

## The bat fauna of the Mpem and Djim National Park, Cameroon (Mammalia Chiroptera)

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### ABSTRACT

The present study reports on a bat inventory in the Mpem and Djim National Park (Mammalia Chiroptera), in the Centre region of Cameroon. Fourteen sites were surveyed from July 2016 to January 2017. A total of 166 bats were captured. This included 14 species, 11 genera, and five families. All species are globally ranked as “Least Concern” except *Glauconycteris egeria*, a Data Deficient species by the International Union for Conservation of Nature Red List of threatened species. *Micropteropus pusillus* and *Lissonycteris angolensis* were recorded from previous surveys in all the ten regions of the country encompassing five agroecological zones. Out of the fourteen species, ten species are known to occur both in the forest and the savanna, while four are reported only from the forest. This study provides baseline data about Chiropteran fauna of this protected area.

### KEY WORDS

Cameroon; Chiropteran; Inventory; Mpem and Djim Park.

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### INTRODUCTION

The average annual rate of deforestation in Cameroon is among the highest in Central Africa (FAO, 1997). Indeed, Ndoye & Kaimowitz (1998) estimated this deforestation at a rate of 80,000 to 200,000 hectares per year. However, it is clear that tropical forests are the largest reservoir of biodiversity (Fittkan, 1997). Each year, the destruction of millions of hectares of tropical forests involves the disappearance of thousands of plant and animal species, of which most was never indexed (Dubois, 2005). Forests in Cameroon have one of the richest and most diverse fauna in Sub-Saharan Africa (Bikié et al., 2000). They contain several classes of vertebrates, including amphibians (190 species),

reptiles (183 species), birds (916 species), and mammals (409 species) (Verbelen, 1999).

Although the Mammal's fauna in Cameroon has been the subject of several studies, bats remain one of the most neglected and poorly studied faunal groups (Bakwo Fils, 2010), despite their major ecological role (Reis & Guillaumet, 1983). Indeed, the valuable ecological services rendered by these animals are ignored by the populations and even by the authorities in charge of managing biodiversity (Bakwo Fils, 2010). Bats, with over 1300 described species, constitute the second most diverse group of mammals after rodents, among the 5000 species of mammals described to date (Bannet-Garcia, 2003). They are unique among mammals as a result of true flight capacity, echolocation abil-

ity, and communal life that could reach several thousands in one assemblage. These poorly known and threatened animals are not included in conservation and wildlife management programs in tropical ecosystems despite their ecological and economic importance (Bannet-Garcia, 2003; Bakwo Fils, 2009a, 2010). This explains the lack of scientific information about bats in Cameroon, which hinders development of effective conservation strategies for these animals.

This preliminary work gives baseline data on the diversity of bats in the Mpem and Djim National Park in the Centre region of Cameroon.

## MATERIAL AND METHODS

### Study area

The Mpem and Djim National Park is situated in the Centre region of Cameroon (Fig. 1). The climate is a Classic Guinean type with four seasons: a long dry season (from mid-November to mid-March); a short rainy season (mid-March to end of June); a short dry season (from July to August) and a long rainy season (from September to mid-November) (Santoir & Bobda, 1995). Precipitations range between 1800 and 2000 mm<sup>3</sup> per year and the temperatures are found between 22° and 29 °C (Santoir & Bobda, 1995). The Mpem and Djim National Park is a vast natural space of 97,480 hectares bounded by the loop which form the Mpem and Djim rivers, two long rivers hosting a rich and diversified aquatic fauna. Recent studies have revealed that the Mpem and Djim Park harbours 76 species of mammals. Among these, rare species (panthers, chimpanzees, hippopotamus, and elephants) are threatened to decline and they even at risk of extinction (MINFOF, 2011). The fact that the park is located in a transition zone between the forest and the savannah gives this protected area a special floristic and faunal character. In the savannah zone there is abundance of *Chromolaena odorata* (L.) R.M. King & H. Rob. (Bokassa Grass) and *Imperata cylindrica* (L.) Raeusch. in the herbaceous layer, while the tree layer is dominated by *Albizia* sp., *Lophira* sp. and *Ochroma africanus*. In the forest, the following species of trees are dominant: *Piptadeniastrum africanum* (Hook. f.) Brenan, *Milicia excelsa* (Welw.) C.C. Berg, *Pterocarpus soyauxii* Taub., *Nauclea diderrichii* (De Wild. & T.

Durand) Merrill, *Alstonia boonei* De Wild., *Mansonia altissima* (A. Chev.) A. Chev., *Garcinia kola* Heckel, *Entandrophragma utile* C. DC., *E. candollei* Harms, *Lovoa trichilioides* Harms.

### Bats capture

In the course of our work, we carried out captures in 14 sites within the forest and the savannah ecosystems (Table 1). Capture sites were chosen based on the potential flight trajectories of bats (water, caves, and tree cavities). The captures were made using nylon mist nets of 12x2.60 m and 6x2.60 m with 16 mm mesh and four pockets. These nets were installed for 20 nonconsecutive nights from June 22, 2016 to January 20, 2017 (Table 1). Mist nets were attached to 4 m-long poles and stretched across potential trajectories of bats, such as water bodies, forest openings, cave openings, and tree hollows between 6 pm and 12 pm to maintain uniform sampling efforts across sites. Mist nets were monitored continuously every 15 minutes. Using gloves, the individuals caught in the mist nets were carefully removed to avoid trauma to the animals.

### Identification

After capture, each individual caught was weighed using a scale balance (Pesola balance, nearest 0.5 g), measured using a vernier caliper following standard techniques (Lindan et al., 1997), and sexed (Table 3). Presence of tragus (for insectivorous bats), date of capture, and geographic position of capture sites were also recorded. Morphological data from each captured bat is used for identification using the keys of Rosevear (1965), Hayman & Hill (1971), Patterson & Webala (2012), and Happold & Happold (2013). After identification, all individual were released.

Literature review was carried out for each species caught in order to identify the different localities (Table 4) in which they have been previously captured in the country. The African Chiroptera Report (ACR, 2017) was used in order to have some indications on the distribution in Cameroon of the species caught at the park. GPS coordinates of the localities of occurrence retrieved from the database and data from this study enabled us to realize new maps of the distribution of the captured species in Cameroon using the software QGIS 2.4.0 Chugiak.

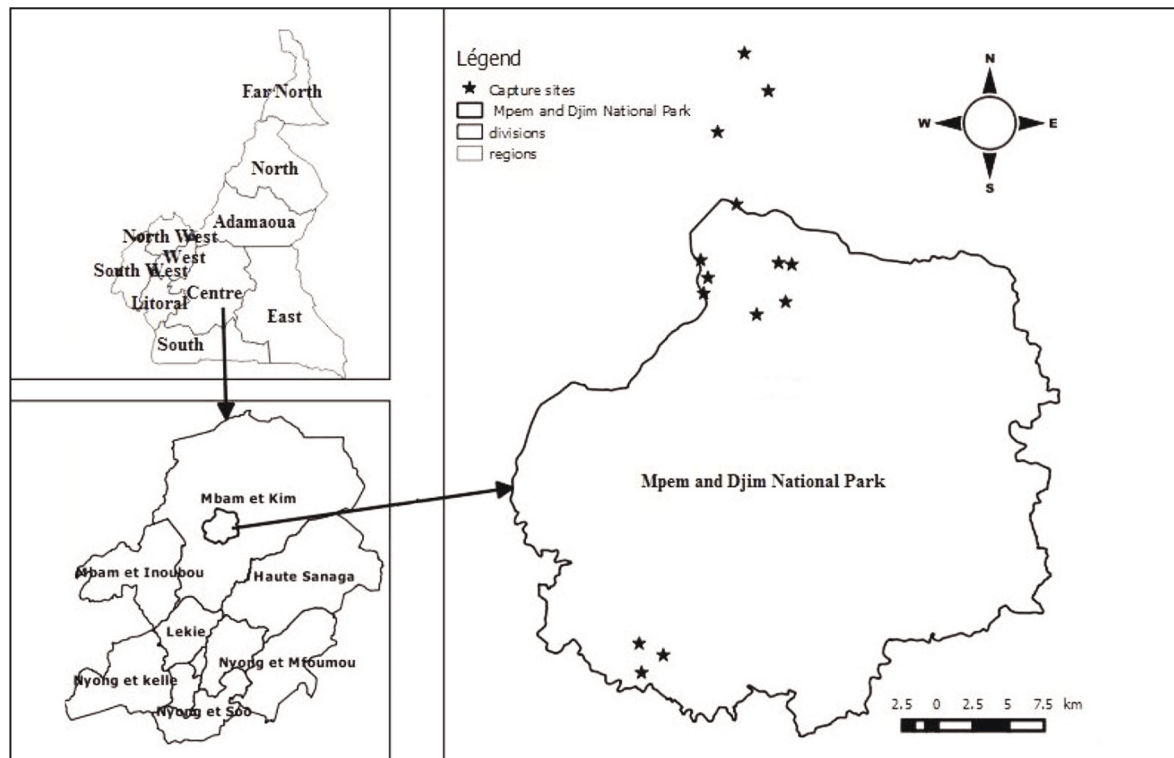


Figure 1. Map of the Mpem and Djim National Park, Cameroon.

SITES	Longitudes	Latitudes	Altitudes	nature of the site	Date	Length and number of net
SITE 1	N 05.03341	E 011.62518	507 m	forest-savannah	22 and 23/07/16	12m(2) and 6m(4)
SITE 2	N 05.04452	E011.63909	542 m	forest	24 and 25/07/16	12m(2) and 6m(4)
SITE 3	N 05.05204	E011.62371	582 m	forest (tree)	26 and 27/07/16	12m(3) and 6m(5)
SITE 4	N05.33230	E011.68691	654 m	savannah	28 and 29/07/16	12m(3) and 6m(5)
SITE 5	N5.26985	E11.71796	630 m	forest	30/07/2016	12m(3) and 6m(5)
SITE 6	N5.26171	E11.69945	657 m	forest	20/11/2016	12m(2) and 6m(4)
SITE 7	N5.27546	E11.66578	607 m	forest	21/11/2016	12m(3) and 6m(5)
SITE 8	N5.28539	E11.66853	631 m	savannah (swamp)	22/11/2016	12m(3) and 6m(5)
SITE 9	N5.29362	E11.72195	674 m	forest	23/11/2016	12m(3) and 6m(5)
SITE 10	N5.29473	E11.71357	632 m	forest	26/11/2016	12m(3) and 6m(5)
SITE 11	N5.29668	E11.66396	639 m	forest	17/01/2017	12m(3) and 6m(5)
SITE 12	N5.37846	E11.67512	617 m	forest (tree)	18/01/2017	12m(3) and 6m(5)
SITE 13	N5.40448	E11.70747	646 m	savannah (cave)	19/01/2017	12m(3) and 6m(5)
SITE 14	N5.42876	E11.69236	792 m	forest (cave)	20/01/2017	12m(1) and 6m(4)

Table 1. Geographical coordinates description of capture sites, date of capture, and number of nets in the Mpem and Djim National Park, Cameroon.

## RESULTS

In 20 nights, we captured 166 bats belonging to 14 species, 10 genera, and 5 families. This corresponds to a capture success of 0.69 individuals per night and a capture effort of 239.2 nets per night (Table 2). The family Pteropodidae was the richest in species richness (6 species), followed by Hipposideridae and Vespertilionidae with 3 species each. Rhinolophidae and Nycteridae were monospecific (Table 2).

### *Species account*

#### *Fruit bats*

##### *Casinycotis argynnis* Thomas, 1910

Only one male individual of this species was captured in the north of the park (forest area) along a river. This species is listed as Least Concern (LC) in the IUCN Red List and its population trend is unknown (Webala et al., 2016). This forest species was previously recorded in Cameroon in Mefo (Peret & Aellen, 1956), Bityé, Mang, Meyo Nkoulou, Mefo (Bergmans, 1990), South Cameroon (Happold & Happold, 2013), Ambam, Meyo, Nkoulou (ACR, 2017) (Fig. 2).

##### *Epomops franqueti* Toms, 1860

Six individuals, including 3 females and 3 males of this species, were captured at sites 2, 10 (secondary forest), and 11 (primary forest). This species is listed as LC in the IUCN Red List and its population trend is unknown (Kityo & Nalikka, 2016). This forest species, captured in the north and south of the park, was previously recorded in Cameroon in Aqua Town, Mungo (Peters, 1876), Kribi (Matschie, 1891), Barombi, Victoria (Matschie, 1895), Itoki (Sjostedt, 1897a & b), Yaounde (Matschie, 1899), Bityé, Bipindi small Batanga (Andersen, 1912), Ndikinimeki, Konn (Aellen, 1952), Ambam, Foullassi, Ngam (Peret & Aellen, 1956), Yaounde (Haiduk et al., 1981), Bamenda, Batanga, Batouri, Bimbria, Bipindi, Bitye, Bota, Buea, Dikume balue, Douala, Ekona, Ekundu, Eseka, Essossong, Foullassi, Garoua, Klein, Kuwait, Mumbai, Mbulu, Mengue, Muquiu, Yoko, Idenau, Ikiliwindi, Isobi, Itoki, Konn, Lake Barombi, Mabeta, Mbo, Meanja,

Mawutu, Metet, Mukonje, Ndikinimeki, Ngam, Ngaoundere, Tiko (Bergmans, 1988), Kilum-Ijim (Maisel et al., 2001), and Dja Reserve (Bakwo Fils, 2009b) (Fig. 3).

##### *Micropteropus pusillus* Peters, 1868

This species is widespread in Cameroon (Fig. 4). Seventeen individuals (10 males and 7 females) were recorded in the north and south of the park. In the north, it was captured beside a river (forest area) and in the swampy savannah. In the south it was caught in the forest-savannah transition zone. This species is listed as LC in the IUCN Red List and its population trend is unknown (Bakwo Fils & Kaleme, 2016a). This species was previously recorded in Cameroon in Yaounde (Matschie, 1895), Tinta (Sanderson, 1940), Ngaoundere (Haiduk et al., 1981; Muller et al., 1981), Banyo (Huterrerr & Joger, 1982), Jauro Massali (Huterrerr et al., 1992), Bafut, Banyo, Bota, Buea, Boukma, Campo, Djohong, Ekona, Eseka, Koutaba, Kribi, Galim, Koza, Kombetiko, Kounden, Lekoung, Lolabe, Maroua, Mbakaou, Mbokaon, Mbouda river, Meanja, Metchum, Meiganga, Mount Cameroon, Mount Manengouba, Molyko, Mokolo, Mpundu, Nachtigal, Ngaoundere, Nkolbisson, Ntui, Obala, Mayo-Darlé, Tibati, Poli, Tombel, Wakwa, Yagoua, Yaounde, Yoko, (ACR, 2017), Maga, Mokolo (Bakwo Fils, personal data).

##### *Lissonycteris angolensis* Bocage, 1898

A single male and a single female were mist-nested at a drinking site in the forest area of the Park. This species is listed as LC in the IUCN Red List and its population trend is unknown (Bergmans et al., 2017). This forest species was previously recorded in Buea (Matschie, 1891), Bibundi, Bonge, Ndiang, (Sjostedt, 1897a; 1897b), Bimbria, Tombel (Eisentraut, 1942), Eseka (Haiduk et al., 1981), Ngaoundere (Muller et al., 1981), Dja Reserve (Bakwo Fils, 2009a). Specimens currently kept in museums were collected in Bafut, Banyo, Boukma, Buea, Campo, Djohong, Eseka, Galim, Gwofong, Lolabe, Mayo Darle, Kombe, Kounden, Koutaba, Koza, Kribi, Lekoung, Mbakaou, Mbokoan, Meanja, Meiganga, Moliko River, Mount Manengouba, Mokolo, Mpundu, Ngaoundere, Ntui, Nachtigal, Obala, Poli, Tibati,



Tiko, Touroua, Tote, Wakwa, Yagoua, Yaounde, Yoko (ACR, 2017) (Fig. 5).

***Myonycteris torquata* Dobson, 1878**

The single male individual was captured in a marshy area, beside a stream within the forest. This forest and savannah species (Fig. 6) is listed as LC in the IUCN Red List and its population trend is unknown (Bakwo Fils & Kaleme, 2016b). This forest species was previously recorded in Ngaoundere (Haiduk et al., 1981), the Natural Reserve of Campo (Cosson, 1995), and Dja reserve (Bakwo Fils, 2009a). Specimens currently kept in museums were collected in Aboulou, Belabo, Bertoua, Bityé, Bota, Buea, Campo, Dimako, Eseka, Ebolowa, Kanyol, Koutaba, Kumba, Lake Barombi, Lake Tisongo, Lolodorf, Lomié, Mesea, Meyo, Mey Joss, Nkoulou, Nguilili, Ngoume, Ntui, Ngobilo, Yaoundé (ACR, 2017).

***Rousettus aegyptiacus* Geoffroy St.-Hilaire, 1810**

This species is widely distributed in the western part of Cameroon (Fig. 7) and it is recorded to come from natural forest gaps in the northern part of the park. Two individuals were captured at drinking sites (rivers) (sites 6 and 9). In the northern periphery of the park, six other individuals were caught in a cave (site 14) that contained more than 300 individuals. All the adult females carried a young as they escaped from the cave. This species is listed as LC in the IUCN Red List and its population trend is unknown (Korine, 2016). This forest species was previously recorded in Buea (Sanborn, 1936), Mamfe (Sanderson, 1940), Kilum-Ijim forest (Maisel et al., 2001), Dja reserve (Bakwo Fils, 2009b). Specimens currently kept in museums were collected in Bafut, Bamenda, Bipindi, Bota, Boteke Village, Campo, CDC Banana Plantation, Doko, Ekona, Great Soppo, Isobi, Lake Barombi, Kribi, Lododorf, Mount Cameroon, Mueli, Mukono, Ngoume, Sakbayeme, Tiko, Toura, Tombel, Yaounde (ACR, 2017).

***Insectivorous bats***

***Rhinolophus alcyone* Temminck, 1853**

This species was recorded in the northern part of the park and it is less widely distributed in

Cameroon (Fig. 8). The single female individual was captured across a river in the forest. This species is listed as LC in the IUCN Red List and its population trend is unknown (Monadjem et al., 2017a). This forest species was previously recorded from Mamfe (Sanderson, 1940), Nyasosso, Mount Kupe, Wildi cave, Buena, Nkoetye (Perret & Aellen, 1956), Mount Cameroon (Eisentraut, 1964). Specimens currently kept in museums were collected in Boteke Village, Bokwango, Bova Village, Eseka, Gwando, Meyo, Moloko, Mounjo, Mpundu, Muyuka, Nkoetye, Nkoulou, Soppo, Soumo River, Soppo (ACR, 2017) (Fig. 8).

***Hipposideros cyclops* Temminck, 1853**

This species is widely distributed in the southern part of the country (Fig. 9). Three individuals (1 female and 2 males) were captured in the northern part of the park beside a river (site 6) and in a dead tree trunk (site 12). This species is listed as LC in the IUCN Red List and its population trend is unknown (Monadjem et al., 2017b). This forest and savannah species was previously recorded on Mount Cameroon (Dobson, 1878), Buea (Matschie, 1891), Kita (Sjostedt, 1897b), Efoulou (Allen, 1922), Besongabang, Okoiyong, Eshobi, Bashauo, Atolo, Tinta, Bitye (Sanderson, 1940), Mubenge-Isongo (Eisentraut, 1942), Kribi, Akak (Aellen, 1952), Dja Reserve (Bakwo Fils, 2009a), Camp II, Mount Kupe (Hill, 1968), Ngam, Meyo, Ambam (Perret & Aellen, 1956). Specimens currently kept in museums were collected in Bebai, Bele, Bertoua, Bipindi, Bokwango, Buea, Bunduma Village, Ebolowa, Efulen, Eseka, Isongo, Kribi, Lake Muyuka, Lombe, Mengueme, Metet, Meyo, Mieri, Muyuka, Nkoulou, Ngoume, Ndjole, Olounou, Sangmelima, Sakbayeme, Tisongo, and Zulabot II (ACR, 2017).

***Hipposideros fuliginosus* Temminck, 1853**

This species is found in both the forest and the savannah in the northern part of the park. Seventeen individuals (9 females and 8 males) were caught at a drinking site (small stream) in the forest (sites 6 and 9) and in a savannah cave (site 13) that contained more than 200 individuals. This species is listed as LC in the IUCN Red List and its population trend is unknown (Monadjem et al., 2017c).

This species was previously recorded in the Mungo (Peters, 1876), Victoria (Sjostedt 1897b), Sakbayeme (Allen, 1921), Ndikiniméki (Aellen, 1952), Dja Reserve (Bakwo Fils, 2009a). Specimens currently kept in museums were collected in Mamfé, Kumba, and Kribi (ACR, 2017) (Fig. 10).

***Hipposideros ruber* Noack, 1893**

This species was caught in the north and south of the forest as well as in the northern periphery of the park. Ninety-seven individuals were caught in 5 sites (2, 3, 5, 9, and 6), all located in the forest. It is the most abundant and was caught in a living tree cavity and along a river. This species is listed as LC in the IUCN Red List and its population trend is un-

known (Monadjem et al., 2017d). This forest and savannah (Fig. 11) species was previously recorded in Jauro Massali (Hutterer et al., 1992), Kilum-Ijim (Maisel et al., 2001), Dja Reserve (Bakwo Fils, 2009a), Makot (Bakwo Fils, personal data). Specimens currently kept in museums were collected in Bertoua, Bipindi, Bitye, Buea, Campo, Ebolowa, Efulen, Eseka, Kribi, Kumba, Lake Barombi, Lomie, Mamfé, Mbalmayo, Mount Cameroon, Nanga Eboko, Poli, Mieri, Sakbayeme, Sangmelima, and Telo (ACR, 2017).

***Nycteris grandis* Peters, 1865**

This species was caught in a swampy area beside a river in the forest (site 7) in the northern part of



Figures 2–7. Distribution maps of the different species caught in the Mpem and Djim N. P. in Cameroon. Star = capture point in the park, dot = capture points of the specimens in the museum and other capture points reported in Cameroon). Fig. 2: *C. argynis*. Fig. 3: *E. franqueti*. Fig. 4: *M. pusillus*. Fig. 5: *M. angolensis*. Fig. 6: *M. torquata*. Fig. 7: *R. aegyptiacus*.

the park. It is listed as LC in the IUCN Red List and its population trend is unknown (Monadjem et al., 2017e). This forest and savannah (Fig. 12) species was recorded in Bitye (Andersen, 1912), Mubengue-Isongo (Eisentraut, 1942), Myntyaminyumin, Ngam (Perret & Aellen, 1956), Dja Reserve (Bakwo Fils, 2009a). Specimens currently kept in museums were collected in Bitye, Bipindi, Bonge, Douala, Edea Game Reserve, Kumba, Kribi, Lumbindu, Malende Swamp Area, Myntyaminyumin, Mount Cameroon, Ngam, Ndjole, Njombo River, Sangmelima, and Tisongo (ACR, 2017).

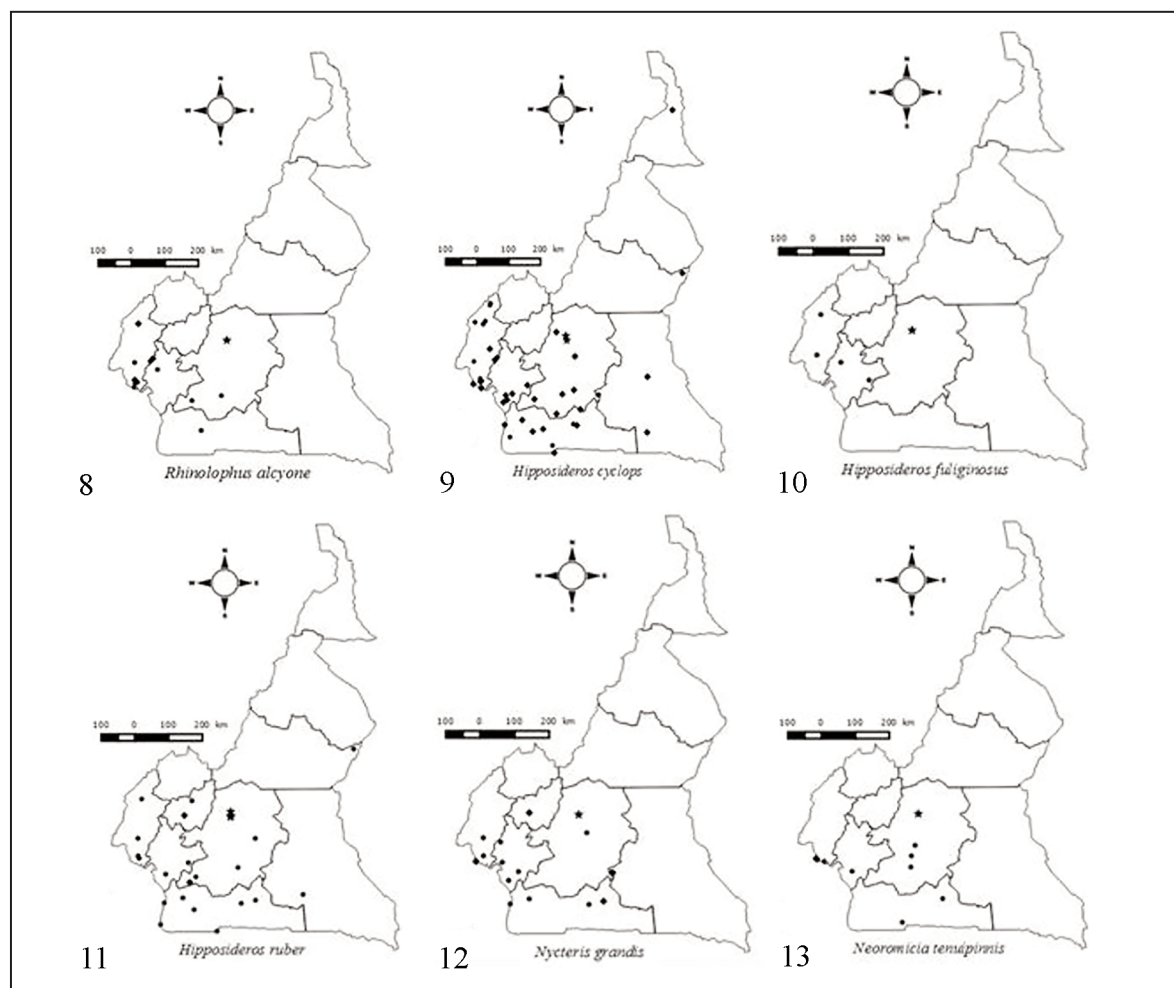
*Neoromicia tenuipinnis* Peters, 1872

This species is found in the forest, in the northern

part of the park. Two male individuals of this forest and savannah species were caught at the drinking sites. *Neoromicia tenuipinnis* is listed as LC in the IUCN Red List (Monadjem & Fahr, 2017a). It was previously recorded in Ambam, Yaounde (Mc Bee et al., 1987), Isongo, Debundscha, Bota (Eisentraut, 1942). Specimens currently kept in museums were collected in Ambam, Bitye, Bota, Boteke Village, Isongo, Kumba, Mawutu, Yaounde, Meanja, Muyuka, Ntui, and Obala (ACR, 2017) (Fig. 13).

*Glauconycteris egeria* Thomas, 1913

The single male individual of this species was caught in the southern part of park in the forest be-



Figures 8–13. Distribution maps of the different species caught in the Mpem and Djim N. P. in Cameroon. Star = capture point in the park, dot = capture points of the specimens in the museum and other capture points reported in Cameroon). Fig. 8: *R. alcyone*. Fig. 9: *H. cyclops*. Fig. 10: *H. fuliginosus*. Fig. 11: *H. ruber*. Fig. 12: *N. grandis*. Fig. 13: *N. tenuipinnis*.

side a river. It is listed as DD in the IUCN Red List and its population trend is unknown (Jacobs et al., 2008). This forest species was previously recorded in Bibundi and Buea (ACR, 2017) (Fig. 14).

#### *Pipistrellus nanulus* Thomas, 1904

This species was caught in the northern part of park, in the forest and savannah. Nine male individuals were captured beside a river in the forest (site 6) and in the savannah (site 4). *Pipistrellus nanulus* is listed as LC in the IUCN Red List (Monadjem & Fahr, 2017b). The distribution map (Fig. 15) shows that *P. nanulus* is a forest and savannah species. Van

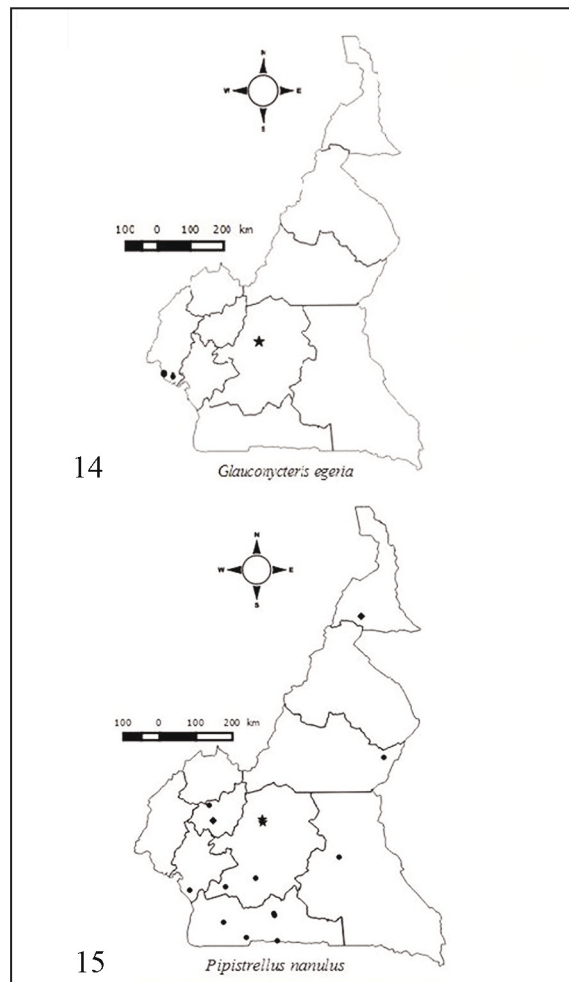
Cakenberghe & Happold (2013) also suggest that this species seems to prefer both forest and savannah zones as well as boundaries between the two. This ubiquitous species was previously recorded in Efulen (Rosevear, 1965), Dja Reserve (Bakwo Fils, 2009b), and Maroua (Aaron Manga, 2012; Bakwo Fils et al., 2014). Specimens currently kept in museums were collected in Aboulou, Ambam, Dimako, Eseka, Foulassi, Galim, Njombo River, Lake Tssongo, Sangmelima, and Yaounde (ACR, 2017).

## DISCUSSION

Bats constitute one of the most ecologically diverse groups of vertebrates of the Mpem and Djim National Park. These animals play an important role in the functioning of the ecosystem. Insectivorous bats regulate insect populations, of which some are agricultural pests. Fruit bats disperse seeds and help maintain forest diversity (Fahr et al., 2002). This function suggests the important role bats play and their absence would impoverish the ecosystems of which they are a part of. This ecological importance may likely explain the spread of these species on the whole territory, characterized by several biogeographical zones.

The bat community of this park harbours species which rely on caves (*R. aegyptiacus* and *H. fuliginosus*) as well as holes in trees (*H. cyclops* and *H. ruber*). Several favourable habitats exist for bats at the Mpem and Djim National Park. However, these habitats are threatened by the ineffective management of the park and thus favouring human action which may be harmful to the bats. These anthropic actions include bush fire caused by herdsmen, deforestation for the plantation of cocoa, etc. With the exception of *G. egeria*, which is DD in the IUCN Red List, all species captured at the study site are Least Concern in the IUCN Red List. These anthropic activities may endanger the conservation of bat species composition at the Mpem and Djim National Park Community.

Most of the captured species at the park are forest species, except *M. pusillus* and *L. angolensis*, which are cosmopolitan in Cameroon. They have been recorded in the ten administrative regions of the country. Thus, they are species of the south tropical forest, of the humid savannah in the Centre, and of the dry savannah in the Far North. It is interesting



Figures 14, 15. Distribution maps of the different species caught in the Mpem and Djim N.P. in Cameroon. Star = capture point in the park, dot = capture points of the specimens in the museum and other capture points reported in Cameroon). Fig. 14: *G. egeria*. Fig. 15: *P. nanulus*.



Species	Numbers of individuals per study site														Total
	site 1	site 2	site 3	site 4	site 5	site 6	site 7	site 8	site 9	site 10	site 11	site 12	site 13	site 14	14
<b>Fruit bats</b>															
<i>Casinycteris argynnis</i>	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1
<i>Epomops franqueti</i>	0	1	0	0	0	0	0	0	0	1	4	0	0	0	6
<i>Micropteropus pusillus</i>	7	0	0	0	0	3	0	4	3	0	0	0	0	0	17
<i>Myonycteris angolensis</i>	0	0	0	0	0	0	2	0	0	0	0	0	0	0	2
<i>Myonycteris torquata</i>	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
<i>Roussettus aegyptiacus</i>	0	0	0	0	0	1	0	0	1	0	0	0	0	6	8
<b>Insectivorous bats</b>															
<i>Rhinolophus alcyone</i>	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1
<i>Hipposideros cyclops</i>	0	0	0	0	0	2	0	0	0	0	0	0	0	0	3
<i>Hipposideros ruber</i>	0	7	82	0	1	0	0	0	1	0	0	0	6	0	97
<i>Hipposideros fuliginosus</i>	0	0	0	0	0	1	0	0	1	0	0	0	15	0	17
<i>Nycteris grandis</i>	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
<i>Neoromicia tenuipinnis</i>	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2
<i>Glauconycteris egeria</i>	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1
<i>Pipistrellus nanulus</i>	0	0	0	6	0	3	0	0	0	0	0	0	0	0	9
<b>Total individual</b>	7	9	82	6	1	10	4	4	9	1	5	7	15	6	166
<b>Total species</b>	1	3	1	1	1	5	3	1	6	1	2	2	1	1	14
<b>Effort for 12 metres/night</b>	20.8	28.6	24.7	28.6	14.3	14.3	14.3	14.3	14.3	14.3	14.3	14.3	14.3	7.8	239.2
<b>capture success /night</b>	0.33	0.31	3.32	0.21	0.07	0.7	0.28	0.28	0.63	0.07	0.35	0.49	0.07	1.3	0.69

Table 2. Sampling effort, capture success, and specific abundance of bats in the Mpem and Djim National Park, Cameroon.

to note that *M. pusillus* was recorded in the forest, savannah, and ecotone zones of the park. This is similar to the results of Fahr (1996) in Ivory Coast who recorded 69% of this species at the savannah, 18% at the ecotone, and 12% at the forest. *E. franqueti*, *M. torquata*, *R. aegyptiacus*, *H. ruber*, *H. fuliginosus*, *N. tenuipinnis*, and *P. nanulus* are found in the tropical forest and the humid savannah. This is in agreement with the works of Napoko et al. (2015) at Burkina Faso who noted the presence of *H. cyclops* in the savannah and forest; Fahr (1996) who sampled 70% of the individuals of *H. ruber* in the forest and 30% in the savanna; Bates et al. (2014) who recorded *N. tenuipinnis* in the two ecosystems in Congo. However, Haiduk et al. (1981) signaled the presence of *L. angolensis* in Adamawa confirming the presence of the species in both ecosystems in Cameroon. *C. argynnis*, *Rhinolophus alcyone*, *H. fuliginosus*, and *G. egeria* were uniquely in the forest zones. These species are

few in number in Cameroon and are found in the Southern part of the country. *Casinycteris argynnis* is a solitary and rare species (Happold & Happold, 2013) and only a single individual was captured at the park. A closely related species, *C. campomaa-nensis*, was discovered in the locality of Campo-Ma'an in the South of the country (Hassanin, 2014). Only two records of *G. egeria* were previously known in the South West region of Cameroon (forest zone). The works of Decher et al. (2016) signal the presence of *H. fuliginosus* in the Mountainous chains of Simandou in Guinea.

## CONCLUSIONS

The Mpem and Djim National Park is one of the hotspots for biodiversity conservation in Cameroon. A significant portion of this ecosystem needs greater attention and we recommend the following actions:

biodiversity surveys should be extended in this protected area in order to understand bats ecological requirements and threats, which help in setting up management plans adapted regionally and that allow a targeted use of resources; more targeted surveys and in-depth studies of species listed as endangered or critically endangered according to the International Red List should be carried out; deforestation

by a combination of ground assessments and remote sensing should be monitored; bat habitat requirements need to be monitored on a long term basis and legal protection of bats roost and habitats at the park and its surroundings should be included in the management of wildlife species; long streams provide foraging and drinking habitats for bats at the park, and so, creation of bridges with vertical crevices can

Sexes	Lb (mm)	Lf (mm)	Lt (mm)	Le (mm)	Ltr (mm)	Lta (mm)	Weight (g)
<i>Casinycotis argyrensis</i>							
Female	72 (n=1)	63	25	20	0	0	11
<i>Epomops franqueti</i>							
Male	(92-130) (n=3)	(100-82)	(33-38)	(20-25)	0	0	(73-131)
Female	(93-104) (n=3)	(85-97)	(33-39)	(20-24)	0	0	(86-109)
<i>Micropteropus pusillus</i>							
Male	(50-63) (n=10)	(42-52)	(18-22)	(13-15)	0	0	(15-29)
Female	(41-68) (n=1)	46-59	16-23	(11-16)	0	0	(16-32)
<i>Myonycteris angolensis</i>							
Male	76 (n=1)	82	35	18	0	16	66
Female	85 (n=1)	82	32	18	0	15	76
<i>Myonycteris torquata</i>							
Female	71 (n=1)	57	31	13	0	12	22
<i>Roussettus aegyptiacus</i>							
Male	108-110 (n=3)	98-99	40-42	16-19	0	(0.8-12)	134-146
Female	105-120 (n=5)	98-102	40-45	19-22	0	15-16	134-148
<i>Rhinolophus alcyon</i>							
Female	55 (n=1)	53	24	19	0	22	15
<i>Hipposideros cyclops</i>							
Male	(64-66) (n=2)	(69-70)	(32-35)	(22-28)	0	(26-32)	(28-40)
Female	70 (n=1)	66	34	25	0	25	30
<i>Hipposideros ruber</i>							
Male	(45-55) (n=44)	(50-60)	(19-24)	(09-17)	0	(19-32)	(10-17)
Female	(42-55) (n=53)	(50-60)	(19-24)	(10-17)	0	(22-32)	(0.8-14)
<i>Hipposideros fuliginosus</i>							
Male	(39-44) (n=8)	(50-52)	(20-24)	(10-15)	0	(30-35)	(0.9-24)
Female	(40-47) (n=9)	(50-52)	(21-23)	(11-14)	0	(30-33)	(0.8-10)
<i>Nycteris grandis</i>							
Male	58 (n=1)	62	34	33	0	70	24
<i>Neoromicia tenuipinnis</i>							
Male	(32-34) (n=2)	(30-31)	(10-11)	(0.7-10)	0	(25-27)	(0.2-0.5)
<i>Glauconycteris egeria</i>							
Male	39 (n=1)	38	18	12	5	32	6
<i>Pipistrellus nanulus</i>							
Male	(25-35) (n=4)	(26-30)	(0.9-19)	(0.7-0.9)	0	(11-30)	(0.2-0.3)

Table 3. Measurements of the different parameters of the species caught in the park. Lb: total body length, Lf: length of forearm, Lt: length of tibia, Ltr: length of tragus, Lta: length of tail, Le: length of ear, n: number of individual.

Localities	Latitude	longitude	Localities	Latitude	longitude	Localities	Latitude	longitude	localities	Latitude	longitude
Aboulou	2.3	12.05	Dokoa	4.36667	11.73333	Lomié	3.16667	E13.61667	Nanga Eboko	4.68333	12.36667
Akak	5.48333	9.36667	Douala	3.75528	9.94472	Mabeta	3.98854	9.28936	Ndiang	4.7697	9.8719
Akon	5.75979	9.06448	Ebolowa	3.9	11.9	Makot	3.5	E10.6	Ndikinimeki	4.76667	10.83333
Ambam	2.38333	11.28333	Edea	3.8	10.13333	Mamfe	5.754	E9.3123	Ndjole	4.81667	11.93333
Atolo	6.22548	9.49478	Efulen	2.76667	10.71667	manengouba	4.9522	E9.8678	Ngam	3.76667	12.58333
Ayos	4.08333	11.28333	Ekona	5.0288	9.4924	Mang	5.45681	10.30582	Ngaoundere	5.26667	14.01667
Bafut	5.89649	10.20066	Ekundu	4.6884	8.96506	Mangamba	4.2456	9.4344	Ngobilo	4.33333	10.61667
Bamenda	5.95971	10.14597	Eseka	3.65	10.76667	Mayo Darle	6.46667	E11.55	Ngoume	5.48333	11.4
Banyo	4.48333	14.01667	Eshobi	5.78583	9.36027	Mbakaou	6.31667	E12.81667	Njombo	4.58056	9.66472
Batanga	4.16667	14.46667	Foulassi	2.98333	11.96667	Mbalmayo	3.72361	E9.955	Nkoulou	3.78333	11.56667
Batouri	4.43333	14.36667	Galim	5.68955	10.3672	mbouda	5.62611	E10.25421	Ntui	4.45	11.63333
Belabo	4.93333	13.3	Garoua	10.2281	14.81743	Meanja	4.265000	9.396700	Obala	4.16667	11.53333
Bele	11.47917	14.79679	Idenau	4.240500	8.991200	Mefo	2.96667	11.96667	Olounou	3.36667	12.08333
Bertoua	7.03879	15.00753	Ikiliwindi	4.7317	9.4881	Meiganga	6.51667	14.3	petit Batanga	3.19861	9.92667
Besongabang	5.70735	9.29875	Isobi	4.12068	8.99244	Mengueme	3.25000	11.400000	Sakbayeme	4.03333	10.56667
Bibundi	4.2191	8.9876	Isongo	4.0687	9.0164	Metet	2.18333	11.33333	Sangmelima	2.933333	11.983333
Bimbia	3.95444	9.245	Itoki	4.83003	8.94229	Meyo	2.83333	11.01667	Somalomo	3.38333	12.73333
Bipindi	5.08333	10.41667	Kita	4.6861	9.0324	Mieri	4.25	13.98333	Soppo	4.1517	9.2514
Bityé	3.01667	12.36667	Klein	3.19861	9.92667	Mokolo	10.74244	13.80227	Tibati	6.46504	12.62843
Bokwango	4.1349	9.222	Kombe	4.08333	E10.96667	Moliko	4.1529	9.285	Tiko	4.0745	9.3699
Bota	4.0197	9.1956	Kounden	5.70311	E10.66639	Moungo	4.5	9.83333	Tinta	6.2722	9.511
mboukma	8.52173	13.9766	Koutaba	5.685403	E10.810337	Mont Cameroun	4.216503	9.213773	Tisongo	3.568056	9.876111
Buca	4.1527	9.241	Koza	10.86846	E13.88205	Mont Kupe	4.801400	9.708100	Tombel	4.7466	9.6705
Campo	2.36667	9.81667	Kribi	2.95	E9.91667	Mpundu	4.2356	9.4108	Touroua	9.08333	12.96667
Debundscha	4.1007	8.9786	Kumba	4.6921	E9.2097	Muea	4.1749	9.3044	Victoria	4.0242	9.2149
Dimako	4.38333	13.56667	Lolabe	2.66667	E9.85	Mukonje	4.5776	9.5067	Wakwa	7.23333	13.58333
Dja	5.30718	10.46168	lolodorf	3.23333	E10.73333	Mukono	4.6283	9.1658	Yagoua	10.34107	15.23288
Djohong	6.83333	14.7	Lombe	3.63389	E9.98611	Muyuka	4.7251	9.6342	Yaounde	3.866667	11.516667
									Yoko	5.53333	12.31667

Table 4. Gazetteer of localities listed in the text.

provide ideal roosting sites when they spun such waters; access to vulnerable caves in the park and its surroundings should be restricted. Furthermore, it is important to create and maintain ponds for managing bats and other wildlife across the Mpem and Djim National Park Forest landscape.

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