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Diversity of Shrews (Soricomorpha: Mammalia) in the Kandolo Forest Reserve (Maniema Province, DR Congo)

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Abstract: ***Our work entitled: Diversity of Shrews (Soricomorpha: Mammalia) in the Kandolo Forest Reserve (Maniema Province, DR Congo) aims to assess the biodiversity of shrews in the Kandolo Forest Reserve while comparing the specific diversity during two capture sessions and in the two prospected habitats Mixed Primary Forest (FPM) and Primary Forest at Gilbertiodendron dewevrei (FPG). Finally, assess the distribution of Shrews in the two habitats (FPG and FPM) prospected by sex. These objectives have been achieved. Only one method was used in the field, the only in-line trapping using two types of traps including Sharmen and Pitfall. After processing the data, the results presented 51 Soricomorphs during our outings. The first capture session carried out in the FPM presents 20 individuals of soricomorphs including: Crocidura cf. littoralis and Scutisorex somereni are the most represented with 6 individuals captured or 30% and Crocidura cf. ludia, Crocidura dolichura and Crocidura hildegardeae which are the least represented with a score of an individual captured, ie 5%. On the other hand, during the second session carried out in the FPG, 31 individuals were captured where Crocidura cf. olivieri is the most represented with 11 carcasses, ie 35.48% and Crocidura caliginea, Crocidura latona and Crocidura ludia are the least represented with a score of one specimen, ie 3.23%. By evaluating the specific richness for the two different habitats, it appears that there is not a significant difference between the stands of Shrews (Kuskal-Walis test, H = 0.082; p = 0.76). Finally, the sex distribution of the shrews captured in the two habitats during the two sessions, it appears that, in all the habitats, the shrews sampled are not distributed equally by sex. On the one hand, males dominate over females in FPG (67.7% of males against 32.3% of females) and on the other hand, females dominate over males in FPM (80% of females against 20% of males).***

Keywords: Biodiversity, Wildlife endemism, Trapping effort, Kandolo Forest Reserve, Democratic Republic of Congo

1. Introduction

The tropical forest presents an animal and vegetable diversity whose high richness is attested by several authors (Dudu et al. 2008b). Unfortunately, these tropical forest ecosystems are very threatened by degradation due to various factors such as regional climate change and the multiple anthropogenic activities which are practiced there (Katuala, 2009; Juakaly, 2007 and Gambalemoke, 2014).

The Democratic Republic of Congo (DRC) is counted among the 17 regions of the world which are home to areas of high biodiversity of flora and fauna (Barriere, 1997b; Gambalemoke et al., 2008a; Masudu et al., 2016). The Kindu region is located in the central Congolese basin of the Congo basin, constitutes one of these pools of mega-biodiversity and wildlife endemism (Asimonyio et al., 2015).

These regions represent, in the collective imagination, the last resort against pollution and against the greenhouse effect because it possesses a great diversity of flora and fauna (World Bank, 2004). Their destruction is causing global anxiety (Eba'Atyi, 2008).

Many species and certain habitat types continue to be threatened with extinction before they are known (Janzen and Vasquez-Yanes, 1991). Thus, the territory of Pangi and the forest reserve of Kandolo located in the Province of Maniema victims of any scientific study and of the demographic growth of the cities and villages which surround them has as obligation, a pioneering study of its biodiversity in order to identify the genera and species of Shrews before any future degradation of the habitats studied.

The present study was conducted during two sessions including: first session (S1 in August 2018) and second session (S2 in September 2018), all during the dry season.

The goals of this study are: to assess the biodiversity of Shrews in the Kandolo Forest Reserve while comparing the specific diversity during the two capture sessions and in the two habitats surveyed including: Mixed primary forest (FPM) and Primary forest at Gilbertiodendron dewevrei (FPG). Finally, compare the distribution of the sexes according to the species caught in the two prospected habitats.

2. Materials and Methods

The biological material consists of 51 Shrews all captured in the Kandolo Forest Reserve. It is a reserve located 37 km from Kalima road towards Kindu in front of Village Pension Biliza (Figure 1).

The in-line trapping method was used with two types of traps installed in combination for the capture of small mammals. In particular the pitfall trap (PF) and Sherman (SH) installed in a 100m transept with a 20-days trap night for the two capture sessions.

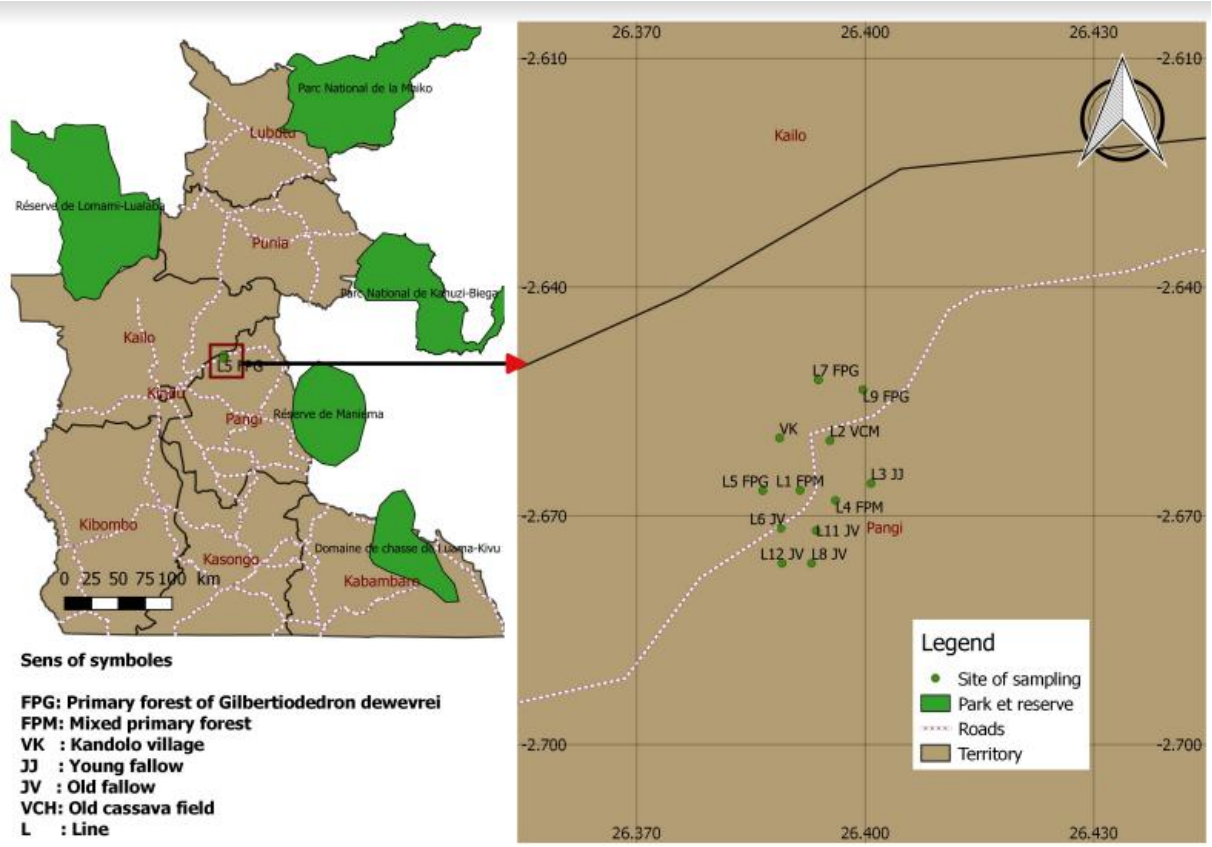

Figure 1: Map of Pangi territory with the research site (Kandolo Forest Reserve)

During the two capture sessions the prospected habitats were made up:

- Primary mixed forest (FPM) with species such as *Gilbertiodendron dewevrei*, *Fagara macrophylla* (Oliv), *Cola gigantea*, *Fagara macrophyla* (Oliv).
- Primary forest at *Gilbertiodendron dewevrei* with a strong dominance of *Gilbertiodendron dewevrei.*

The identification of Shrewswas made on the basis of external morphological characters using the guide of African Mammals (Kingdon, 1997; Kingdon, 2006; Kingdon, 2010) and the identification key of Shrewsin the Kisangani region. Five measurements were taken on each Rodent carcass: body biomass (BMC), ear length (LO), hind foot length (LP), tail length (LQ) and total body length (LT).

The biodiversity indices were calculated by determining the trap success (TS) was deduced from the trapping effort (Ep = Nn x Np, where Nn is the number of trapping nights and Np is the number of traps), trapping success (TS = N / Ep x 100, where N is the number of Shrews captured) and relative abundance or frequency of each species (i.e. the percentage of individuals of a species out of the total number of individuals captured) were calculated per habitat. In addition, the Shannon-Wiener alpha index (Ha), specific richness (RS) of Shrews stands in a given habitat, while the beta index (Hß) made it possible to compare the populations of Shrews caught in two different habitats (young secondary forest and young fallow).

The Shannon-Wiener index is suitable for the comparative study of SR since it is relatively independent of the sample size. It varies directly depending on the number of species and the numbers observed. Rare species weigh much less than the most common species.

The formulas used to calculate (Ha), (Hß), the Fairness Index (E) are taken from Ramade (1984).

(1) $H_a = -\sum_{i=1}^{s} p_i Log_2 p_i$

(a) Ha = alpha index of biological diversity

(b) $p_i = \frac{n_i}{N}$, it is the probability of meeting the species which occupies an ième rank.

(c) N = total number of individuals caught and (ni) = number of specimens of the ith species in the sample studied.

(2) $H' = Log_2 S$

(d) (H ') = evenly distributed or maximum Fairness index, which corresponds to the case where all species are represented by the same number of individuals.

(e) S = total specific wealth

(3) $E = \frac{H_a}{H'}$

(f) (E) = Fairness index which varies between 0 and 1. It tends towards zero, when almost all the numbers correspond

to a single species of the stand and it tends towards 1, when each of the species is represented by the same number of individuals.

(5) $H_b = H_{a(1,2)} - 0{,}5(H_1 + H_2)$

(g) (Hß) = interbiotop similarity index (interhabitat); it makes it possible to measure the difference between two stands which colonize two neighboring biotopes; (Hß) tends to zero, when the 2 stands are identical and (Hß) tends to 1, when the 2 stands are entirely different (no common species); Ha (1,2) is Shannon-Wiener's alpha index for samples 1 and 2 combined.

Finally, the results were compared by a series of analyzes using the statistical test such as the Kuskal-Walis Test H, which makes it possible to compare the distribution of Shrews by catching session and by habitat type, respectively. If necessary, the post hoc test (Tukey or Mann-Whitney Pairwise Comparisons) was used (when p <0.05), to determine the habitat pairs showing significant differences.

3. Results

3.1 Stand composition

The results that we present in this work concern the harvests made in the two habitats (FPM and FPG) prospected during two sessions (S1 and S2) all in the dry season in the Kandolo Forest Reserve located in the Territory of Pangi, Province of Maniema in DR Congo. This is a total of the 51 Soricomorphs presented in detail in the following tables:

Table.3.1: Shrews captured in both habitats (FPG and FPM) during the two capture sessions (Session 1 and 2)

		Habitats		
No	*Species*	*FPG*	*FPM*	*Total*
1	*Crocidura caliginea*	1	0	1
2	*Crocidura* cf. *littoralis*	9	6	15
3	*Crocidura* cf. *ludia*	0	1	1
4	*Crocidura* cf. *olivieri*	11	5	16
5	*Crocidura dolichura*	0	1	1
6	*Crocidura hildegardeae*	3	1	4
7	*Crocidura latona*	1	0	1
8	*Crocidura ludia*	1	0	1
9	*Scutisorex somereni*	5	6	11
	Grand total	**31**	**20**	**51**
	Number of traps	80	80	160
	Trapping effort (Ep)	1600	1600	3200
	Trapping success(Ts)	1,94	1,25	1,59
	Specific	7	6	9
	Simpson_1-D	0,7513	0,75	
	Fairness	0,8116	0,8474	
Test of Kruskal-Wallis		H = 0,082 et p = 0,76		

It emerges from the table. 3.1 that: Of the 20 individuals of soricomorphs captured in the FPM at the first capture session, *Crocidura* cf. *littoralis* and *Scutisorex somereni* are the most represented with 6 individuals captured, ie 30% followed by *Crocidura olivieri* with 5 individuals, ie 25%. On the other hand, *Crocidura* cf *ludia*, *Crocidura dolichura* and *Crocidura hildegardeae* are the least represented with a score of an individual captured, ie 5%.

Also, out of the 31 shrews carcasses captured in the FPG during the second capture session, *Crocidura* cf. *olivieri* is the most captured with 11 individuals captured, ie 35.48% followed by *Crocidura* cf. *littoralis* with 9 individuals captured, or 29.03%. In contrast, *Crocidura caliginea*, *Crocidura latona* and *Crocidura ludia* are the least represented with a score of one specimen, namely 3.23%.

In addition, in the FPG is the best represented quantitatively and qualitatively (31 specimens, TS = 1.94%, Ep = 1600 trap nights, Ep = 1600). *Crocidura* cf. *olivieri* which ranks first with 11 individuals out of 31 and qualitatively with 7 species caught. Different from the FPM which occupies the second position (20 specimens, TS = 1.25%, EC = 1600 trap nights) with 6 species caught.

Then, for the indices of specific diversity, it appears that, in the two habitats there is the probability of randomly drawing 2 individuals to have 2 different species because Simpson tends to1 everywhere. And in the two habitats, the species are not evenly distributed.

Finally, the specific richness evaluated at the level of the two different habitats reveals that there is not a significant difference between the stands of Shrews (Kuskal-Walis test, H = 0.082; p = 0.76).

3.2 Distribution of Shrews captured in the two habitats by sex

Table 3.2: Distribution of Shrews captured in the Kandolo RF by sex

		FPG					FPM						
N°	**Species**	**F**	**M**	**Tot FPG**	**%F**	**%M**	**F**	**M**	**Tot FPM**	**%F**	**%M**	TG	**Ar**
1	*Crocidura caliginea*	1	0	1	100	0	0	0	0	0	0	1	**1,96**
2	*Crocidura cf. littoralis*	0	9	9	0	100	4	2	6	66,7	33	15	**29,41**
3	*Crocidura cf. ludia*	0	0	0	0	0	1	0	1	100	0	1	**1,96**
4	*Crocidura cf. olivieri*	5	6	11	45,5	54,5	4	1	5	80	20	16	**31,37**
5	*Crocidura dolichura*	0	0	0	0	0	1	0	1	100	0	1	**1,96**
6	*Crocidura hildegardeae*	2	1	3	66,7	33,3	1	0	1	0	100	4	**7,84**
7	*Crocidura latona*	1	0	1	100	0	0	0	0	0	0	1	**1,96**
8	*Crocidura ludia*	1	0	1	100	0	0	0	0	0	0	1	**1,96**
9	*Scutisorex somereni*	0	5	5	0	100	5	1	6	83,3	17	11	**21,57**
	Grand total	**10**	**21**	**31**			**16**	**4**	**20**			**51**	**100,00**
	Specific wealth	**7**					**6**					**9**	

Legend: FPG = primary forest at *Gilbertiodendron dewevrei*; FPM = mixed primary forest; F = female; M = male; Tot = total; TG = grand total; % = percentage, Ar = Relative abundance.

Table (3.2) shows that in all the habitats, the Shrews sampled are not evenly distributed by sex.

On the one hand, males dominate over females in FPG (67.7% of males against 32.3% of females) and on the other hand, females dominate over males in FPM (80% of females against 20% of males).

Also, in each habitat, limiting ourselves to the best represented species, the numbers of males dominate those of females especially in FPG (54.5% of males against 45.5% of females for *Crocidura* cf. *olivieri* followed by *Crocidura* cf. *littoralis* with 100% of males and 0% of females and *Scutisorex somereni* with 100% of males and 0% of females). On the other hand for the FPM, the females dominate the males for the most represented species with successive scores of 80% of the females against 20 of the males for *Crocidura* cf. *olivieri* followed by *Crocidura* cf. *littoralis* with 66.7% of females against 33% of males and 83.3% of females against 16.6% of males in *Scutisorex somereni*

4. Conclusion

At the end of our study entitled: Diversity of Shrews (Soricomorpha: Mammalia) in the Kandolo Forest Reserve (Prov du Maniema, DR Congo) we have reached our objective; that of comparing the specific diversity during the two capture sessions and in the two prospected habitats Mixed Primary Forest (FPM and Primary Forest at *Gilbertiodendron dewevrei* (FPG). Finally, evaluate the distribution of shrews in the two habitats (FPG and FPM) prospected by gender.

From our investigations, we draw the following conclusions:

The results provided a total of 51 individuals captured in the two prospected habitats.

During the two capture sessions, the following emerges:

During the first capture session carried out in the FPM, a total of 20 individuals of shrews including: *Crocidura* cf. *littoralis* and *Scutisorex somereni* are the most represented with 6 individuals captured or 30% followed by *Crocidura olivieri* with 5 individuals captured or 25% and *Crocidura* cf *ludia*, *Crocidura dolichura* and *Crocidura hildegardeae* which are the least represented with a score of an individual captured either 5%.

On the other hand, during the second release which took place in the FPG, it emerges the following:

For the 31 individuals captured, *Crocidura* cf. *olivieri* is the most represented with 11 carcasses, or 35.48% followed by *Crocidura* cf. *littoralis* with 9 individuals (29.03%) and *Scutisorex somereni* with 5 individuals captured (16.13%). On the other hand *Crocidura caliginea*, *Crocidura latona* and *Crocidura ludia* are the least represented with a specimen, ie 3.23%.

In comparison with habitats and capture sessions, the following is concluded:

The FPG is the best represented quantitatively (31 specimens, TS = 1.94%, Ep = 1600 trap nights with a specific richness of the 7 species with *Crocidura* cf. *olivieri* which occupies the first rank, with 11 individuals out of 31 specimens captured) . Different from the FPM which occupies the second position (20 specimens, TS = 1.25%, EC = 1600 trap nights with a specific richness of the 6 species with *Crocidura* cf. *littoralis* and *Scutisorex somereni* which dominate with 6 individuals out of the 20 captured).

But for the indices of specific diversity, it should be noted that in the two habitats there is the probability of randomly picking 2 individuals to have 2 different species because Simpson tends to 1 everywhere. And the two habitats are fairly distributed because equitable tends to 1 for the two habitats.

Then, the analysis of variances indicates that the 2 habitats show that there is not a significant difference between the stands of Shrews (Kuskal-Walis test, H = 0.082; p = 0.76).

Finally, for the evaluation of the sexes, the results show that, on the one hand, it is the males who dominate over the females in FPG (67.7% of the males against 32.3% of the females) and on the other On the other hand, females dominate over males in FPM (80% of females against 20% of males).

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