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Research Paper

Diversity and distribution of Microchiroptera along the Mega-Transect in the Yangambi Biosphere Reserve (D.R. Congo)

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Abstract
This study examines the diversity and distribution of Microchiroptera in the Yangambi Biosphere Reserve (RBY), in the Democratic Republic of Congo. Sampling was carried out at three separate site (BondeMoke, Ikoo and Mawate) along the mega-transect. A total of 23 species divided into 16 genera and 5 families were recorded. Analysis of the Shannon and Simpson diversity indices shows an equitable distribution of species. The presence of species specific to certain habitats suggests ecological adaptation. These results underline the importance of conserving Microchiroptera biodiversity in the region.

***Keywords:* Microchiroptera, diversity, distribution, ecology, Yangambi, D.R. Congo**

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I. Introduction

Microchiroptera play a crucial role in tropical ecosystems, in particular by regulating insect populations and helping to disperse seeds (Michael 1984; Zerguini 2013). However, their distribution and diversity remain poorly documented in the Democratic Republic of Congo. This study aims to analyse the diversity and distribution of Microchiroptera along the mega-transect in the Yangambi Biosphere Reserve (RBY).
The main aim of this study is to assess the specific diversity and relative abundance of Microchiroptera in three contrasting sites in the reserve, in order to gain a better understanding of their spatial distribution.

II. Material and Methods

Study area

The present study was carried out in the Yangambi Biosphere Reserve (RBY) in the Democratic Republic of Congo, more precisely along the mega-transect in 3 different sites: Bondemoke, Iko and Mawate (Figure 1). These three sites present different environmental conditions that change progressively from one site to another, depending on vegetation density, human pressure and species diversity. All three Sites are primary forests, and anthropisation along the mega-transect decreases as one moves away from areas of human habitation:

- Bonde-moke: This site is a little closer to human settlements than Ikoo, which means that its degree of anthropisation is greater than that of the other two sites, given its proximity to human activities.
- Ikoo: Located between Bonde-Moke and Mawate, its degree of anthropisation is moderate, as it is some distance from inhabited areas.
- Mawate: This site is relatively far from human settlements and is also some distance from Ikoo and Bonde. Because of this distance, it is less influenced by human activity, making it a low anthropisation site.

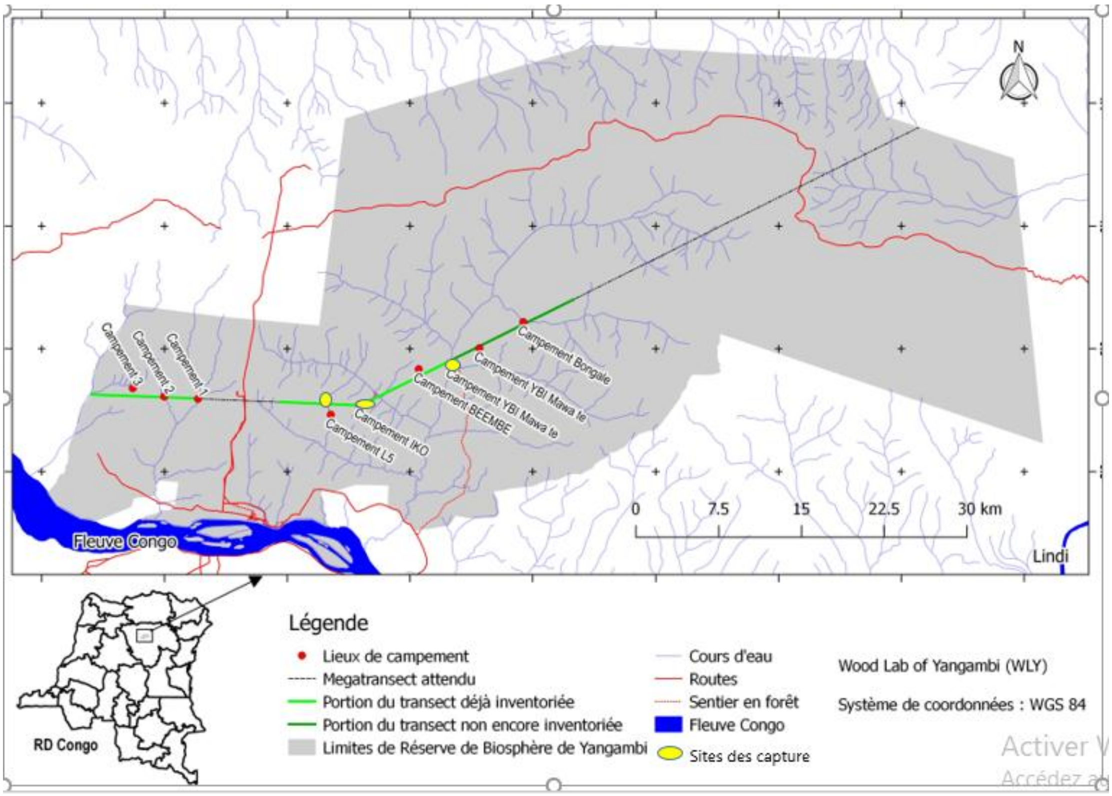

Figure 1. Location of the RBY and sampling points along the Mega-transect.

Biological material

Microchiroptera are the biological material of this study (Figure 2).

Figure 2. Microchiroptera captured in the RBY

Methods

Data collection

Data was collected from May to December 2023. We spent 15 days collecting data at each site. Each site represented a distinct habitat. We divided each site into 6 botanical and zoological sampling lines. We laid out the botanical plots using all the principles and techniques that respect the 'non-destructive methods' for sampling Microchiroptera and to preserve as much as possible of the physiognomy of the vegetation around the permanent mega-transect. We then divided each site into 6 botanical sampling lines, laid out over a distance of 1000 m. On each line, 3 botanical plots were installed. This gives a total of 18 plots per site for the botanical survey. Each plot was 5 metres wide and 20 metres long, giving a surface area of 100 m² per plot. To characterise the structure and composition of the habitats, a dendrometric survey was carried out in each plot. For each plot, all trees, shrubs and lianas with a diameter at breast height (DBH) greater than or equal to 5 cm were measured using a dendrometric tape.

Sampling of Microchiroptera was structured on the undergrowth and arboreal forest substrates by combining capture with 6 mist nets and 2 harp traps for each site. We then laid out 6 lines per site, and each line included a plot for setting the traps. These plots were placed opposite each other at a distance of 200 m (Figure 3).

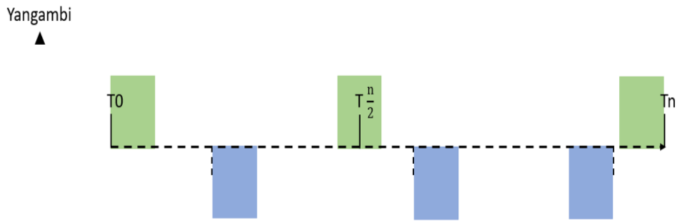

Figure 3. Chiroptera sampling plan

The nets remained in place from 6pm to 6am. Capture was organised on three consecutive nights in the early evening (18:00-22:00), near midnight (22:00-23:00) and near morning (05:00-06:00).
In the laboratory, the captured chiropterans were returned to the field laboratory in a ventilated cloth bag in the dark, where they were subjected to various biometric measurements. To avoid stress during handling (Powell and Proulx, 2003), we excluded pregnant females from all measurements and used photographs only. Pesola (20 g, 50 g, 100 g and 300 g) was used to help determine the individual's weight. The calipers were used to measure the length of the forearm, tibia, wingspan, pinna and tragus. A CANON camera was used to take photos of the captured specimens. In order to facilitate the identification of taxa in situ, we used the identification key from (Patterson and Webala, 2012). Tissue was preserved in absolute ethanol for molecular identification. Suggested Microchiroptera handling techniques were in accordance with ethical guidelines approved by the American Society of Mammalogists Animal Care and Use Committee (Sikes, 2016).

Data analysis

Shannon (H') and Simpson (D) diversity indices were calculated for each site to assess species richness and community equitability. A principal component analysis (PCA) was carried out to explore the relationships between species and sampling sites.

III. Results

Systematic position of Microchiroptera species captured.

The systematic position of the Microchiroptera species captured during this study is presented in this section, in order to provide a clear taxonomic classification and to illustrate their diversity within the Yangambi Biosphere Reserve (Table 1).

Table 1: Systematic position of Microchiroptera species caught

Suborder	**Family**	**Genres**	**Species**
Microchiroptera	Hipposideridae	Doryrhina	*Doryrhina cyclops (*Temminck 1853)
		Hipposideros	*Hipposiderosbeatus (*Thomas 1905)
			*Hipposideroscaffer (*Sundevall 1842)
		Macronycteris	*Macronycteris gigas (*Wilhelm 1852)
	Megadermatidae	Lavia	*Laviafrons (*Temminck 1823)
	Nycteridae	Nycteris	*Nycterissp*
	Rhinolophidae	Rhinolophus	*Rhinolophussp*
	Vespertilionidae	Afronycteris	*Afronycteris nana (*Thomas 1905)
			Afronycterissp
		Eptesicus	*Eptesicussp*
		Glauconycteris	*Glauconycteriscurryae (*Williamerguson 1959)
			Glauconycterissp
			*Glauconycterishumeralis (*Williamerguson 1959)
			*Glauconycterissuperba (*Williamerguson 1959)
		Kerivoula	*Kerivoulasp*
		Mimetillus	*Mimetillussp*
			*Mimetillusmoloneyi (*Dobson en 1876)
		Myotis	*Myotissp*
		Neoromicia	*Neoromiciasp*
			*Neoromiciatennuipinis(*Temminck 1853)
		Scotophilus	*Scotophilusdinganii (*Smith en 1833)

			Scotophilussp
		Vesper	*Vespersp*
TOTAL	**5**	**16**	**23**

Table 1 shows that a total of 23 species of Microchiroptera were captured. These species are divided into 16 genera and 5 families, including Hipposideridae, Megadermatidae, Nycteridae, Rhinolophidae and Vespertilionidae.

Microchiroptera species present in each site sampled/ Species diversity and ecological indices

The following results present the Microchiroptera species recorded at each site sampled, as well as their abundance and diversity, in order to better understand their distribution and variability in the habitats studied (Table 2).

Table 2: Microchiroptera species present at each site sampled.

species	**Bonde Moke**	**Ikoo**	**Mawate**	**TOT**	**RA(%)**
Afronycteris nana	0	0	19	19	11,5
Afronycterissp	14	16	1	31	18,9
Doryrhina cyclops	3	1	3	7	4,2
Eptesicussp	0	0	1	1	0,6
Glauconycteriscurryae	0	2	0	2	1,2
Glauconycterishumeralis	0	1	0	1	0,6
Glauconycterissp	6	11	5	22	13,4
Glauconycterissuperba	1	2	1	4	2,4
Hipposiderosbeatus	3	8	6	17	10,3
Hipposideroscaffer	9	2	7	18	10,9
Kerivoulasp	0	2	2	4	2,4
Laviafrons	0	1	0	1	0,6
Macronycteris gigas	9	1	0	10	6
Mimetillusmoloneyi	1	0	0	1	0,6
Mimetilussp	0	0	1	1	0,6
Myotissp	1	2	0	3	1,8
Neoromiciasp	3	1	0	4	2,4
Neoromiciatennuipinis	1	0	0	1	0,6
Nycterissp	0	1	0	1	0,6
Rhinolophussp	0	0	1	1	0,6
Scotophilusdinganii	1	1	10	12	7,3
Scotophilussp	0	0	1	1	0,6
Vespersp	1	0	1	2	1,2
General total	**53**	**52**	**59**	**164**	100
Taxa_S	13	15	14	23	
Dominance_D	0,152	0,17	0,1698	0,104	
Simpson_1-D	0,848	0,83	0,8302	0,896	
Shannon_H	2,138	2,14	2,11	2,54	
Equitability_J	0,8334	0,79	0,7996	0,81	

Le tableau (2) présente la liste des 164 Microchiroptera capturés sur les 3 sites le long du Mega-transect à Yangambi. Au total, nous avons une richesse en espèces de 23 pour les 3 sites. 12 espèces étaient présentes sur les 3 sites, mais 2 espèces, dont Mimetillusmoloneyi et Neoromiciatennuipinis, n'étaient présentes qu'à Bonde Moke. 4 speciesincludingGlauconycteriscurryae, Glauconycterishumeralis, Laviafrons and Nycterissp are presentonly at Ikoo. 5 speciesincludingAfronycteris nana, Epesicussp, Mimetilussp, Scotophilussp and Rhinolophussp are presentonly at Mawate. The dominance index shows that there is no species dominance at any of the sites. The probability that two randomly selected individuals belong to different species is 84% at Bondemoke, 83% at Ikoo and 83% at Mawate (1-D tends towards 1 for all 3 sites), so we observe greater diversity in our 3 sampled sites. The equitability index shows that the species are evenly distributed across the 3 sites.

Sex ratio

Of the 164 individuals caught, 55.48% were males and 44.51% females; males were the most abundant with 91 individuals (79 individuals with visible scrotum and 12 juveniles), followed by females with 73 individuals (59 multiparous females, 11 pregnant females and 3 nursing females). The proportion of males was higher than that of females during the sampling period (sex ratio male/female=1 : 0.7).

Distribution of species caught according to collection sites using Principal Component Analysis (PCA)

The main objective of the graph is to highlight the association between the species caught and their sites using Principal Component Analysis (PCA). (Figure4).

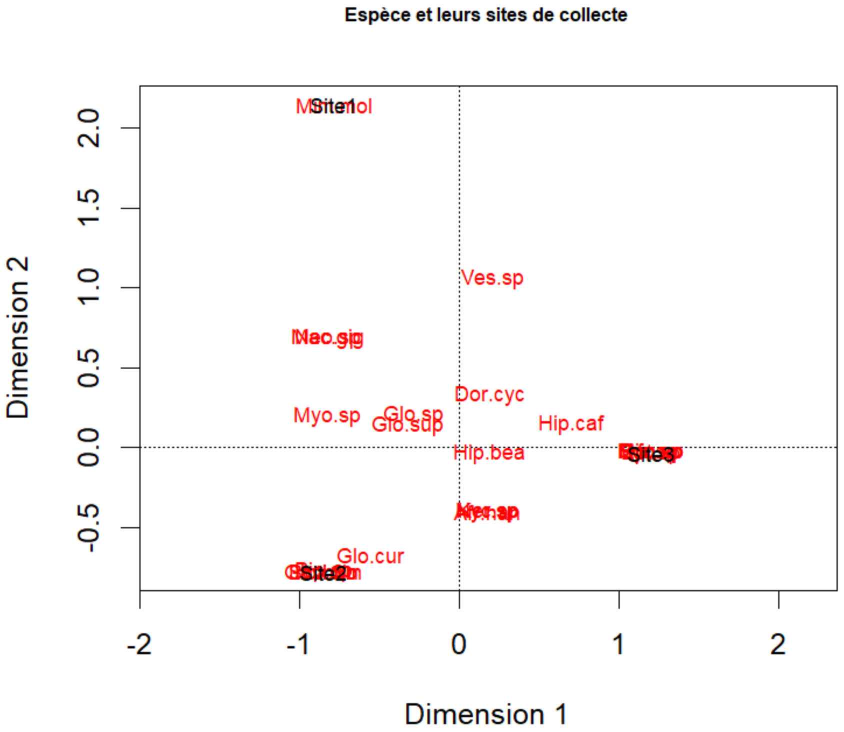

Figure 4: Distribution of Captured Species by Collection Site using ACP

Figure 4 shows that:

- Species such as Hipposiderosbeatus, Hipposideroscaffer and Doryrina cyclops are close to the origin. This means that they have a homogeneous distribution between the different Sites and are not strongly associated with a single dimension.
- Eptesicussp, Vesper sp: Very different from the other species. It is specific to a single site
- o Glauconycteris.curryae, Glauconycterissp, and Myotis.sp: These species are strongly associated with the same site. The close grouping indicates a high degree of similarity between them.
- o Species positioned on opposite sides of the axes (e.g. Mimetillussp vs. Glauconycteriscurryae) have very different profiles.

In conclusion, analysis of the data revealed that certain species were specific to certain habitats:

- Afronycteris nana dominated at Mawate, a Sitefar from human settlements and not anthropised.
- Glauconycterissp was more abundant at Ikoo, where human settlement is moderate.
- Hipposiderosbeatus and Hipposideroscaffer were present at all sites, indicating high ecological tolerance.

IV. Discussion

The high species richness (23 species) is evenly distributed between the sites, with no marked dominance**.**

This equitable distribution is explained by the diversity of microhabitats available in the Yangambi Biosphere Reserve. The coexistence of multiple species on similar territories indicates a partitioning of acoustic and feeding niches (Kunz &Lumsden, 2003). For example, Afronycteris nana, which is dominant in Mawate, could use different frequencies from those of Glauconycterissp observed in Ikoo, limiting direct competition (Schnitzler et al., 2003).

Species diversity and even distribution illustrate an effective partitioning of ecological niches in the reserve, favouring the coexistence of species. The diversity indices (Shannon and Simpson) reveal a high level of specific diversity at the three sites sampled.

These indices confirm the key role of tropical forests in maintaining Microchiroptera biodiversity, as reported by Hutson et al. (2001). Diversity is favoured by the variety of niches available, reinforced by the complex interactions between vegetation and prey. This result highlights the sensitivity of Microchiroptera to habitat modifications, a crucial aspect for their conservation.

In short, the high diversity indices show the importance of forest habitats for the survival of Microchiroptera and underline the need to conserve these ecosystems.

V. Conclusion and outlook

This research highlights a high level of species richness and a structured distribution of Microchiroptera according to habitat. The diversity observed in the RBY highlights the importance of preserving these ecosystems in order to maintain this unique biodiversity. The results also suggest that targeted conservation efforts, taking account of habitat diversity, are crucial to the sustainable management of the Yangambi Biosphere Reserve.

Further analysis of population dynamics and interspecific interactions would be required to expand on this study. The impact of human activities, such as agriculture and deforestation, on Microchiroptera in this region could also be an important area of research in order to better understand the threats to these populations.

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