



## **Vegetarian diet in Guenon and Mangabey monkeys of Moukalaba-Doudou National Park, Gabon: Similarities and Differences**

**MANGAMA-KOUMBA Lilian Brice<sup>\*,1,2</sup>, EBANG ELLA Ghislain Wilfried<sup>1,2</sup>, AKOMO-OKOUE Etienne François<sup>2</sup>, MINDONGA NGUELET Fred Loïc<sup>1,2</sup>, M'BATCHI Bertrand<sup>1</sup> and MAVOUNGOU Jacques François<sup>2</sup>**

<sup>1</sup>Université des Sciences et Techniques de Masuku (USTM), BP: 901, Gabon

<sup>2</sup>Institut de Recherche en Ecologie Tropicale (IRET), BP : 13354, Gabon

**Corresponding author:** MANGAMA KOUMBA Lilian Brice

Université des Sciences et Techniques de Masuku (USTM), BP: 901, Gabon

\*E-mail address: [mangamalilian@yahoo.fr](mailto:mangamalilian@yahoo.fr)

### **ABSTRACT**

*A study of the vegetarian diet of mangabeys and guenons was conducted for 10 between 2013 and 2014 in Moukalaba-Doudou National Park, Gabon. By using the direct observation method, we identified 83 plant species integral to the vegetarian diet of these two groups of monkeys. Thus, we have recorded similarities and differences. Guenons (69 species) consume the same plant species as the Mangabeys (49 species;  $V = 1594$  p-value = 0.1796). They are considered frugivores at large because they consume an average of 84.77% fruit for guenons and 63.37% for the mangabeys, with a difference in the consumption of seeds 18.93% and 3.31% respectively. These results suggest that Mangabey have a seed-eating regime while the guenons tend to consume even when they are unavailable fruits. Our analyzes also showed that these two groups have preference different family of the species that they consume. This is due to the nature of the fruit produced by each family. Furthermore the mangabey ( $\chi^2 = 5.6989$ ,  $df = 5$ , p-value = 0.3366) interested in several of plants while monkeys ( $\chi^2 = 15.817$ ,  $df = 5$ , p-value = 0.007387) remain more attached to fruit consumption.*

**Keys word:** Mangabeys, Guenons, diet, Moukalaba-Doudou, difference and similaritie

Received 22.07.2016

Revised 10.08.2016

Accepted 21.08.2016

### **INTRODUCTION**

Cercopithecine monkeys are integral part of Cercopithecidae's family belonging to the large group of catarrhines. Cercopithecines include 12 genera divided into two tribes, *Cercopithecini* (Guenons) and *Papionini* (baboons, mangabeys and macaques). Many genera of Cercopithecines occupy habitats of African forest, where they form exceptionally diverse communities in tropical forests including up to four different species with colobus monkeys and great apes (gorillas, chimpanzees and bonobos).

In Gabon, African country, there are 13 national parks including the Moukalaba-Doudou National Park which is the third largest. This park is known for his diverse habitats and his characteristics in primatology. Today it is considered as a sanctuary of western lowland gorillas, with an abundance and high density of apes [1, 2]. Also, there are two main groups of Cercopithecines monkeys (Mangabeys and Guenons) and a lack of colobines monkey which generally dominated in the African rainforest. Mangabeys and Guenons form permanent polyspecific associations and share the same habitats. They have common behavior and their diet is varied: fruits, flowers, buds, plant stems, leaves, nuts, roots, bulbs, corms, insects and bird eggs.

Several studies on the diet of these two groups of monkeys have been made in many areas of Gabon [3-8]. However, there are few data on the difference of diets between these two groups in a region where they are sympatric and where there is a lack of Colobine monkeys.

This study is dedicated to the analysis of vegetarian diet of Mangabeys and Guenons monkey of Moukalaba-Doudou National Park, Gabon. The objective is to identify, quantify and compare their diets and in order to bring the differences and similarities.

### **METHODS**

### Study site

The Moukalaba-Doudou National Park is located at south-western Gabon and covers an area of ~5028 km<sup>2</sup> (figure 1). The park faces the Atlantic Ocean on its south-western boundary. The Doudou mountain Range, up to 900m in altitude, runs north to south. The Park contains a mosaic of vegetation: primary and secondary forest, mountain forest, marsh and savannah [9]. The study area covers approximately 500 km<sup>2</sup> around the village of Doussala, which is located on the eastern side of the park. During 2004-2006, the annual rainfall fluctuated between 1582 mm and 1886 mm [10, 11], and the mean monthly minimum and maximum temperatures range from 21.3°C to 24.1°C and from 29.3°C to 33.7°C, respectively [1]. They are two distinct seasons a rainy season from October to April, and a dry season from May to September. During the 3 months in the middle of the dry season, rainfall is very infrequent [12]. The high-altitude forest (>450 m) in the Doudou mountain is believe to be one the Pleistocene refuges, and may harbor some endemic plant species [13]. Fisher [14] conducted a floral and faunal inventory survey of the study area.

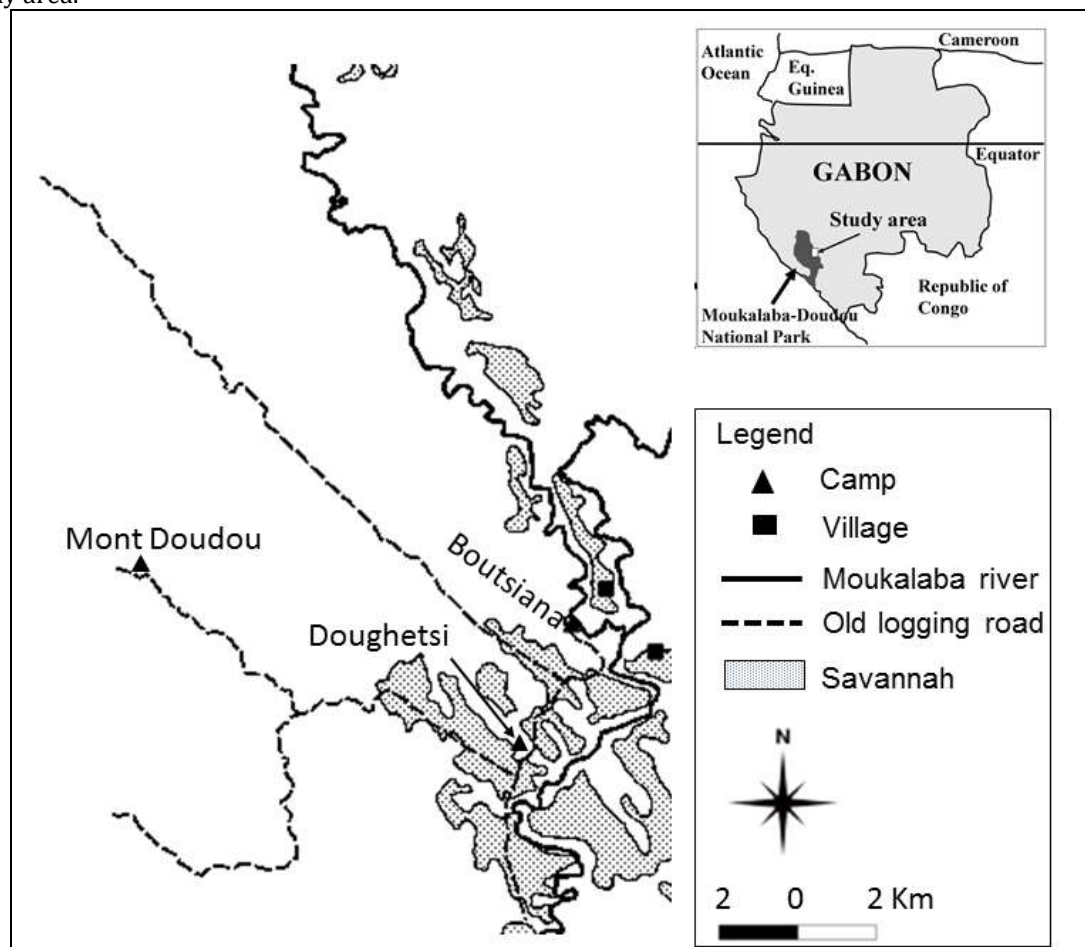


Figure 1: Localization of study site of Northern part of Moukalaba-Doudou National Park

### Data collection and analysis

Two species of mangabeys the Red-capped mangabey *Cercocebus torquatus* and the Grey-cheeked mangabey *Lophocebus albigena*, and four species of guenons, the mustached *Cercopithecus cephus*, Putty-nosed *Cercopithecus nictitans*, the crowned *Cercopithecus pogonias*, the Northern talapoin *Miopithecus ogouensis* [15] was chosen as target species.

Diet records were compiled have been made for each species from direct observations on unmarked individual at Northeastern part of Moukalaba-Doudou National Park. Survey was done randomly, and observers walked in all major habitats in the study area. The observations were made in four zones which composed our study area. The zones were walked in sequences so that all zones were sampled by month, excepted the month of December 2013 and January 2014 which had been disturbed by the mission programs. Whenever vocalization of mangabeys or guenons was understood, we got closer of the group and we marked their activities. If monkeys were feeding, we recorded the plant species and plant item (i.e., fruit, leaf, seed, bud...) which they consumed. We recorded also, all others foods that were not plants. Each fruiting plants was considered a subject, and only one feeding observation was counted per frugivore species, irrespective of the number of individual feeding. Furthermore, a fruit species was

designated as a diet item if a frugivore was been observed to ingest the fruit, or to regurgitate or defecate a seed. Areas of feedings monkeys were regularly scanned by the observer to identify fruit consumed by mangabeys and guenons. Feeding observation of mangabeys and guenons were recorded from July 2013 and June 2014 excepted the months of December 2013 and January 2014.

The data collected have been analyzed by R commander. The means of observations made have been calculated, we have used the statistics test H of Kruskal-Wallis for simultaneous comparison of the means and Wicoxon test for analysis of means series paired. The differences in the consumption of parts of plants (fruits, leaves, seeds, bark, and dead wood) have been shown in box plots. We have established the differences in tree and liana families consumed by two main groups (Guenons and Mangabeys).

## RESULTS

During 10 months, a total of 553 combined observations of Mangabeys and Guenons have been made of which main activity was supply feeding. 251 observations from Mangabeys and 302 from Guenons. Table 1 shows the list of plant species eaten by Guenons and Mangabeys. They are 84 plant species belonging to 33 different families which compose diet of Mangabeys and Guenons. Whether around 44 species inventoried for Mangabeys supply and 69 species for Guenons ( $V = 1594$  p-value = 0.1796). These results suggest that there are similarities and differences in the frugivorous diet of both groups.

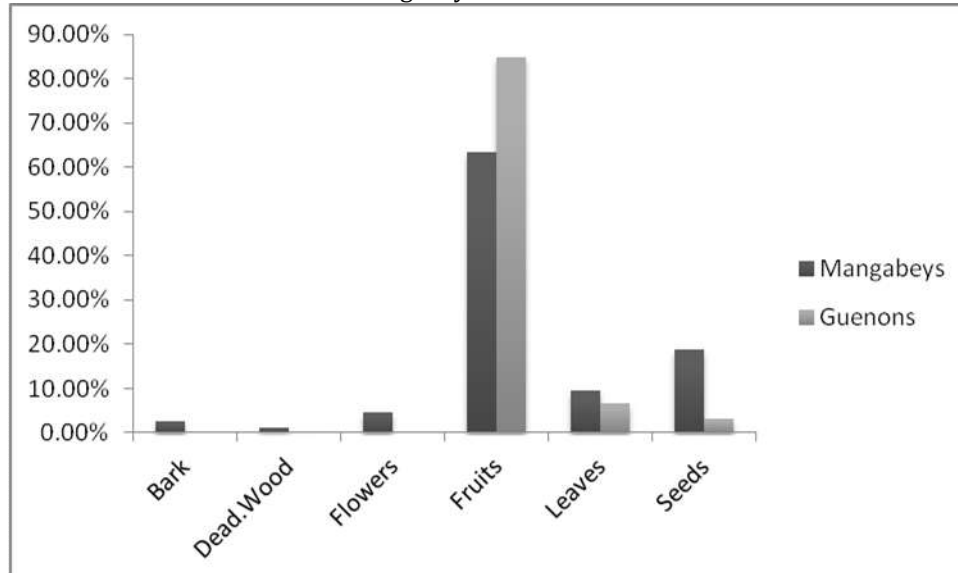
**Tableau 1:** list of plants eaten by Guenons and Mangabeys

Plant species	Guenons	Mangabeys
<i>Aframomum leptolepis</i>		x
<i>Afrotyraxlepidophyllus</i>		x
<i>Afzeliabella</i>		xx
<i>Anthonothasp</i>		xxx
<i>Anthostema aubryanum</i>		xx
<i>Aucoumea klaineana</i>	xx	
<i>Baillonellatoxisperma</i>	x	
<i>Berliniabracteosa</i>		xx
<i>Caloncobawelwitschii</i>	xxx	
<i>Calpocalyxheitzii</i>	x	xx
<i>Cassia mannii</i>	xx	xx
<i>Ceibapentandra</i>	x	xx
<i>Celtistessmanii</i>	x	x
<i>Cissus dinklagei</i>	xxx	xx
<i>Cola sp</i>	xx	
<i>Cola sp</i>	x	
<i>Cola sp1</i>	x	
<i>Coula edulis</i>		x
<i>Cylicodiscus gabunensis</i>	x	xxx
<i>Dacryodes butnerii</i>	xx	xx
<i>Dacryodes butneri (Pachylobus b.)</i>	x	x
<i>Desbordesiasp</i>	x	xx
<i>Dialumsp</i>	xx	xx
<i>dibindi</i>	x	
<i>Diogoazenkeri</i>	xx	
<i>Diospyrosmannii</i>	xx	x
<i>Diospyrossp</i>	x	x
<i>Diospyrossp 1</i>	x	x
<i>Disthemonentussp</i>	xx	x
<i>Dubosciamacrocampa</i>	xx	xxx
<i>Ficus sp</i>	xxx	
<i>Gambeya africana</i>	xx	xx
<i>Garcinia cola</i>	x	

<i>Guibourtiatessmanii</i>	X	X
<i>Harunganamadagascariensis</i>		X
<i>Indetermined 2</i>		XX
<i>Indetermined 3(IIalaba)</i>	XX	
<i>Indetermined 4(muvayu)</i>		X
<i>Indetermined 5</i>		X
<i>Indetermined 6</i>		X
<i>Indetermined 7</i>	X	
<i>Irvingiagabonensis</i>	X	XX
<i>Irvingiagrandifolia</i>	X	X
<i>Klainedoxagabonensis</i>	XX	XX
<i>Landolphia mannii</i>	X	
<i>Lanneawelwitchii</i>	XX	X
<i>Macaranga spinosa</i>	XX	X
<i>Mammea africana</i>	X	
<i>Meiocarpidium lepidotum</i>	X	XX
<i>Milicia excelsa</i>	X	X
<i>Musangacecropioides</i>	XXX	
<i>Myrianthus arboreus</i>	XX	X
<i>Nauclea diderichii</i>	X	X
<i>Octobotolissp(grand fudi)</i>	X	
<i>Pachylobus ferruginea?</i>	X	X
<i>Panda oleosa</i>	XX	
<i>Parinarisp</i>	XX	X
<i>Parkia bicolor</i>		X
<i>Pentaclethra macrophylla</i>	XX	XXX
<i>Piptadeniastrum africanum</i>	XX	XX
<i>Plagiostyles africana</i>	XX	
<i>Polyalthia suaveolens</i>	X	X
<i>Pseudospondias longifolia</i>	XXX	XX
<i>Pterocarpus soyauxii</i>	XX	XX
<i>Pycnanthus angolensis</i>	XXX	XXX
<i>Sacoglottis gabonensis</i>	X	XX
<i>Salacia sp</i>	X	
<i>Santiria trimera</i>	XX	X
<i>Scyphocephalum ochoncoa</i>		X
<i>Staudtia gabonensis</i>	XXX	XXX
<i>Strychnos sp.?</i>	X	
<i>Swartzia fistuloides</i>		XX
<i>Synsepalum dulcificum</i>	XX	X
<i>Tetrapleuratetrapleura</i>	X	XXX
<i>Tieghmella africana</i>	X	X
<i>Trichilaprieureana</i>	XX	XX
<i>Tricoscyphas</i>	XX	X
<i>Uapacaguineensis</i>	X	XX
<i>Vitex sp</i>		X
<i>Xylopiiaethiopica</i>	XX	X
<i>Xylopiaguintasii</i>	XX	XXX
<i>Xylopiahypolampra</i>		X
<i>Xylopiastaudtii</i>	X	X
<i>indetermined1(mousoni cocu)</i>	X	X

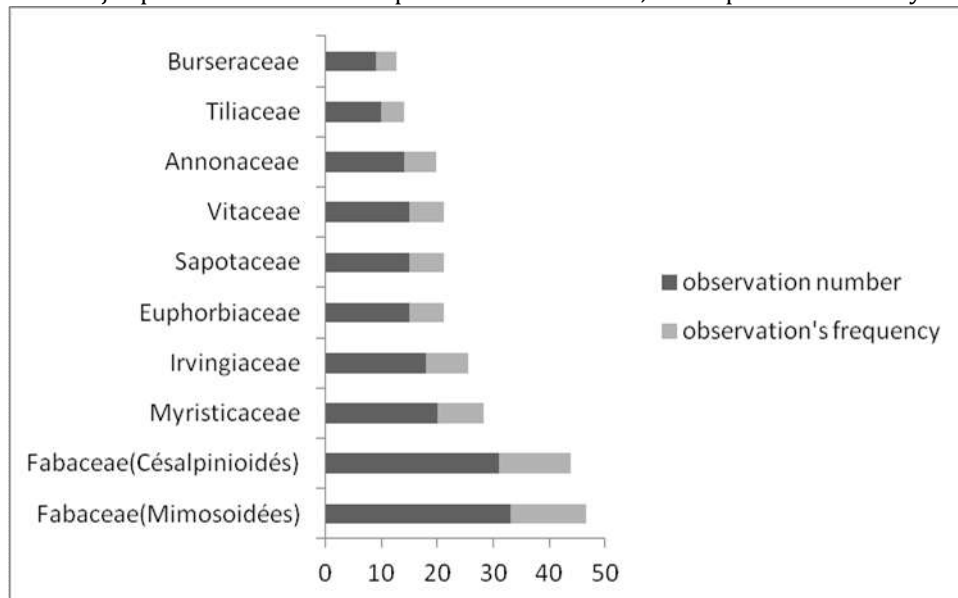
(x represent diet preference; x :low preference; xx : mean preference et xxx : high preference)

The observations of diets Mangabeys and Guenons have shown that their plant-term consumption is limited only 6 mainly plant part: fruits, flowers, leaves, seeds, bark and dead wood. The results show us that the Guenons have a relatively small spectrum to fruits while that of Mangabeys is wide. Figure 2 shows that the percentages of fruits among Guenons (84.77%) are greater than the Mangabeys (63.37%). The consumption of the seeds is higher in Mangabeys compared to Guenons when in regards sheets, the difference is not significant. We note also a lack of consumer dead flowers and dead wood that are widely well below those observed in Mangabeys.

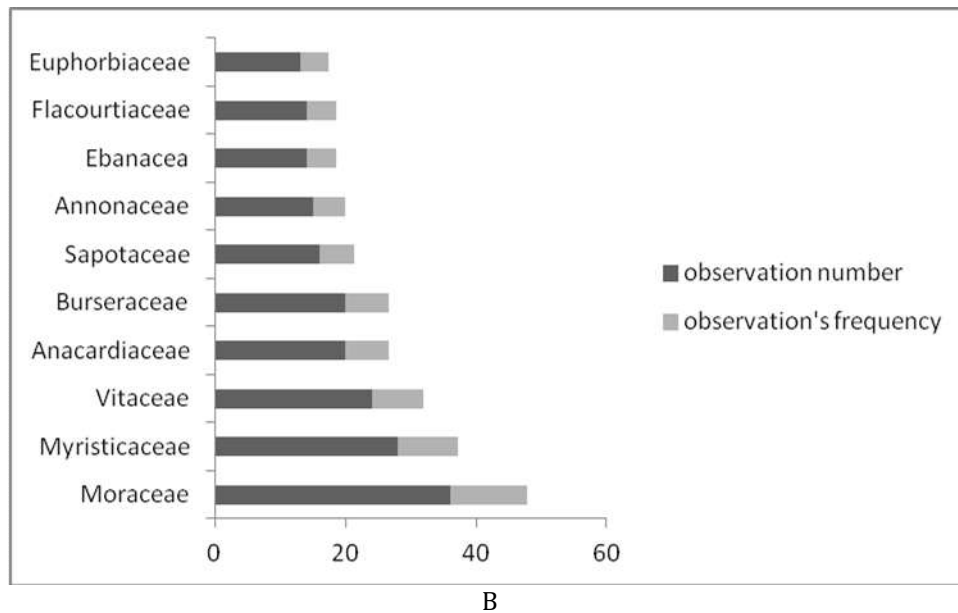


**Figure 2:**Percentage of consumption of plant parts by Guenons and Mangabeys

Data analysis on the top 10 of the various families of plants consumed by monkey's shows that the families most consumed by Guenons are different from those consumed by the Mangabeys. In the top 10 families consumed by Guenons, we have Moraceae, Myristicaceae and Vitaceae. Mangabeys as to them consume in the major part of their time the species of Mimosaceae, Ceasalpiniaceae and Myristicaceae.



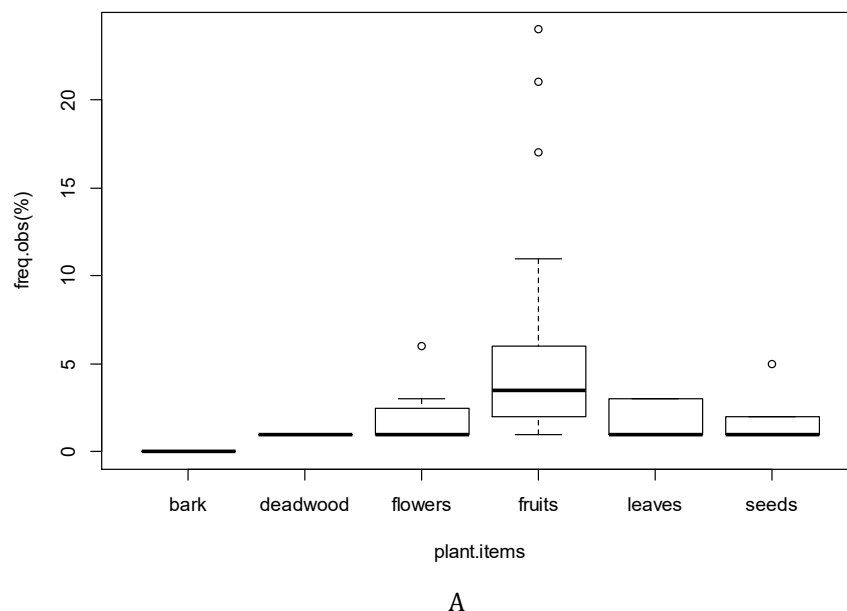
A

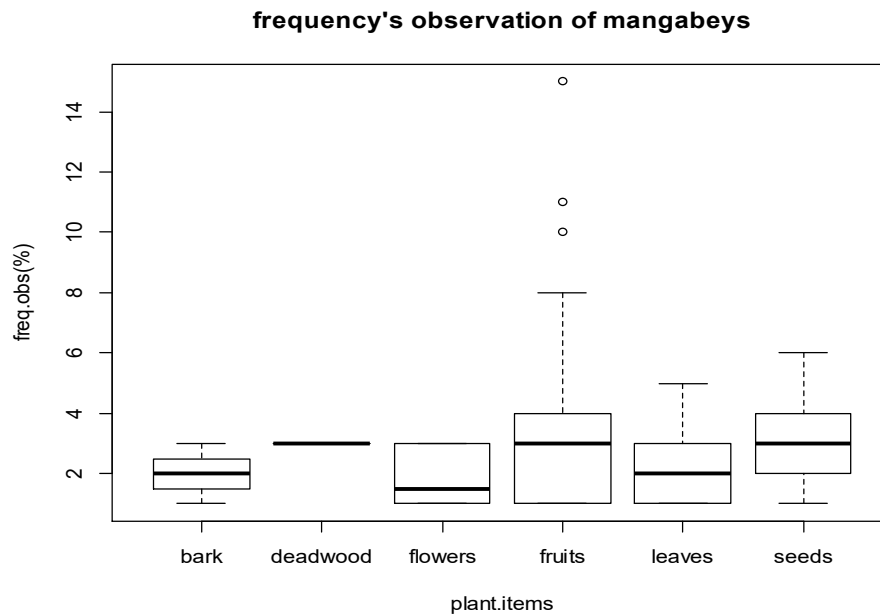


**Figure 3:** Top 10 families consumed by both groups. A) mangabeys and B) guenons

In the list of plant species consumed by two major groups combined, it appears that the Guenons eat more plants than Mangabeys. Figures 4a and 4b show us that Guenons consume fruits of several plant species while Mangabeys consume an average amount of different of plants that they consume. We find that the average consumed fruit in Guenons is much higher than the averages of seeds, leaves, flowers, and dead wood. In Mangabeys there is not difference. The Kruskal-Wallis test H is significant for Guenons (chi-squared = 15,817, df = 5, p-value = 0.007387) and not significant for Mangabeys (chi-squared = 5.6989, df = 5, p-value = 0.3366). More than all the species eaten by monkeys only the fruits are preferred while Mangabeys not only consume the fruits but also, the leaves, seeds, flowers, bark and dead wood. This result suggests that the Mangabeys have a broad spectrum of plant species consumption.

#### frequency's observation of guenons





B

**Figure 4:** Observation frequency in the plant parts supply. A) Guenons B) Mangabeys

## DISCUSSION

The vegetarian diet of mangabeys and Guenons of Moukalaba-Doudou collected during a 10-month period has shown that in their diet small monkeys together consume 84 different plant species. 69 species were identified in the diet of Guenons while mangabeys we identified 44 species. The difference was not significant ( $P > 0.05$ ). They consume the same plant species in the majority of cases. Three fruit species were preferred by both monkeys group (*Pycnanthus angolensis*, *Staudtiagabunensis* and *Cissus dinklagei*). Previous studies of fruit-eating primates have often reported between 75 and 100 different species in their dietary [8, 16, 17]. Our results show high percentages of fruit 84.77% and 63.37% respectively in guenons and mangabeys. However, consumption of seeds is representative in Mangabeys than in Guenons. To Dja National Park in Cameroon, guenons consume 78% of fruits and seeds 4% while mangabeys ate 47% fruit and 31% seeds [18]. Our results show that it would be a difference in the consumption of seeds between mangabeys and Guenons (18.93% and 3.31% respectively). In other areas, where Guenons, Mangabeys and Colobines the results show that Colobines consume more seeds than the other two groups [19, 20] and are considered as predator of seeds. In Moukalaba, granivorous is observable among Mangabeys. Indeed, during periods of fruit scarcity, Mangabey consumes a wide variety of seeds while Guenons tend to look for fruit available [21, 17]). The dentition of Mangabeys is an adaptation in granivorous diet may be explaining this phenomenon [22-24,3].

Our analysis allowed us to show that the Mangabeys and Guenons eat different plant families. The Mangabeys consume mostly species of family of Ceasalpinaceae, Mimosaceae and Myristicaceae while Guenons consume more species from families Moraceae, Myristicaceae and Vitaceae. These results are explained by the fact that the species of the families Mimosaceae and Ceasalpinaceae produce for most fruits whose seeds are consumed by Mangabeys whereas Guenons their dependence on the consumption of fruit is confirmed by the preference of Moraceae (*Ficus* sp et *Musangacecropioides*) which produce fruit available for several months of the year [17, 8]. At Makokou, data on the diets of Guenons (*Cercopithecus cephus*, *Cercopithecus nictitans* and *Cercopithecus pogonias*) showed that *Cissus dinklagei* (Vitaceae) is an essential element in their diet of frugivorous [25]. Our results confirm that this food is preferred by Guenons. The preference of Myristicaceae by the two groups is due to the fact that during periods of fruit scarcity (dry season), they consume *Pycnanthus angolensis* and *Staudtiagabonensis*.

Finally, the analysis of vegetarian diet of Guenons and mangabey has also shown that these two groups have different dietary strategy. Our results allowed to see that Mangabey consume several parts of plants unlike monkeys whose diet is more inclined towards fruit consumption. Indeed, consumption strategies could be explained by environmental factors, different habitats and behavior of species in each group. In the group Mangabey we have *Cercocebus torquatus* that are semi-terrestrial species and therefore have food diversity. Their strategy is different from the others because they can feed on all strata of the forest.

Then *Lophocebus albigena* is known as strictly arboreal and therefore feeds on seeds, leaves etc. showed that *Lophocebus albigena* is omnivorous and consumes more parts of plants (Poulsen, 2001). Our results show that Mangabeys (*Lophocebus albigena* and *Cercocebus torquatus*) consume more plant parts in their diet and that monkeys have a tendency to consume fruits. We have obtained non-significant test from Mangabeys but significant test from Guenons.

In this study we have think it that, Guenons and Mangabeys consume a large variety of plant in Moukalaba-Doudou National Park. However, we have recorded many difference, Mangabeys consume different plant part whereas Guenons consume on majority fruits. This different diet may to explain the lack of competition when those different groups form polyspecifics associations.

## ACKNOWLEDGMENTS

This study was conducted in cooperation among the Centre National de la Recherche Scientifique et Technologique (CENAREST), the Institut des Recherches en Ecologie Tropicale (IRET), Université des Sciences et Techniques de Masuku (USTM), Gabon, and Kyoto University, Japan. We thank the Agence Nationale des Parcs Nationaux (ANPN) of the Gabonese government for permission and support for our research project in Gabon. We are also greatly indebted to M. MAKOULOUTOU Patrice for her help and all the field assistants at Moukalaba-Doudou National Park and the people in the villages of Doussala and Mboungou for their kind support and hospitality. This study was financed in part by a Grant-in-Aid for the Doctor Course Program of University des Sciences et Techniques de Masuku (to L.B MANGAMA KOUMBA), Grants-in-Aid for Scientific Research by the Ministry of Education, Culture, Sports, Science and Technology, Japan (No. 162550080, No. 19107007, No. 24255010 to J. YAMAGIWA), and SATREPS (Science and Technology Research Partnership for Sustainable Development) by JST/JICA, Japan.

## REFERENCES

1. Takenoshita Y, Yamagiwa J. 2008. Estimating gorilla abundance by dung count in the northern part of Moukalaba-Doudou National Park, Gabon. *Afri. Stud. Mono* 39:41–54.
2. Nakashima. Y., Iwata. Y., Ando. C., NzeNkogue. C., Inoue E., AkomoOkoue. E., MbehangNguema. P., DiopBineni T., NgokBanak L., Takenoshita. Y., Ngomanda. A., & Yamagiwa. J. (2013). Assessment of Landscape-Scale distribution of Sympatric Great Apes in African Rainforest Concurrent Use of Nest and camera-Trap surveys. *Int. Jour. Prim.* 9999: 1–11.
3. Waser, PM. 1987. Interactions among primate species. In *Primate Societies*, ed. B. B. Smuts, Cheney DL, Seyfarth RM, Wrangham RW, Struhsaker TT, pp. 210–26. Chicago: Chicago University Press.
4. Charles-Dominique, P. 1977. Ecology and Behaviour of Nocturnal Primates: Prosimians of Equatorial West Africa. New York: Columbia University Press.
5. Gautier-Hion A. 1980. Seasonal variation of diet related to species and sex in a community of Cercopithecus monkeys. *Jour. An. Ecol.* 49, 237–69.
6. Gautier-Hion, A. 1984. La dissémination des graines par les cercopithecides forestiers Africains. *Terre. Vie.* 39:159–165.
7. Gautier-Hion A. 1988. The diet and dietary habitats of forest guenons. In A. Gautier-Hion, F. Bourliere, J. P. Gautier, and J. Kingdon, (ed). *Primate radiation: evolutionary biology of the African guenons*. Cambridge University Press, Cambridge, UK. 257–283.
8. Gautier-Hion A, Brugière D. 2003. Significance of Riparian forest for the conservation of Central African Primates. *Int. Jour. Prim.* 26: 515–523.
9. Iwata Y, Ando C. 2007. Nest and nest-site reuse by western lowland gorillas (*Gorilla g. gorilla*) in Moukalaba-Doudou National Park, Gabon. *Prim.* 48: 77–80.
10. Ando C, Iwata Y, Yamagiwa J. 2008. Progress of habituation of western lowland gorillas and their reaction to observers in Moukalaba-Doudou National Park, Gabon. *Afri. Stud. Mon.* 39S:55–69.
11. Takenoshita Y, Ando C, Yamagiwa J. 2008. Fruit phenology of the great ape habitat in the Moukalaba-Doudou National Park, Gabon. *Afri. Stud. Mono.* 39:23–39.
12. Thibault M, Fisher BL, Goodman SM. 2004b. Description of Mounts Doudou, Gabon, and the 2000 *biological inventory of the reserve*. In: Fisher BL (ed.) *Mounts Doudou, Gabon: A floral and faunal inventory with reference to elevational distribution*. California Academy of Science, San Francisco. 3–16.
13. Sosef MSM, Issembe Y, Bourobou HPB, Koopman WJM. 2004. Botanical diversity of the Pleistocene forest refugia Mounts Doudou. In: Fisher BL, (ed). *Mounts Doudou, Gabon: Floral and faunal inventory with reference to elevational distribution*. San Francisco, CA: California Academy of Science. P 17–92.
14. Fisher BL. 2004. *Mounts Doudou, Gabon: A floral and faunal inventory : with reference to elevational distribution*. California Academy of Sciences, San Francisco.
15. Wilson, DE, DM, Reeder. 2005. *Mammal species of the world. A taxonomic and geographic reference*. Baltimore, The Johns Hopkins University Press.
16. Ham RM, 1994. Behaviour and ecology of the grey cheeked mangabeys (*Cercocebus albigena*) in the Lope Reserve, Gabon. Dissertation. University of Stirling, Stirling, UK.
17. Tutin, CEG, Ham RM, White LJT, Harrison MJS. 1997. The primate community of the Lope Reserve, Gabon: diets, responses to fruit scarcity, and effects on biomass. *Int. Jour. Prim* 42:1–24.



18. Poulsen. RJ, Clark. JC, Smith TB. 2001. Seasonal Variation in feeding Ecology of Grey-Cheeked Mangabey (*Lophocebusalbigena*) in Cameroon.*Int. Jour. Prim.* 54:91-105.
19. Sun I, Chen Y, Hubbell S, Wright S, Noor N. 2007. Seed predation during general flowering events of varying magnitude in a Malaysian rain forest.*Jour. Ecol.*95, 818-827
20. Maisels F, Gautier-Hion A, Gautier JP. 1994. Diets of two sympatric colobines in Zaire : More evidence on seed-eating in foress on poor soils. *Int. Jour. Prim* 15: 681-701.
21. PoulsenRJ, Clark JC, ConnordEF, Smith TB. 2002. Differential resource use by primates and hornbills: implications for seed dispersal. *Ecol.* 83:228-240.
22. Kinzey W, Norconk M. 1990. Hardness as a basis of fruit choice in two sympatric primates.*Am. Jour. Physic. Anthropol.* 81:5–15.
23. Lambert JE. 1999. Seed handling in chimpanzees (*Pan troglodytes*) and redtail monkeys (*Cercopithecusascanius*): implications for understanding hominoid and cercopithecine fruit-processing strategies and seed dispersal.*Am. Jour. Physic. Anthropol.* 109:365–386.
24. Lambert J. E., Chapman C. A, Wrangham. R .W.,& Conklin-Brittain N. L. 2004. Hardness of cercopithecine foods: implications for the critical function of enamel thickness in exploiting fallback foods.*Am. Jour. Physic. Anthropol.* 125:363–368.
25. Gautier-Hion, A. 1978.In Recent Advances in Primatology, Vol. 1.*Food niches and coexistence in sympatric primates in Gabon*.Chivers DJ.andHerbert J. (ed). New York: Academic Presspp. 269–86.

#### CITATION OF THIS ARTICLE

Mangama-Koumba Lilian Brice, Ebang Ella Ghislain Wilfried, Akomo-Okoue Etienne François, Mindonga Nguelet Fred Loic,M'batchi Bertrand and Mavoungou Jacques François. Vegetarian diet in Guenon and Mangabey monkeys of Moukalaba-Doudou National Park, Gabon: Similarities and Differences. Bull. Env. Pharmacol. Life Sci., Vol 5 [10] September 2016: 80-88