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Diversity of bats in the city of Ouagadougou (Burkina Faso)

Napoko Malika Kangoyé*, Wend Payãgdé Jean De Dieu Sawadogo, Winkom Noellie Kpoda, Noel Gabiliga Thiombiano, Adama Oueda

Laboratoire de Biologie et Ecologie Animales, UFR/SVT, Université Joseph KI-ZERBO, Burkina Faso, 03 BP 7021 Ouagadougou 03. Burkina Faso

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Abstract

Bats are often observed in the city of Ouagadougou; they are found in homes, offices and open spaces, especially under large trees. They are consumed as bushmeat and used by Traditional Medical Practitioners. In the context of re-emerging zoonosis, it is important to produce comprehensive knowledge about problematic species such as a bat. Then, the aim of this study is to produce reliable information about bat diversity and its distribution in the city of Ouagadougou. To achieve this goal, bats were captured in the city of Ouagadougou from July to November 2017 using a mist net in 15 stations. Eleven species belonging to nine genera and four families (Molossidae, Nyteridae, Pteropodidae and Vespertilionidae) have been inventoried. While *Eidolon helvum* is the most observable species in the city of Ouagadougou, *Epomophorus gambianus*, *Scotophilus leucogaster* and *Nycticeinops schlieffenii* are the most occurring species in samples. Kamboinse, Kossodo and Premier Ministère are the sites with the highest species diversity.

* **Corresponding Author:** Kangoyé Napoko Malika ✉ kangoyemalika@yahoo.fr

Introduction

Bats are the only mammals capable of active flight, representing about a quarter of all terrestrial mammals, with about 1435 species listed (Simmons and Cirranello, 2020). Africa records 17 families, 80 genera and 392 species of bats, among which four families, 24 genera and 53 species are extinct (African Chiroptera Report, 2020). Bats have ecological and economic importance (Kasso and Balakrishnan, 2013). Despite their different role, bats can be an important reservoir of emerging viruses (Calisher *et al.*, 2006). The consumption of bats and, therefore, their handling could lead to a potential risk of disease transmission to humans and animals.

Several species of bats are present in Burkina Faso. Fifty-two (52) species have been identified (Kangoyé *et al.*, 2015; Thiombiano *et al.*, 2021). In the site of Ouagadougou, Koopman *et al.* (1978) reported two species, Koch-Weser (1984) reported three species. After these studies, Kangoyé *et al.* (2015) reported 51 species of bats for Burkina Faso, with six species captured in Ouagadougou including five in the urban park Bangr-Weoogo. Then, from the first studies on bats in Burkina Faso six species are reported from the city of Ouagadougou (*Eidolon helvum* (Kerr, 1792), *Epomophorus gambianus* (Ogilby, 1835), *Laephotis guineensis* (Bocage, 1889), *Pipistrellus nanulus* Thomas, 1904, *Pipistrellus rusticus* (Tomes, 1861) and *Scotophilus leucogaster* (Cretzschmar, 1826). It is clear from all this information that no study to cover the entire city of Ouaggougou has been conducted. Given the species present in Burkina Faso, we hypothesized that several other species could be captured if a more extensive sampling is done throughout the city. We also noted that Ouagadougou knows the presence of bats in several places, especially in the rainy season, where several colonies can be encountered. Several restaurants offer bat meat on their menu. Bat specimens are also used in traditional medicine throughout the city. We can therefore say that a certain part of the population of the city of Ouagadougou gives particular importance to these species. In order to protect the population of the city of Ouagadougou from the resurgence of certain re-emerging diseases, including Ebola and coronavirus, and to preserve bat populations for better conservation of biodiversity, it was more than necessary to figure out the diversity and distribution of bats in the city of Ouagadougou.

Material and methods

Study site

This study took place in the city of Ouagadougou, the capital of Burkina Faso (Fig. 1.). It is the biggest city in Burkina Faso. It is located between 12°21'58" North latitude and 1°31'05" West longitude. It has an area of 2,805 km². In 2020, its population was estimated at 2 684 052 inhabitants (INSD, 2021). The primary vegetation of the city has undergone a clear degradation. Only species considered useful by the population like *Vittelaria paradoxa* C. F. Gaertn., and *Lannea microcorpa* Engl. & Krause have been spared or preserved. Some fruit and non-fruit species such as *Mangifera indica* L., *Eucalyptus globulus* Labill., *Anacardium occidentale* L., and *Khaya senegalensis* (Desr.) A. Juss. have been planted in or around the concessions and along the streets. Most of these plants are used as a shelter for bats and fruits as food for fruit eaters. Ouagadougou is under the northern Sudanian climate, with two seasons: a rainy season from May to September and a dry season from October to April. The average rainfall is 740 mm with large inter-annual variability. Its average temperature is 24.2°C with large average diurnal thermal amplitudes that can exceed 13°C.

Sample collection

Bat collection was done using nylon or polyester Vohwinkel mist nets (length: 6 m or 12 m, height: 2.80 m, 5 stages, mesh size: 16 mm, denier 70/2) from July to November 2017. The nets were set up and opened from 6 p.m. to 12 a.m., according to the activities of bats. Sampled sites were georeferenced using a Garmin etrex 10 GPS. The nets were visited regularly to remove captured bats according to capture intensity. Each captured bat was placed individually in a cotton capture bag. Each bat was then weighed with a Pesola weighing machine with an accuracy of 0.25 g, 1 g or 2 g depending on the size of

the specimen. Bat forearm was measured with a Mahr caliper 16U with an accuracy of 0.1 mm. Recorded parameters were sex (male, female), age (juvenile, sub-adult, adult) following Antony (1988) and reproductive status following Racey (1988). The reproductive status of males (reproductive or non-reproductive) was determined by testicular size. The reproductive status of females (nulliparous, pregnant, lactating, or post-lactating) was determined by abdominal palpation, observation and mammary traction. Bats were therefore identified using the keys of Rosevear (1965), Hayman and Hill (1971) and the compilation of Bergmans (2002). Once identified, bats were released on site. Only a few specimens and animals that are difficult to identify in the field are sacrificed with ether and preserved in 70° alcohol. Body measurement (accuracy 0.1 mm) and cranial measurements (accuracy 0.01 mm) were conducted on these specimens. The cranial measurements were performed under a stereomicroscope Leica MZ8.

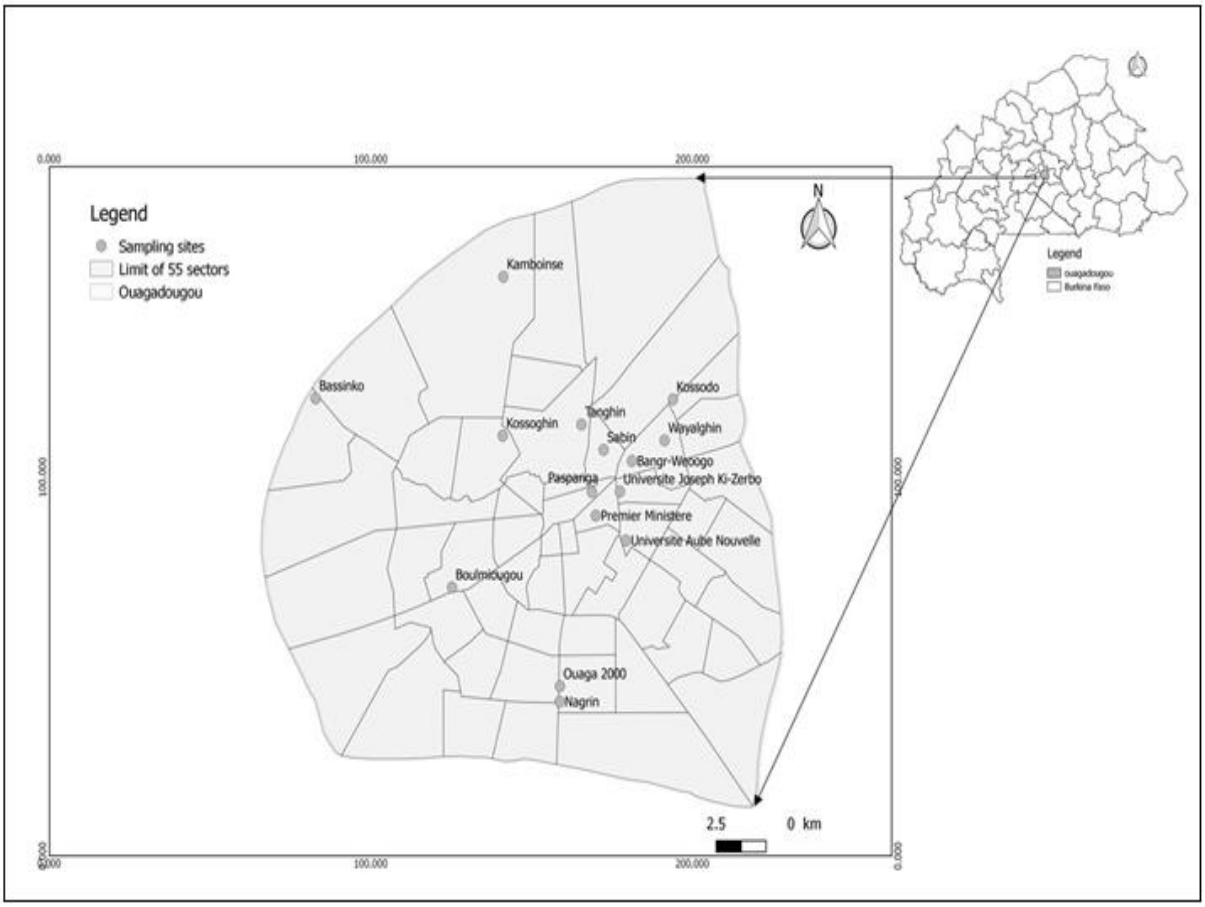

Fig. 1. Bats capture sites.

Data analysis

The analysis of bats' community structure was based on taxonomic richness, the Shannon-Weaver diversity index and the Piélou evenness index. The Shannon diversity index was used to estimate the taxonomic diversity. It is calculated following the above formula (1), where q*i* is the number of individuals of species i and Q is the total number of individuals:

$$H' = -\sum_{i=1}^{s}[(\frac{q_i}{Q})\log_2(\frac{q_i}{Q})] \qquad \text{Formula (1)}$$

The Piélou Index of evenness (E) was used to measure the regularity of species distribution following the formula (2). It varies from 0 (when a species dominates the whole stand) to 1 (when the species are equi-frequent and their abundance is identical). It is obtained by the formula:

$$E = \frac{H'}{\log_2 S} \qquad \text{Formula (2)}$$

Statistical analysis of the data was carried out with

the R. 4.1.0 statistical software.

Results

Bats diversity and abundance

In this study, 523 bat specimens were captured. They belong to 11 species and four families (Table 1). Insectivorous represent 81.82% of the species inventoried. They include nine species represented by three families (Molossidae, Nycteridae and Vespertilionidae). Frugivorous represent 18.18% of the species inventoried. They include two species of the family of Pteropodidae. Despite the colonies of thousands of individuals observed in the city, no specimen of *E. helvum* was caught with the mist net during the sampling. The specimens included in this study (4) were given to us by an adolescent that shot them using a slingshot. Among these four individuals, there are two adult females (post-lactating) and two adult males (one non-reproductive and one reproductive). Fig. 2 shows bat abundance by family in Ouagadougou. Then, Pteropodidae is the most abundant family, followed by Vespertilionidae and Molossidae. Nycteridae is a less abundant family.

The species are unevenly distributed over all the catch sites. *Epomophorus gambianus*, *S. leucogaster* and *N. schleiffenii* are the most occurring species. Indeed, they are found in more than 60% of the sites. *Pipistrellus nanulus* is recorded in 47% of the sites. *Laephotis guineensis* occupies 33% of the sites. *Laephtotis rendalli* occupies 27% of the sites. *Mops pumilus* and *L. nanus* are found in 20% of the sites. *Eidolon helvum, N. macrotis* and *M. condylurus* occur in 7% of the sites in the city of Ouagadougou.

Table 1. Species abundance by sex, age and reproductive status.

		Female					Male			IND	
		SAD	AD				SAD	AD		JUV.	
Family	Species	NUL	NUL	P	AL	PL	NR	NR	R		Total
Pteropodidae	*Eidolon helvum* (Kerr, 1792)	0	0	0	0	2	0	1	1	0	4
	Epomophorus gambianus (Ogilby, 1835)	48	72	0	11	71	47	59	33	5	346
Molossidae	*Mops condylurus* (A. Smith, 1833)	0	4	6	0	1	0	5	8	0	24
	Mops pumilus (Cretzschmar, 1826)	0	1	2	0	0	0	2	0	0	5
Nycteridae	*Nycteris macrotis* Dobson, 1876	0	0	0	0	0	0	1	1	0	2
Vespertilionidae	*Laephotis guineensis* (Bocage, 1889)	0	3	0	0	4	0	11	1	0	19
	Laephotis nanus (Peters, 1852)	0	1	0	0	0	0	2	0	0	3
	Laephotis rendalli (Thomas, 1889)	0	1	0	0	0	0	4	0	0	5
	Nycticeinops schlieffenii (Peters, 1859)	0	7	0	0	5	0	5	2	0	19
	Pipistrellus nanulus Thomas, 1904	0	13	0	0	5	0	15	4	0	37
	Scotophilus leucogaster (Cretzschmar, 1826)	0	23	0	0	9	0	19	8	0	59
	Total	48	125	8	11	97	47	124	58	5	523

IND.: indetermined, JUV.: juvenile, SAD: Sub adult, AD: adulte

NUL: nulliparous, *P:* pregnant, *AL:* lactating, *PL:* post-lactating, *R:* reproductive, *NR:* non-reproductive.

The Table 2 reveals that the Shannon index is highest at the Premier Ministère, Sabin and Kossoghin. It is zero at Université Aube Nouvelle and Wayalghin sites. The Index of evenness (E) was high at Boulmiougou, Premier Ministère, Sabin and Kossoghin sites. It was very low at Université Aube Nouvelle, Wayalghin, Kamboinse and Université Joseph Ki-Zerbo. Kamboinse, Kossodo and Premier Ministère are the sites that have recorded a great specific diversity. The lowest diversities were observed at Université Aube Nouvelle and Wayalghin.The rarefaction curve results show that a significant sampling effort was made during this study (Fig. 3). The Jacknife index 1 and 2 predict a specific richness of 13 and 16 species,

respectively. Then the 11 recorded species represent 68.75% to 84.62% of the potential species richness.

Bats abundance by sex, age and reproductive status

Table 1 shows bat species abundance by sex, age and reproductive status. Females are represented by 55.26% of bat specimens; then, the sex ratio is 0.79. The sex of five (5) individuals, all juveniles attached to the udders of their mothers, were not determined. Most of the bats captured are adults (80.88%). Subadults represent 18.16% and juveniles 0.96%. 32.70% of males are non-reproductive, against 11.09% who are reproductive. For females, nulliparous represent 33.08% of the individuals, pregnant 1.53%, lactating 2.10% and post-lactating 15.55%. In general, immature bats represent 66.73% of the population, while mature individuals represent 33.27%. All pregnant females belonged to the Molossidae family and were captured during the month of August.

Table 2. Diversity indices by site.

Site	Species richness	Shannon (H)	Index of evenness (E)
Bangr-Weoogo	5	0,91	0,57
Bassinko	3	0,62	0,57
Boulmiougou	3	0,97	0,88
Kamboinse	8	0,95	0,46
Kossodo	6	1,17	0,65
Kossoghin	5	1,30	0,80
Nagrin	3	0,77	0,71
Ouaga 2000	3	0,60	0,54
Paspanga	4	0,86	0,62
Premier Ministère	6	1,57	0,86
Sabin	5	1,30	0,81
Tanghin	5	1,06	0,65
Université Aube Nouvelle	1	0	NA
Université Joseph Ki-Zerbo	3	0,52	0,47
Wayalghin	1	0	NA

Discussion

523 bats specimens were captured during this study. Among them, 11 species were identified including six new records for the city of Ouagadougou (*M. condylurus*, *M. pumilus*, *N. macrotis*, *L. nanus*, *L. rendalli* and *N. schlieffenii*). The five previously reported species are *E. helvum*, *E. gambianus*, *L. guineensis*, *P. nanulus* and *S. leucogaster* (Koopman *et al.*, 1978; Koch-Weser, 1984; Kangoye *et al.*, 2015). The high number of new records could be explained by the important sampling effort. The Jacknife index 1 and 2 respectively predict a specific richness of 13 and 16 species. Then 2 to 5 additional species are likely to be found. Indeed, one species, *Pipistrellus rusticus* was not captured during this study. As observed in the field, some bat species are difficult to capture with mist nets. This could explain why this species was not captured again. Only two specimens of this species were captured by Koch-Weser (1984). Kangoye (2013) also captured only two specimens in the urban park Bangr-Weoogo, two specimens at Bama, one specimen at Karfiguéla and one specimen at Néguéni. This could indeed show that this species is difficult to capture with mist net. Taking into account this species, they are now 12 bats species known from the city of Ouagadougou. All the six new recorded species are insectivorous. Among them, three species, *M. pumilus N. macrotis* and *N. schlieffenii* are widespread in Burkina Faso (Kangoye *et al.*, 2015). It is, therefore, not surprising to meet them in Ouagadougou. The sampling effort also resulted in the capture of *Mops condylurus* and *Laephotis rendalli* previously captured at Gobnangou range, protected forests of Niouma, Toessé and

Hippopotamus biosphere reserve for *M. condylurus* and at Pama for *L. rendalli* (Kangoye *et al.*, 2012). Although less distributed, these species have been captured in the city of Ouagadougou. This could also justify the capture of *L. nanus* located in the South-Sudanian zone in Burkina Faso (Kangoye *et al.*, 2015). Of the 11 bat species captured in the city of Ouagadougou, only *P. nanulus* was not captured in another site than Ouagadougou. All other species were captured in other localities in Burkina Faso. *Pipistrellus nanulus* was found with an abundance of 37 individuals captured in different sites in Ouagadougou.

This is the second time that this species has been captured in the city of Ouagadougou, after the specimen collected by R. E. Vaden on 27 April 1969 (Schmidt *et al.*, 2008). One might think that it was this great sampling effort that allowed all these individuals to be captured in the city of Ouagadougou.

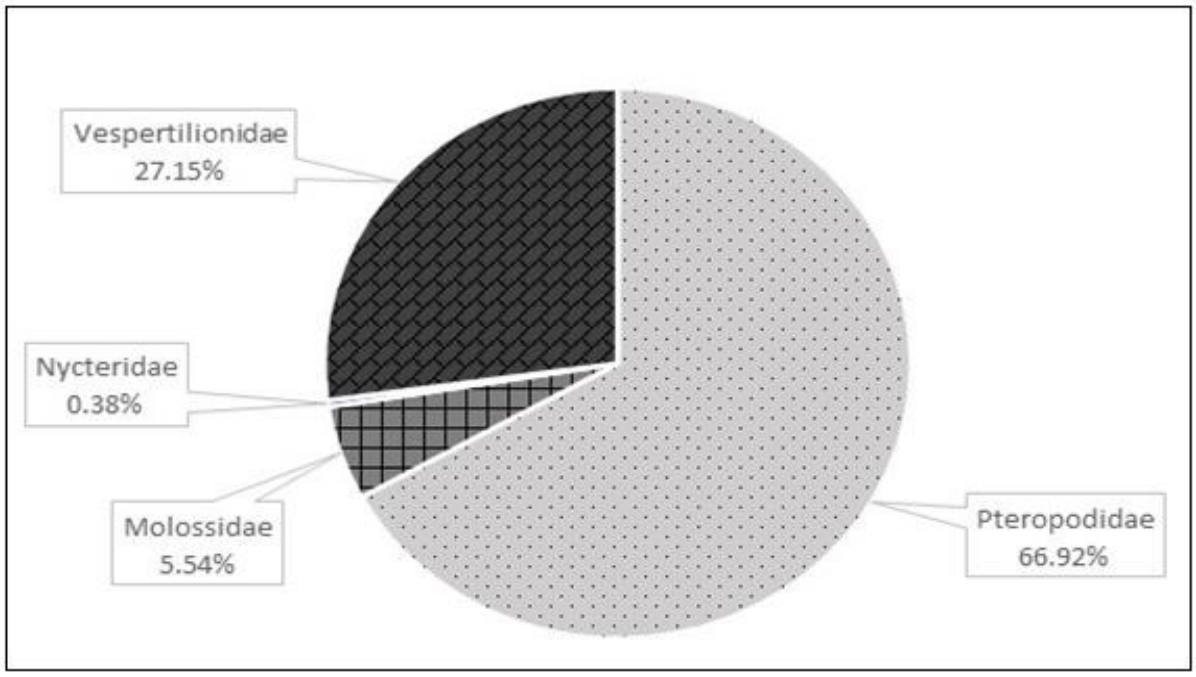

Fig. 2. Bats abundance by family.

It could also be thought that a more thorough sampling effort allows the capture of even some species that are difficult to capture with mist nets. The family Pteropodidae, despite their low species diversity (18.18%), was the most abundant (66.92%). Indeed, previous studies have shown that urbanization can have a positive, negative, or no effect on bats. While some species show a strong degree of adaptation to urban habitat or are even favoured by it, others will decline in response to habitat loss and disturbance (Jung and Caragh, 2018; Li and Kalcounis-Rueppell, 2018; Palheta *et al.*, 2020). According to Russo and Ancillotto (2015), bats respond to urbanization in a species-specific manner. The great abundance of the Pteropodidae family is liked by *E. gambianus*; this species occurs in all stations. It is a species that is easy to observe, especially in houses and different places when the plants are flowering or bearing fruit. According to Egert-Berg *et al.* (2021), when foraging in urban environments, bats were much more exploratory than when foraging in rural environments, visiting more sites per hour and switching foraging sites more often on consecutive nights. The presence of many fruit trees in houses and throughout the city could explain the abundance of this species in the city of Ouagadougou. The increased movement of fruit bats in urban areas, as indicated by Egert-Berg *et al.* (2021), could explain why it is more easily captured in nets. Of the two species of fruit bats identified in the city of Ouagadougou, *E. gambianus* is the one that is actually easy to capture. It was indeed caught in the

nets during each capture. It occurs in all stations. Unlike *E. gambianus*, *Eidolon helvum* is a very difficult species to catch in mist nets. Despite the presence of colonies of thousands of individuals, it is only found in 7% of the sites surveyed.

In Ouagadougou, *E. helvum* is mainly observed during the rainy season when it forms colonies of thousands of individuals. As soon as night falls, they fly very high across the city, where they go in search of food. The low presence of *E. helvum* in the samples can be explained by the use of mist nets that are unsuitable for the capture of this species because it flies very high. In insectivorous, two species, *N. schlieffenii* and *S. leucogaster* have an occurrence rate of more than 50%, indicating that these species do not have particular habitats and adapt to different types of environments.

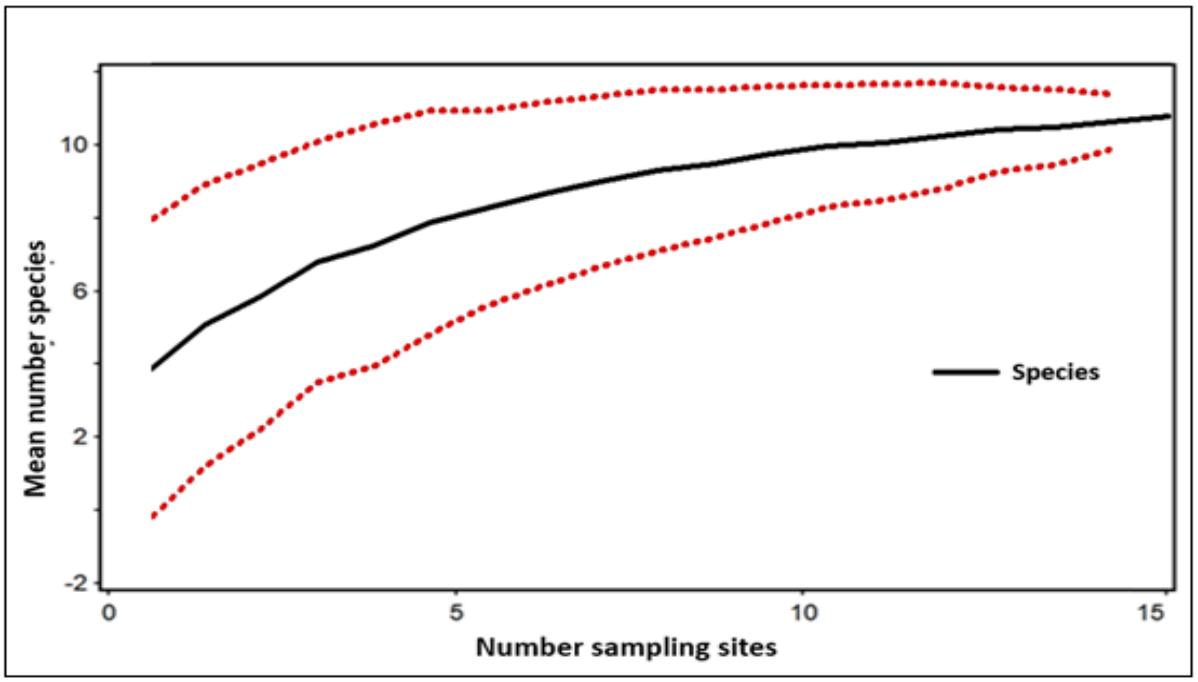

Fig. 3. Rarefaction curve of the specific richness of bats according to the sites.

Kamboinse is the site with the highest species richness. All four families were captured at this site. The distance of this site from the center of the city could explain the presence of greater diversity. This site is closer to a rural environment than others. *Nycteris macrotis* was captured only at this site. All specimens of *M. pumilus* were captured near buildings or water points. This shows that the species is inferred to urban habitats like buildings. Rodríguez-Aguilar *et al.* (2018) confirmed that species of the Molossidae family presented the highest activity in urban sites. The fact that no specimens of Molossidae were caught in the Bangr-Weoogo urban park also shows the preference of this family for buildings. All specimens of *M. condylurus* were caught near the University campus of Kossodo who is a building.

Conclusion

The present study shows substantial species richness of bats in the city of Ouagadougou, including frugivorous and insectivorous. Bats were present everywhere. Some species are abundant, widely distributed and easily captured.

The population of Ouagadougou interacts with the bats. Then, furthers sites are necessary to highlight these interactions and the potential associate risks.

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