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

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ABSTRACT

To order to know any differences and similarities between Mangabeys and Guenons study of their vegetarian diet was conducted for 10 months between 2013 and 2014 in Moukalaba-Doudou National Park, Gabon. By using the direct observation method, we identified 84 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 consummation 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-squared = 5.6989, df = 5, p-value = 0.3366) interested in several of plants while monkeys (chi-squared = 15.817, df = 5, p-value = 0.007387) remain more attached to fruit consumption.

Keywords: Mangabeys, Guenons, diet, Moukalaba-Doudou, difference and similarity.

INTRODUCTION

Cercopithecines monkey are considerate as the large group of diurnal primates of African and Asian tropical forest (Grubb et al., 2003; Marini et al., 2012). Cercopithecines include 12 genera divided into two tribes, *Cercopithecini* (Guenons) and *Papionini* (baboons, mangabeys and macaques; Smith and Junger, 1997). Many genera of Cercopithecines occupy habitats of

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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 (Takenoshita and Yamagiwa, 2008; Nakashima et al., 2013b). 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 (Chapman et al., 1999; Matsuda et al., 2013a). 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 (NRC, 2003). A study of Chapman et al (2002) and analysis of others author showed that many groups of cercopithecines frequently eat diets which, though very similar in gross content (percentage of fruit, leaves, insect matter, and other materials), differ in the specific plants consume. Also, monkey's population of the same species in different forests ate diets that tended to be more similar to sympatric groups of other species than to conspecifics in other forests.

Morphological and behavioral differences, which presumably reflect different positional behaviors, were found within both Guenons and Mangabeys groups (Nakatsukasa, 1994), and in areas where living sympatricaly Colobus, Guenons and Mangabeys, diets of each group have been widely discussed (Chapman et al., 2002; Buzzard, 2006; Harris and Chapman, 2007). 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.

MATERIALS AND METHODS

Study site

The Moukalaba-Doudou National Park is located at south-western Gabon and covers an area of ~5028 km² (Figure 1). This park (S02°20'49.0"; E010°34'19.0") is located mainly in the province of Nyanga (Mounioko et al., 2015). The park faces the Atlantic Ocean on its south-western boundary. The Doudou mountain Range, up to 900 m in altitude, runs north to south. The Park contains a mosaic of vegetation: primary and secondary forest, mountain forest, marsh and savannah (Iwata and Ando, 2007). The study area covers approximately 500 km² 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 (Ando et al., 2008; Takenoshita et al., 2008), 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 (Takenoshita et al., 2008). 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 (Thibault et al., 2004). 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 (Sossef et al., 2004). Fisher (2004) conducted a floral and faunal inventory survey of the study area.

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 ogoouensis* (Wilson and Reeder, 2005) 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 except the months of December 2013 and January 2014.

The data collected were analyzed by R commander. The means of observations made were calculated. The statistical test H of Kruskal-Wallis was used 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 boxplots. The differences in tree and liana families consumed by the two main groups (Guenons and Mangabeys) were established.

RESULTS

During 10 months, a total of 553 combined observations of Mangabeys and Guenons have been made of which the 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 45 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.

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

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. The fruit average consumed in the Guenons is much higher than the averages of seeds, leaves, flowers, and dead wood. To the 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 for consumption.

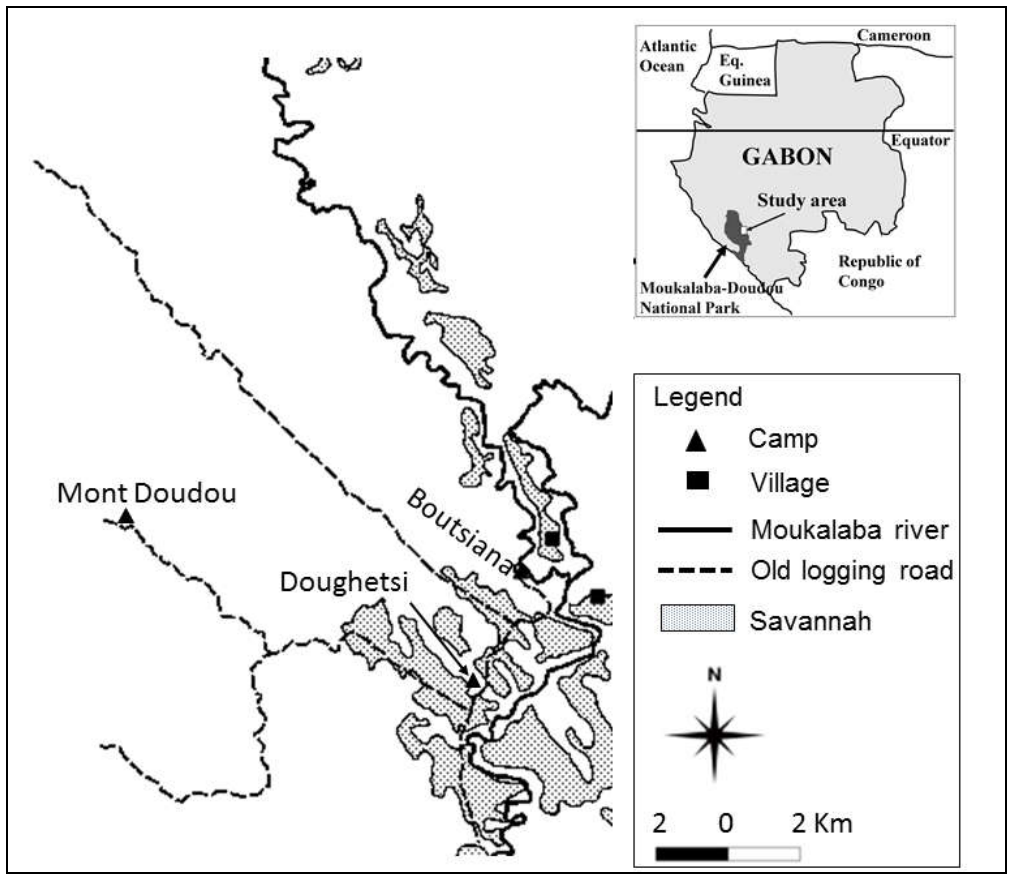


Figure 1: Localization of study site of Northen part of Moukalaba-Doudou National Park.

Tableau 1: List of plants eaten by Guenons and Mangabeys.

Plant species	Guenons	Mangabeys
Aframomum leptolepis	x	
Afrostyrax lepidophyllus	x	
Afzelia bella		xx
Anthonotha sp		xxx
Anthostema aubryanum		xx
Aucoumea klaineana	xx	
Baillonella toxisperma	x	
Berlinia bracteosa		xx

Caloncoba welwitschii	xxx	
Calpocalyx heitzii	x	xx
Cassia mannii	xx	xx
Ceiba pentandra	x	xx
Celtis tessmanii	x	x
Cissus dinklagei	xxx	xx
Cola sp	xx	
Cola sp	x	
Cola sp1	x	
Coula edulis		x
Cylicodiscus gabunensis	x	xxx
Dacryodes butnerii	xx	xx
Dacryodes buttneri (Pachylobus b.)	x	x
Desbordesia sp	x	xx
Dialum sp	xx	xx
dibindi	x	
Diogoa zenkeri	xx	
Diospyros mannii	xx	x
Diospyros sp	x	x
Diospyros sp 1	x	x
Disthemonentus sp	xx	x
Duboscia macrocarpa	xx	xxx
Ficus sp	xxx	
Gambeya africana	xx	xx
Garcinia cola	x	
Guibourtia tessmanii	x	x
Harungana madagascariensis		x
Indetermined 2		xx
Indetermined 3(Ilalaba)	xx	
Indetermined 4(muvayu)		x
Indetermined 5		x
Indetermined 6		x
Indetermined 7	x	
Irvingia gabonensis	x	xx
Irvingia grandifolia	x	x
Klainedoxa gabonensis	xx	xx
Landolphia mannii	x	
Lannea welwitchii	xx	x
Macaranga spinosa	xx	x
Mammea africana	x	
Meiocarpidium lepidotum	x	xx
Milicia excelsa	x	x
Musanga cecropioides	xxx	
Myrianthus arboreus	xx	x
Nauclea diderichii	x	x
Octobotolis sp (grand fudi)	x	
Pachylobus ferruginea?	x	x
Panda oleosa	xx	

Parinari sp	xx	x
Parkia bicolor		x
Pentaclethra macrophylla	xx	xxx
Piptadeniastrum africanum	xx	xx
Plagiostyles africana	xx	
Polyalthia suaveolens	x	x
Pseudospondias longifolia	xxx	xx
Pterocarpus soyauxii	xx	xx
Pycnanthus angolensis	xxx	xxx
Sacoglottis gabonensis	x	xx
Salacia sp	x	
Santiria trimera	xx	x
Scyphocephalium ochoncoa		x
Staudtia gabonensis	xxx	xxx
Strychnos sp.?	x	
Swartzia fistuloides		xx
Synsepalum dulcificum	xx	x
Tetrapleura tetrapleura	x	xxx
Tieghmella africana	x	x
Trichilia prieureana	xx	xx
Tricoscypha sp	xx	x
Uapaca guineensis	x	xx
Vitex sp		x
Xylopia aethiopica	xx	x
Xylopia guintasii	xx	xxx
Xylopia hypolampra		x
Xylopia staudtii	x	x
Indetermined1(mousoni cocu)	x	x

x represent diet preference; x :low preference; xx : average preference et xxx : high preference.

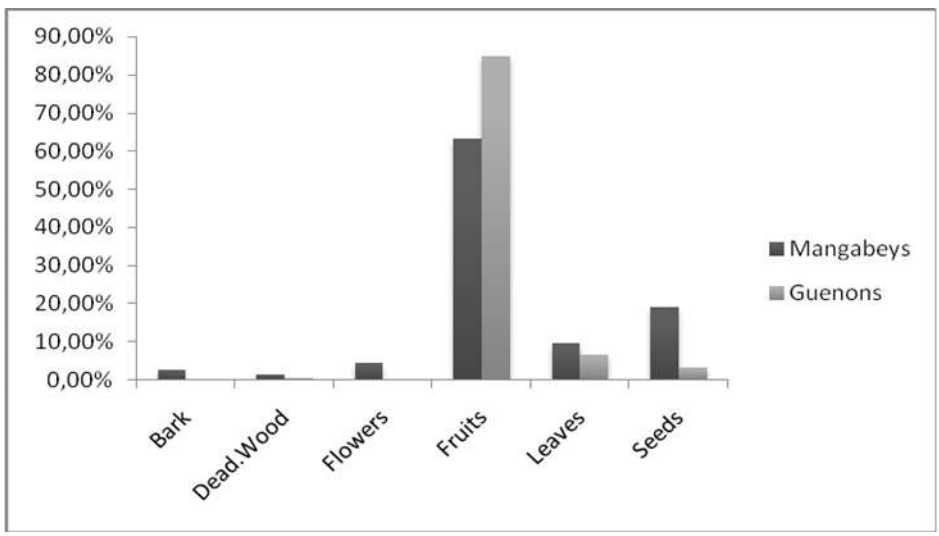
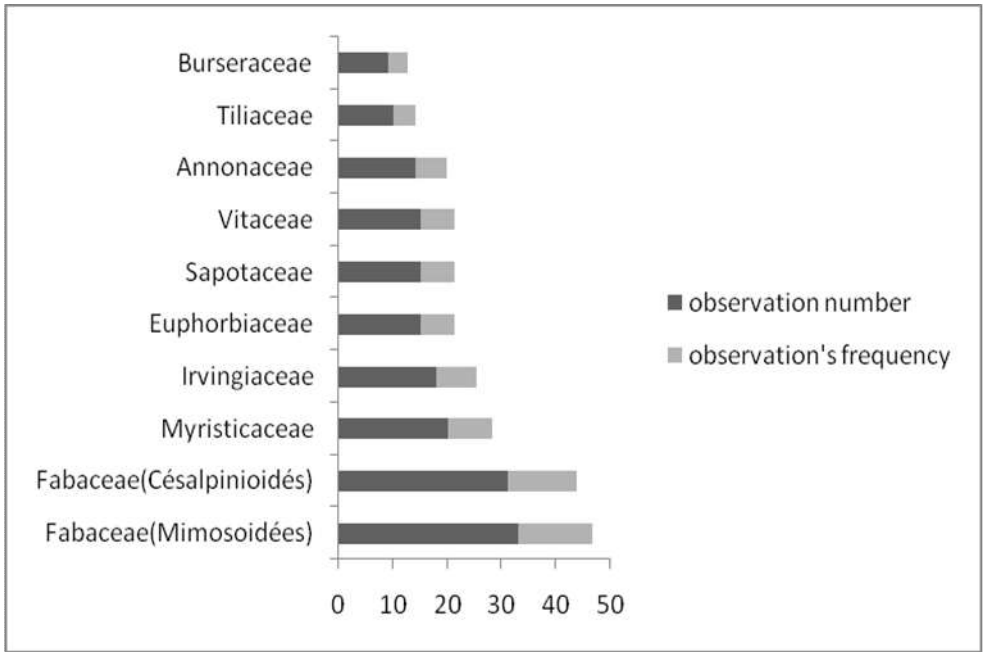
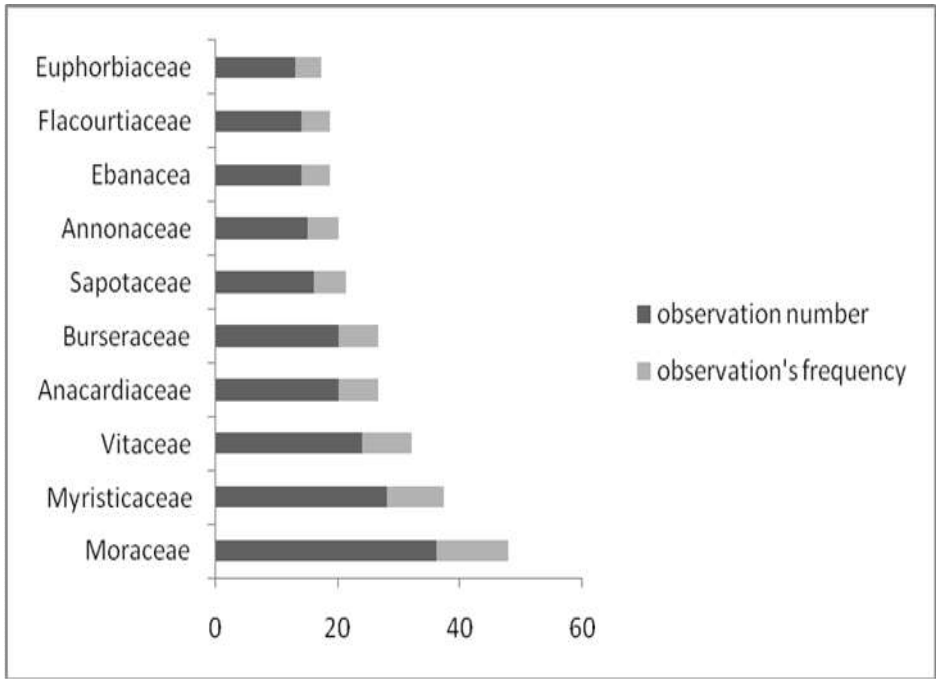


Figure 2: Percentage of consumption of plant parts by Guenons and Mangabeys.

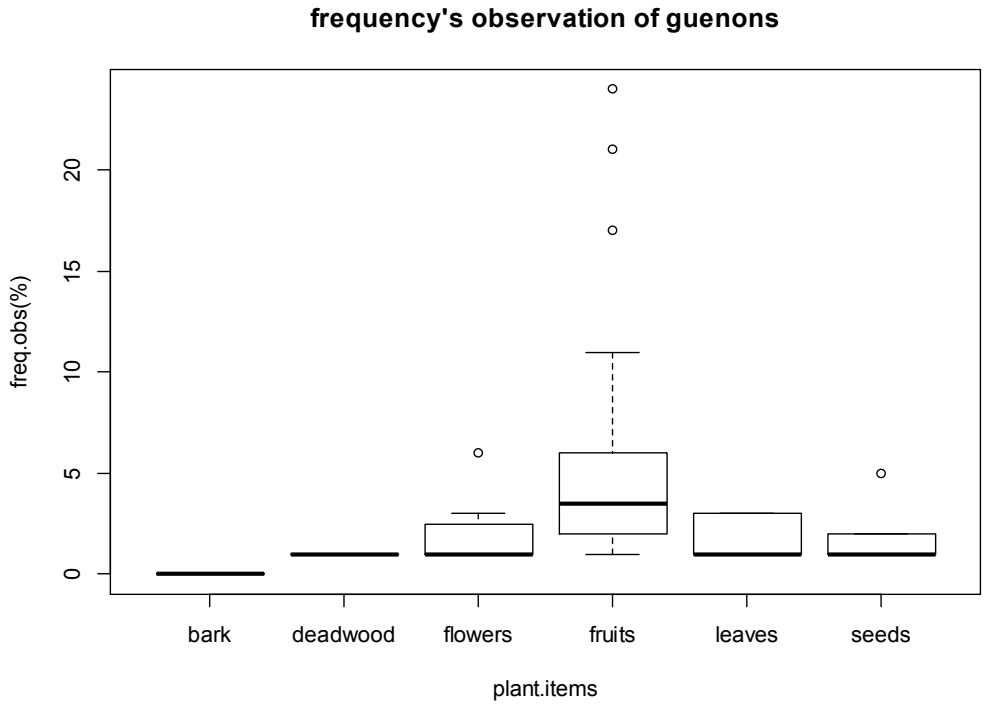


A)

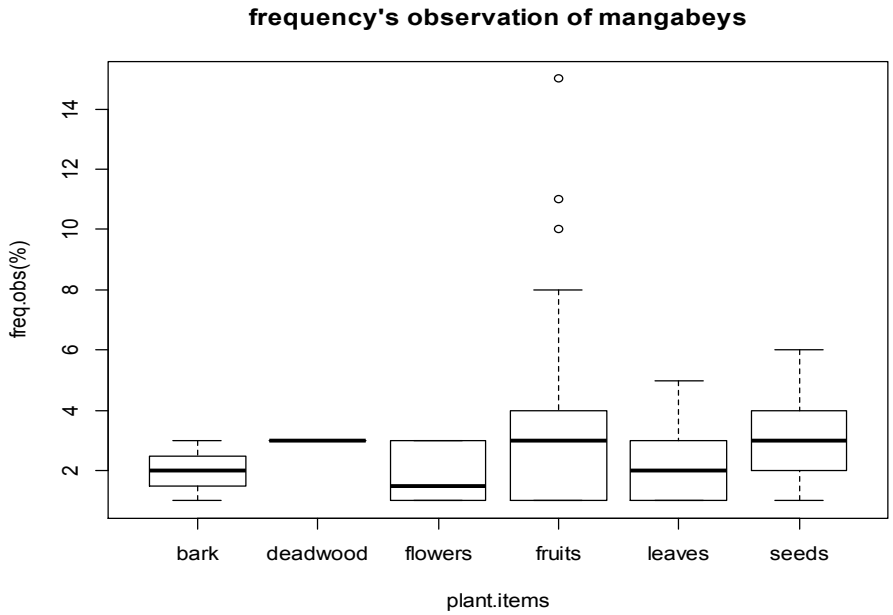


B)

Figure 3: Top 10 families consumed by both groups. A) Mangabeys and B) Guenons.



A)



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. They consume the same plant species in the majority of cases. Three fruit species were preferred by both monkeys group (*Pycnanthus angolensis*, *Staudtia gabonensis* and *Cissus dinklagei*). Previous studies of fruit-eating primates have often reported between 75 and 100 different species in their dietary (Gautier-Hion, 1988; Ham, 1994; Tutin et al., 1997; Anderson et al., 2005). 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 (Poulsen et al., 2000). 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 (Sun et al., 2007; Maisels et al., 1994) 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 (Poulsen et al, 2000; Anderson 2005). The dentition of Mangabeys is an adaptation in granivorious diet may be explaining this phenomenon (Kinzeyan Norconk, 1990, 1993; Lambert et al, 2004).

Our analysis allowed us to show that the Mangabeys and Guenons eat different plant families. The Mangabeys consume mostly species of family of Ceasalpiniaceae, 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 Caesalpiniaceae 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 *Musanga cecropioides*) which produce fruit available for several months of the year (Gautier-Hion, 1984; Takenoshita et al., 2008). 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 (Gautier-Hion, 1980). 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 *Staudtia gabonensis*.

Finally, the analysis of vegetarian diet of Guenons and mangabeys 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 Mangabey group 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.

Conclusion

In this study we think 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 explain the lack of competition when those different groups form polyspecific associations.

COMPETING INTERESTS

The authors declare that they have no competing interests.

AUTHORS' CONTRIBUTIONS

LBM-K was the principal investigator and drafted the manuscript; GWEE and FLMN help in data collection and propositions; EFA-O performed research and Maps conception; BM and JFM participated in the study and manuscript writing. All authors read and approved the final manuscript.

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