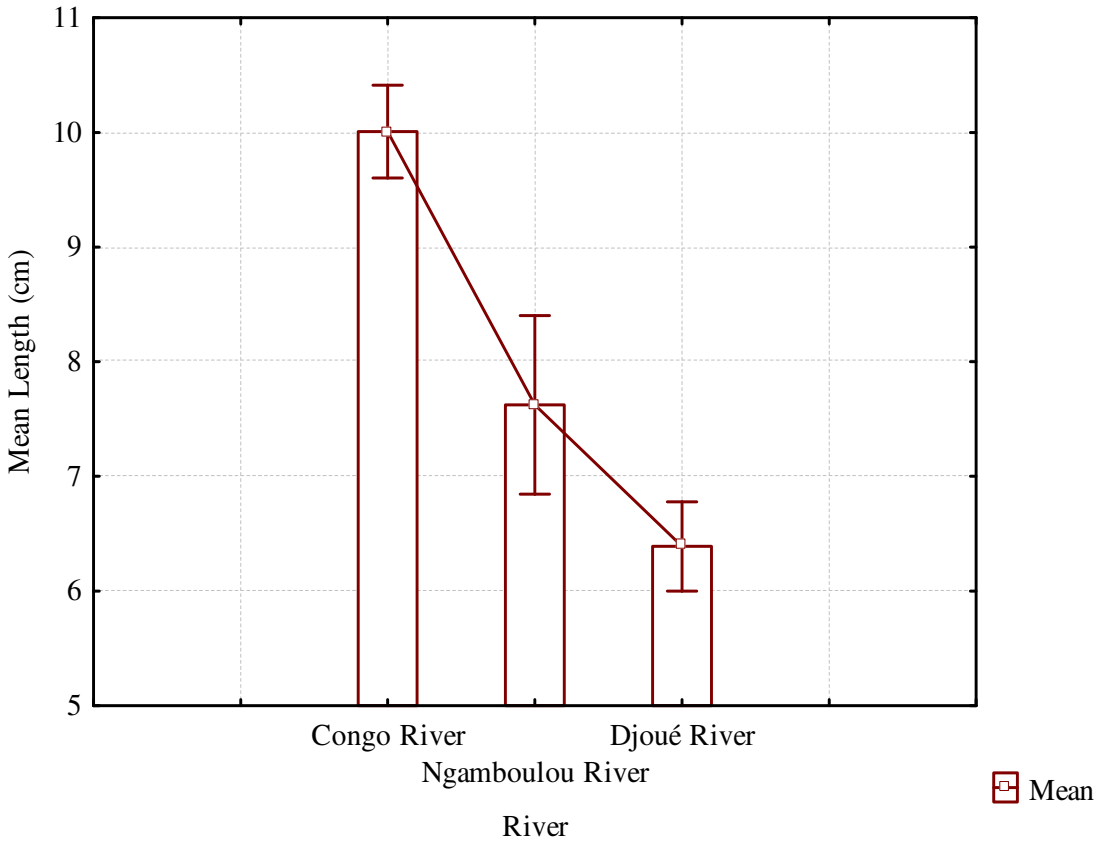


Figure-2
Comparison of median length of frogs

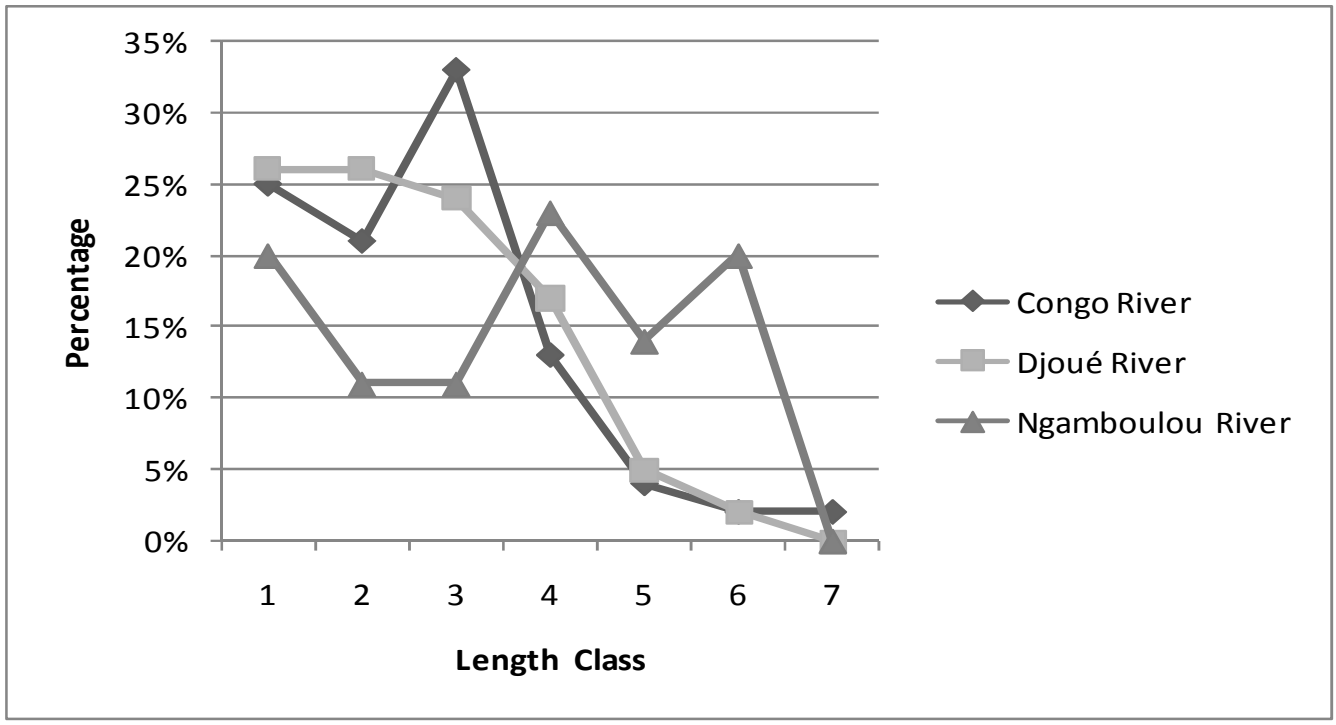


Figure-3
Frogs distribution in three sites following size classes

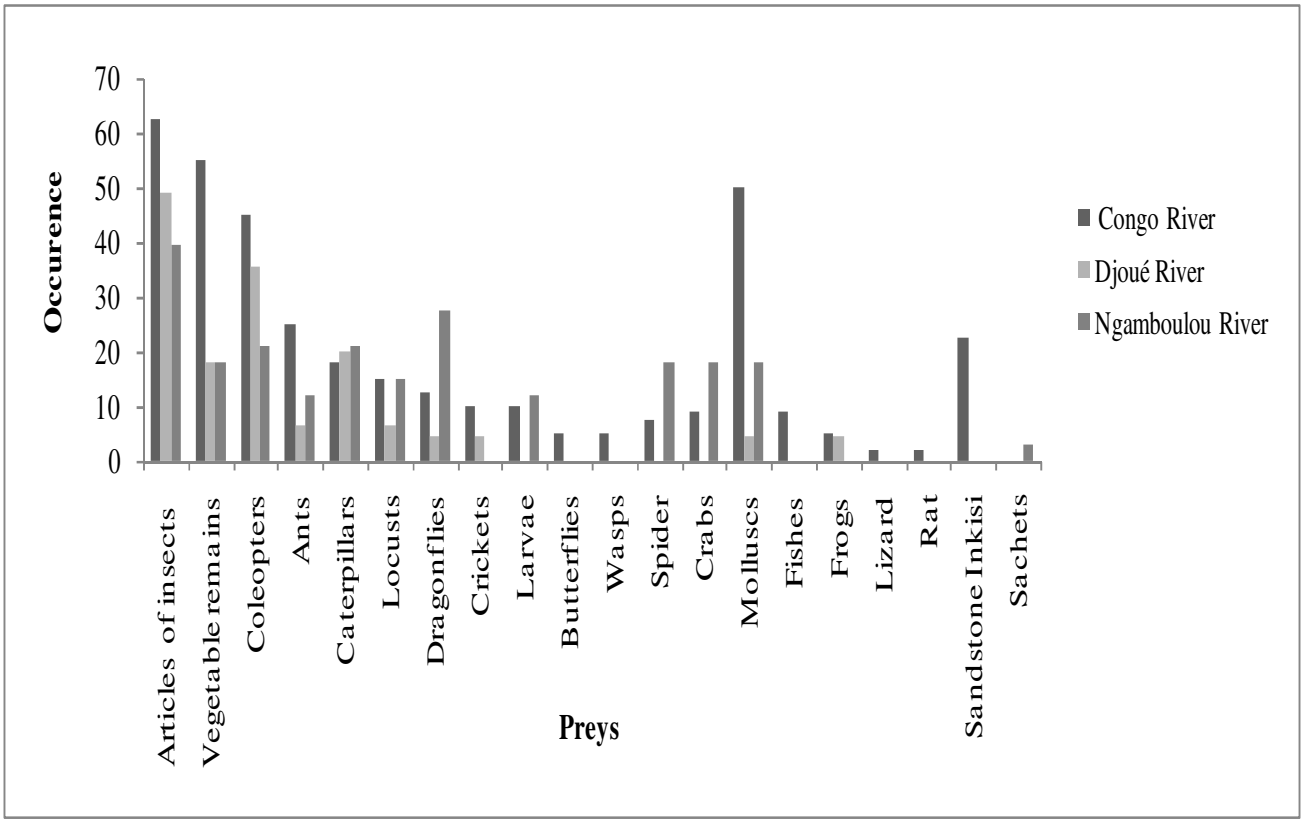


Figure-4
Occurrence of preys identified on the three sites

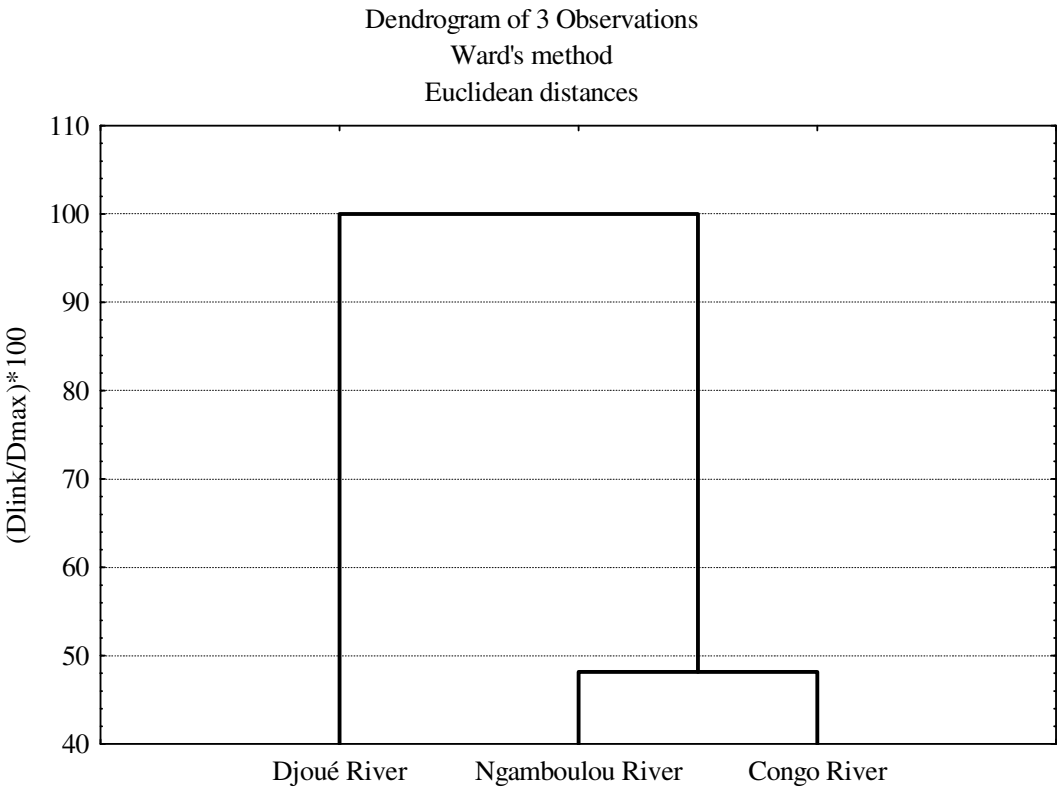


Figure-5
Dendrogram of frogs dietary habit

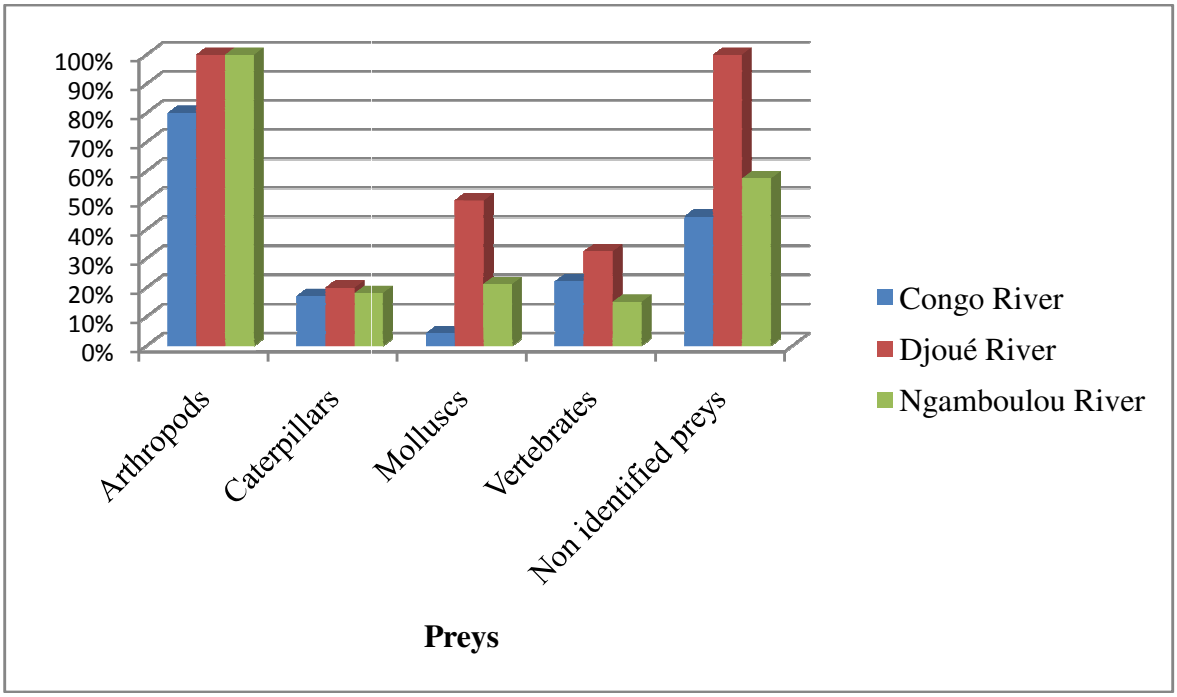


Figure-6
Occurrence of preys groups

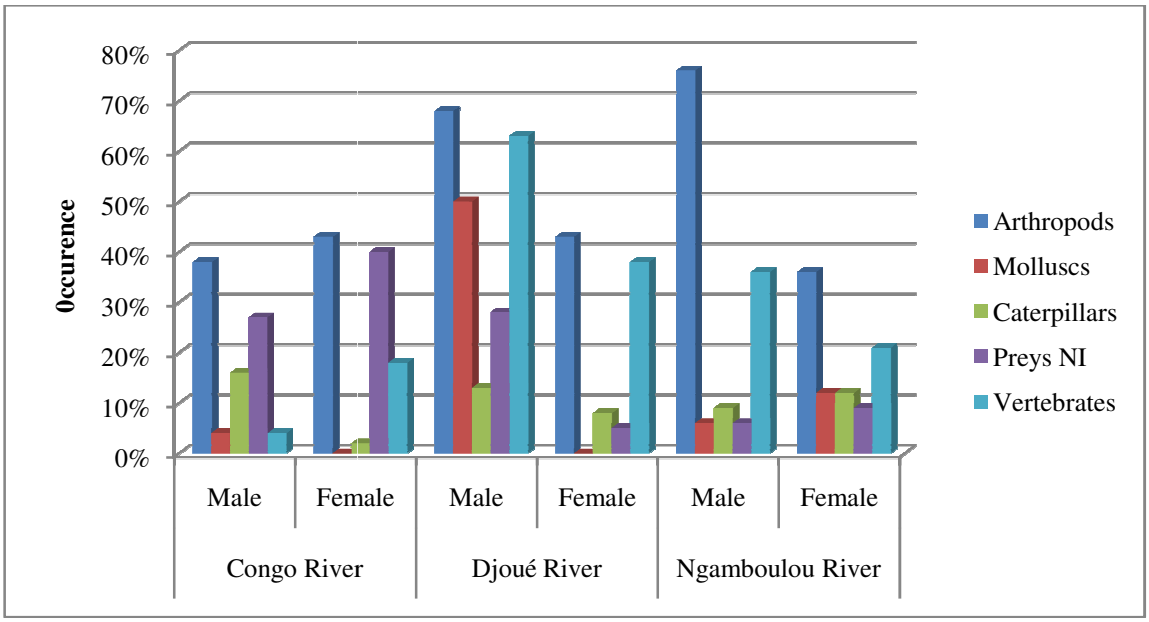
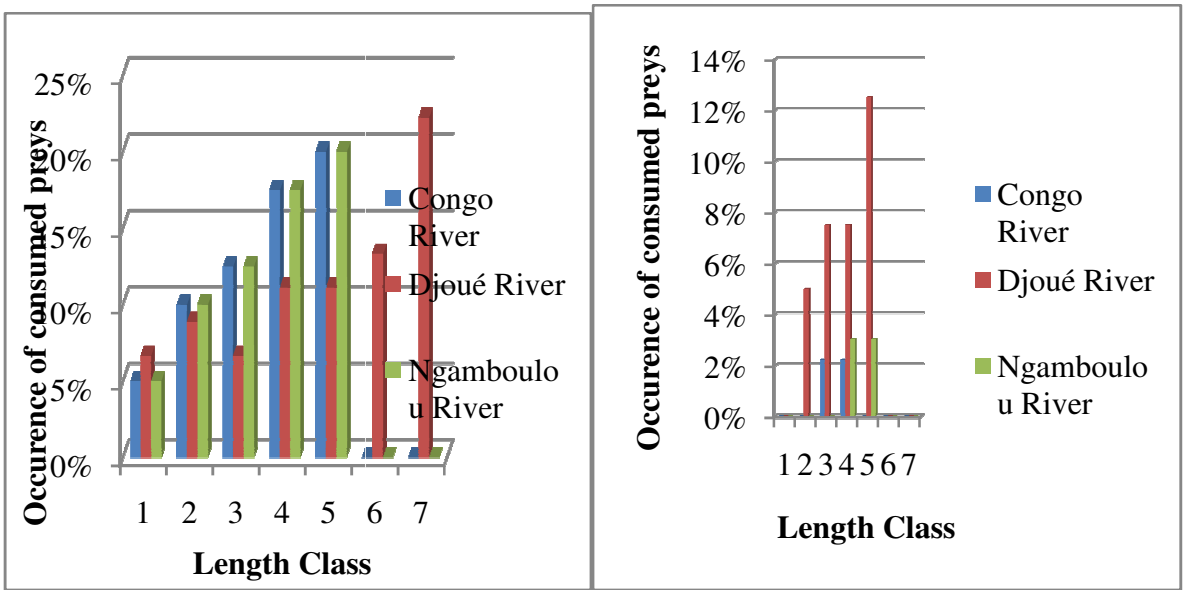


Figure-7
Occurrence of the groups of preys according to the sex NI= Non Identified



A- Arthropods **B- Molluscs**

Figure-8
Occurrences of the 2 groups of preys consumed according to size classes

The preliminary study of the edible frog *Hoplobatrachus occipitalis* of the three rivers of Brazzaville made it possible to note that in the whole the sex-ratio is higher than 1. It is also largely higher among males of Djoué River, (69.04%) and Ngamboulou River (60%) and slightly superior among males of the Congo River (50.9%).

Females are bigger and the maximum of the body length observed (14.54cm) is higher than that of the specimens collected in West Africa which was of 12cm [9]. The maximum weight (350g) is also higher than that of the specimens usually observed in West Africa and Central Africa the maximum weight of which reaches only 130g [2].

The size prevalence of the females is observed in the three sites, and these results are comparable with those obtained in West Africa[9]. In the Congo River, the maximum length and the weight of the body are largely greater than those usually observed in Central Africa. The Congo River presents the largest specimens; this is explained by the great diversity of the preys found in the stomachic contents. In Djoué River and Ngamboulou River, the maximum body length and the maximum weight prevail among females and are comparable with the results observed in West Africa[9].

The comparison of the three studies sites shows that size and weight of frogs are higher in Congo River followed respectively by Ngamboulou River and Djoué River. The difference of the size between frogs of the Congo River and those of the two other sites are important. The difference of size between Congo River and Ngamboulou River is 28mm, that of the Congo River and Djoué River is 45.6 mm and that of Ngamboulou River and Djoué River is 17.6 mm. This difference is explained by the richness or each site deprives of preys. The dietary habit of frogs of the explored sites is characterized by a great diversity of preys, this result is comparable with the results obtained in Kinshasa[13]. This diversity is more important with Congo River and Djoué River which are less anthropised sites than Ngamboulou River which is located in the urban area. However, the frogs of Ngamboulou River have a size higher than those of frogs of Djoué River because in this last site, the ground is rocky with a sparse vegetation. The arthropods remain the group of preys most consumed by frogs of the three sites. We noted the prevalence of the coleopters in the Congo River, molluscs in Djoué River and the dragonflies in Ngamboulou River. On the other hand, a prevalence of the cockroaches was observed[13]. Lastly, the dietary habit of frogs in the three sites varies according to the size and the sex of specimens; the same observations were made by the preceding authors.

Conclusion

The preliminary study of an edible frog (*Hoplobatrachus occipitalis*) very widespread in Brazzaville allowed to study the sex-ratio, the morphometry, and the dietary habit. The sex ratio of frogs of three rivers (Congo River, Djoué River and Ngamboulou River), shows a prevalence of the males; the size of the females is higher than males size. In Congo River, the frogs have big size with a maximum weight of 350g ; those of Djoué River are smaller. The frogs of Ngamboulou River have an intermediate morphometry. The dietary habit of frogs of the three prospected sites is dominated by the arthropods. The preys consumed by frogs of the Djoué River are different from those consumed by frogs of Congo River and Ngamboulou River according to a different environment. The bioecology of *Hoplobatrachus occipitalis,* which is a very widespread edible frog in Congo, must be well controlled because it constitutes a choice model for raniculture, because of its big size and its resistance compared with the others local edible species.

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