# Use of vertical space by the mother-young greater bamboo lemur (*Prolemur simus*) in the fragmented forest of Ambalafary-Eastern Madagascar.

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**ABSTRACT**

*Vertical and horizontal space use and exploitation are different in primates depending on the state of degradation of their habitats. For the mother and the young Prolemur simus data on space use according to the developmental phase of the young were recorded assuming that the young exploits its space independently of its mother. To achieve the objectives, both mother-young individuals were followed in october 2014 to september 2015 in the site of Ambalafary using the focal animal sampling method every 5 min including rare events in "ad libitum". The results show that during phase 1 (0-2 months old) and phase 2 (3-5 months old) the supports used by the dyad are bamboos (young: 69.9%; mother: 70.7%), trees (young: 26.4%; mother: 25.2%) and ground (young: 3.7%; mother: 4.1%). There was no significant difference in the height chosen by the mother and the young on the trees for all phases. For phase 3 (6-8 months old) and phase 4 (9-11 months old) the use of ground as a support is no longer observed and is replaced more by bamboos (young 94.8%; mother: 94.3%). Thus the exploitation of the vertical space by the young Prolemur simus is done in the presence of its mother at least until its first year of life. It is essential to extend the study of the ecology of the young to a more advanced age in order to detect how far this mother-young relationship holds to have an idea on the dynamics of the population of Prolemur simus given the degradation of the site and to be able to ensure the survival of the species in the long term.*

**Key words**: *Prolemur simus; lemur, developmental phase; Ambalafary; Madagascar*

## 1. INTRODUCTION

Primates exploit the space or habitat in which they live differently. For example, small primates tend to use small supports while large primates tend to use larger supports because there is a positive relationship between the type of support used and body mass [1]. Indeed, habitat selection and use for primates is influenced by several factors including resource distribution and predation risk [2][3][4][5], but also by group size, population density, season, and state of degradation or fragmentation of the habitat [6][7][8].

In lemurs, habitat characteristics influence habitat use and selection, such as the abundance of foods: *Canarium* sp for *Aye aye* [9], the abundance of insects, fruits, and gums for omnivorous lemurs [10][11][12][13]; leaf and fruit quality and production for folivorous and frugivorous lemurs; and habitat structure for lemurs that specialize in jumping or climbing [14][15]. Bamboo lemurs (*Hapalemur* sp; *Prolemur simus*) are no exception in how they use and select their habitats. Indeed, almost all forest spaces and levels are exploited: from the

ground [16][17][18][19][20] to the highest canopy as well as the lowest levels of the trees because of the characteristics of these lemurs (which fed mainly on bamboos) or just to protect themselves from possible predators [21].

For *Prolemur simus*, which is also a bamboo lemur and is the subject of our study, bamboo is their primary source of food at about 90% [22][23][24][25][26][27][28][29][30][31][32][33] Space use in *Prolemur simus* is therefore conditioned by the distribution of bamboo, the latter is often located at various altitudes [28] but as a result of human activities: these bamboos are often commercialized [34] or burned and turned into crop fields (pers obs). Therefore the potential habitat of bamboo lemurs including *Prolemur simus* is threatened and as so far no detailed studies regarding habitat use in the fragmented forest of Ambalafary have been undertaken and it is not yet known to what extent this fragmented habitat can support a population of *Prolemur simus* in the long term, there is an urgent need for data on the ecology of the mother-young *Prolemur simus* and detailed information on the choices that lead them to choose this or that support among many others.

The mother-young dyad *Prolemur simus* was chosen in the habitat use study because being already classified by the IUCN in 2020 [35] as a critically endangered species it also lives in a degraded habitat while often the quality of the habitat has a huge influence on the health of young lemurs, In particular, it causes nutritional stress affecting a slowing of the maturation period of the young [36] as well as its development [37] which would impact reproduction up to the dynamics of the whole population [38][39]. For the mother, the survival of her young; her own survival as well as the survival of her future young are in question because a fragmented habitat often does not allow her to maximize her genetic heritage [40]. Thus the aim of the study is to know the ecology and the mode of use of the habitat by the mother-young *Prolemur simus* according to the various phases of development of the young. Specific objectives include: Identify the supports used by mother-youth according to each phase; Determine the average height used by the mother-young dyad according to each phase; Identify the supports used by mother-young by season; Determine the average height used by the dyad according the season.

## 2. METHODS

### 2.1.Method of identifying individuals

As the animals were not collared, the patrol method was used. This consists of the direct survey of the species from recent traces left by the animal such as food remains or faeces or the smell of urine. When the animals are finally located, direct counting and sexing (when possible) is performed. The identification of the mother-young dyad is done by marking the right eye of the mother which is bounded.

### 2.2. Instantaneous observation

Observations were made every 5 minutes using the "focal animal sampling" method [2]. This method consists of observing the behavior of the mother-calf every 5 minutes and observing rare behaviors and recording them in ad libitum [2]. As the species is partly arboreal, a unit of measurement was taken into account to determine the height frequented by the animal and is calculated as follows:

"Unit of measurement = average adult size (without tail)*2=1m

### 2.3 Observation period

The monitoring of the mother-young *Prolemur simus* itself began in October 2015 and ended in September 2016 with periods interspersed with days of non-monitoring because of inaccessibility to the site (heavy rain leading to high flooding of the Ivohitra River) or the annual vacation or the cut of the railroad. In short, we spent a total of 150 days at the site for the monitoring itself, that is to say, about 1200 hours.

### 2.4. Study sites

Located on the other side of the Tananarivo Côte Est (TCE) railroad line between PK 227+12, the site of Ambalafary is an isolated site of the Commune Rurale de Fanasana gare and is among the 17 communes of the district of Brickaville Region Atsinanana. It has as geographical coordinates S18, 80080° E48, 8092° and is located between the chief town of the Rural Commune of Fanasana station to the west and the fokontany of Mangabe to the east on the north bank of the Ivohitra River. This site is managed by a local community based conservation named Ainga Vao II created on purpose by the local population when the presence of *Prolemur simus* was confirmed in the area [41]. This is a site dominated by the bamboo species *Bambusa vulgaris* and *Valiha diffusa.*

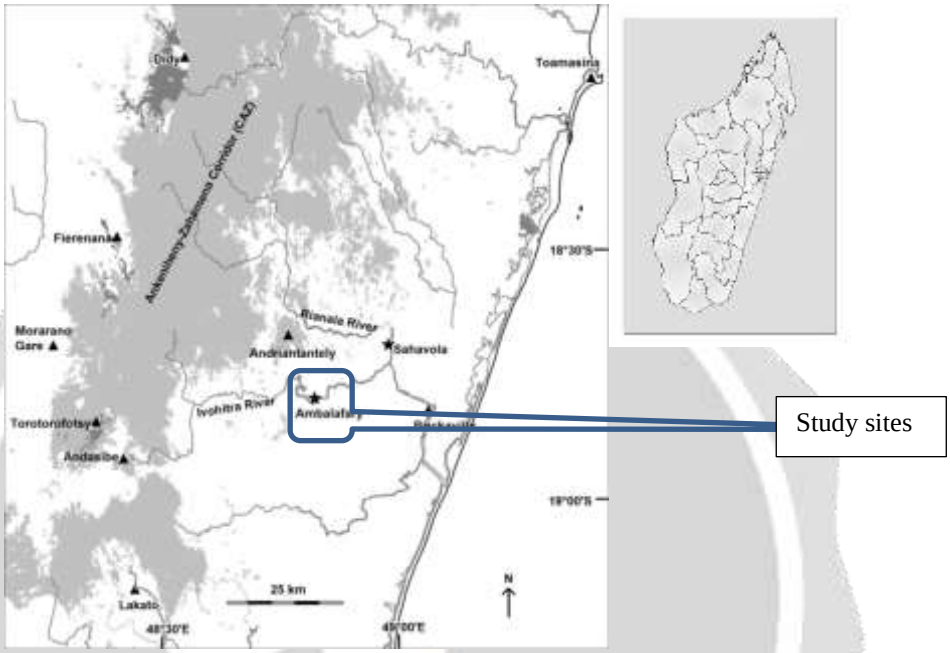


**Fig-1:** Localisation of the study sites Ambalafary

## 3. RESULTS

### 3.1 Use of the vertical space (phase 1)

By comparing the supports most frequently used by the dyad, the Chi two test of independence ($X^2_c$=0.281.; ddl=2 P=0.86>0.05) shows that the supports used by the mother and her young have no significant difference during phase 1: the use of bamboos is respectively for the young and the mother (69%). The use of bamboos is respectively for the young and the mother (69.9%; 70.7%), then come the supports that are not made of bamboos such as fruit trees for the young (26.4%) and for the mother (25.2%) finally the ground is also used but at a slightly lower frequency respectively for the young and the mother (3.7%; 4.1%). Comparing the height chosen by the mother and the young to carry out their activities, Student's t-test (t=0.39; P=0.69>0.05) shows that there is no significant difference in this height for the mother (4.72±0.10m) and the child (4.78±0.10m). Fig -2.

### 3.2.Use of the vertical space (phase 2)

Regarding phase 2, the Chi two test of independence ($X^2_c$=3.37. ;ddl=2 ; P=0.18>0.05) still shows that there is no significant difference between the supports used by the mother and the young during phase 2: bamboo supports are still the most used by the mother (69.8%) and the young (73.6%). The use of the ground is slightly higher than in phase 1: for the mother (14.4%) while for the young (15.7%). The non-bamboo supports are used by the mother at 15.8% and for the young at 10.6%. Fig 2c. In phase 2, Student's t-test (t=-1.84; P=0.06>0.05)

shows that there is no significant difference between the height chosen by the mother and the young: for the mother it is 4.33±0.17m while for the young it is 3.86±0.18m. Fig-3.

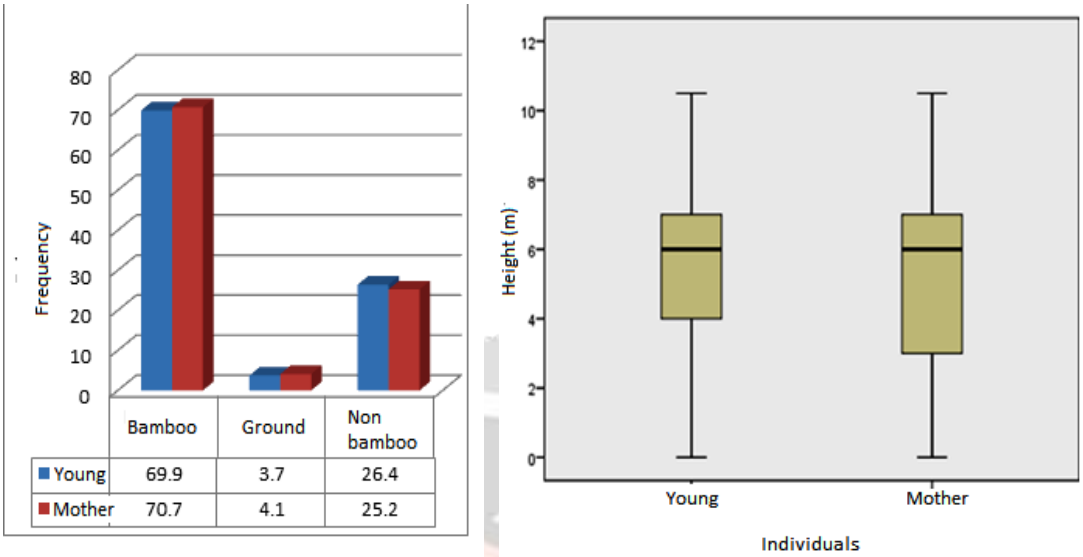


**Fig-2**: Vertical support (left) and Height (right)of young mother in phase 1

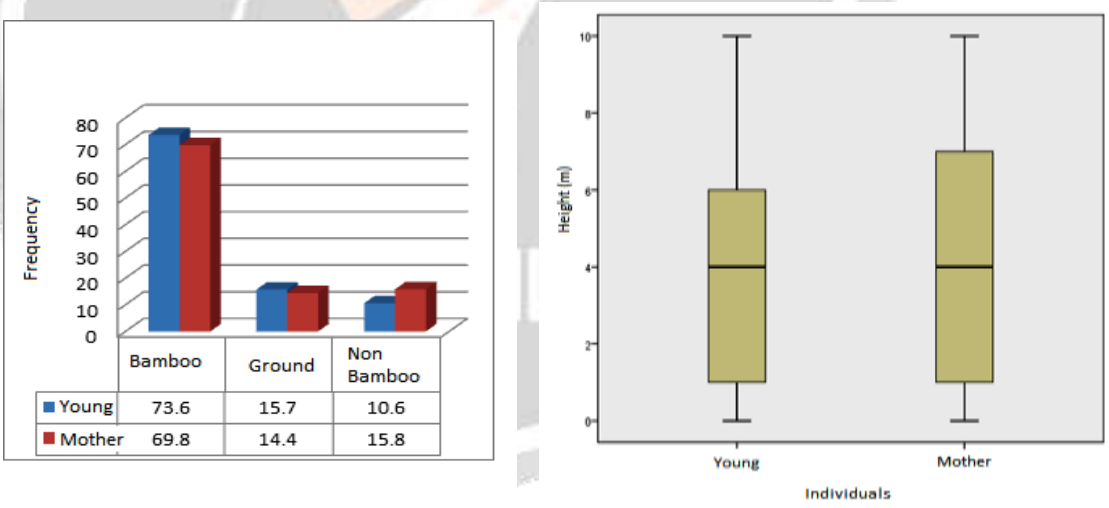


**Fig-3**: Vertical support (left) and Height (right)of young mother in phase 2

### 3. 3.Use of the vertical space (phase 3)

In the same way for phase 3 the Chi two test of independence ($X^2_c$=2.53=3. ;ddl=1 ; P=0.82>0.05) shows again that there is no significant difference between the supports used by the mother and the young . Let us note that during this phase the ground is no longer used as support for the dyad. The use of vertical supports is limited only to bamboos and trees respectively for the mother and the young (94.3%; 5.7%; 94.8%; 5.2%). For phase 3, Student's t-test (t=-0.55; P=0.58>0.05) shows that there is no significant difference between the height chosen by the dyad even if the young frequents a slightly higher height (5.08±0.10m) compared to the mother (4.94±0.01m) (Fig-4).

### 3.4. Use of the vertical space (phase 4)

The Chi two test of independence ($X^2_c$=4.79=3. ;ddl=1; P=0.02<0.05) shows for phase 4 a significant difference exists between the supports used by the dyad. As in phase 3 the ground is no longer used as a support. Only bamboo and trees are used as supports. Respectively for the mother and the young (bamboos: 98.5; 97.1%; non-bamboos: 1.5%; 2.9%). As for phase 4, by comparing the height chosen by the dyad, the Student's t-test (t=1.008; P=0.31>0.05) shows that it is not significant: for the mother it is 5.91±0.06m and for the young it is 5.86±0.02m (Fig-5).

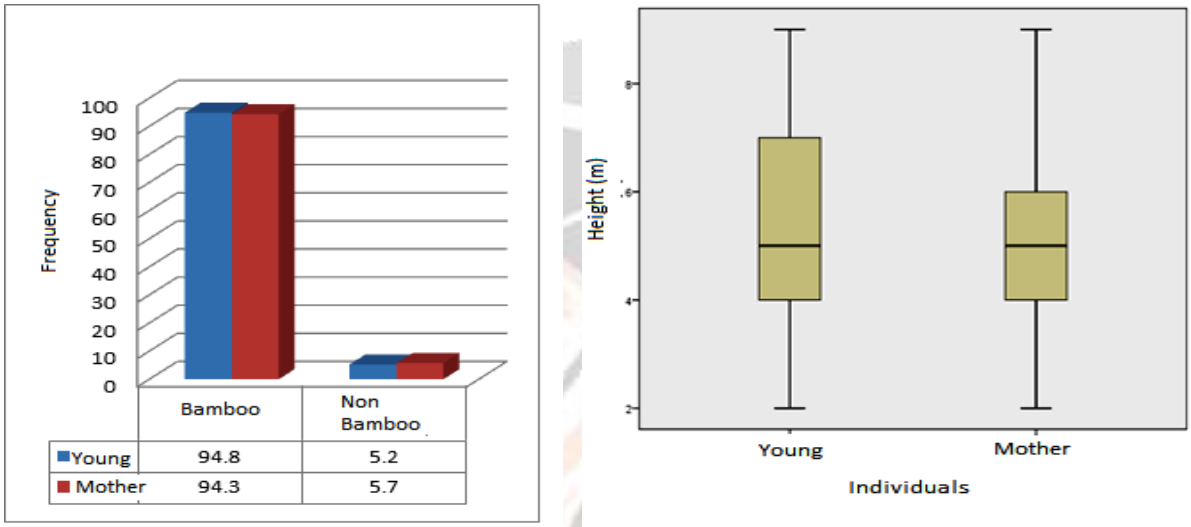


**Fig-4**: Vertical support (left) and Height (right) of young -mother in phase 3

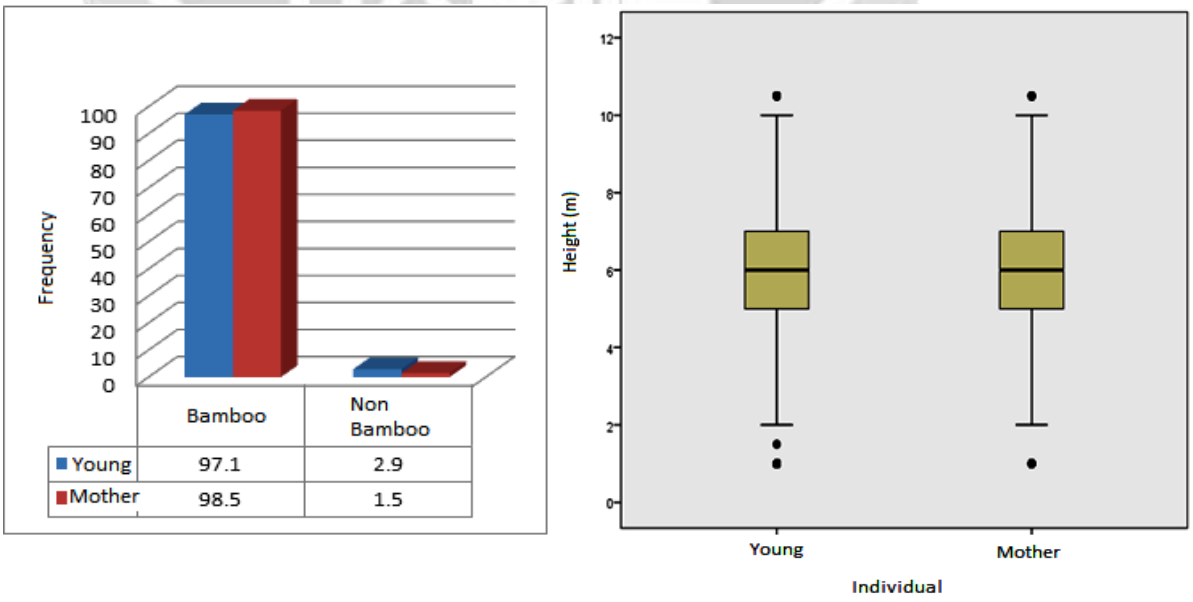


**Fig-5:** Vertical support (left) and Height (right)of young- mother in phase 4

## 4. DISCUSSION

### 4.1 Use of the vertical space by the mother and the young *Prolemur simus*

During phase 1 (between 0 and 2 months) the mother *Prolemur. simus* uses non-bamboo supports such as *Ravenala madagascariensis* or fruit trees such as *Arthocarpus heterophilus* then supports made of bamboo; the ground is also used as a support but at a lower frequency. During phase 2 (between 3 to 5 months) it also uses the ground then supports made of bamboo and non-bamboo supports. Regarding the supports used by the young, our study starts from phase 2 (3 to 5 months) because for the previous phase the young *Prolemur. simus* still has a complete dependence on its mother (pers obs). The ground is also used as a support of play for the phase 2 but also a place of consumption of bamboo shoots.

The young *Lemur catta* spend about 35% of their time on the ground which explains their rapid developmental phase with locomotor independence and ingestion of solid food from the age of 6 weeks (around 1.5 months) [42].

During phase 3 (6 to 9 months) and phase 4 (10 to 12 months) the bamboo occupies almost all the supports of the mother and the young *Prolemur. simus* because at this stage it is the young itself which provides its own food, made only of bamboo but at the same time the mother with her offspring exploits the various parts of the bamboo (pers. obs).

### 4.2. Height of young and mother *Prolemur simus*

Apart from her activities on the ground, the average height used by the mother *Prolemur simus* is not significant to that of her offspring as well as for phase 2; phase 3 and phase 4. Thus the dyad has no particular preference for height when performing its activities because all forest levels are exploited in search of food whether it is the ground or the highest peak of the bamboo stem. For lactating females *Propithecus coquereli* of the lake group inhabiting Ankarafantsika National Park the other activities apart from feeding is done at stratum level 2 (between 6 to 10 m) and feeding is frequently done in stratum level 1 (0 to 5 m) [43]. As for the suckling females of *Eulemur flavifrons* they spend most of their time at a stratum level between 5 and 10m at a rate of about 63.2% and only very rarely descend to the ground (0.6% [44].

Indeed it is during phase 1 and 2 that the initiation phase and the exploitation phase of the young begins because it exploits bamboo, trees as well as the ground consequently that would affect its height. For other lemurs such as *Hapalemur griseus griseus* its height is influenced by the height of the trees it uses as support. Some factors such as behavioral activities including marking, resting and vigilance also condition the height of *Hapalemur griseus griseus* on the trees. Similarly, this height is also influenced by the individuals closest to the focal animal because these individuals come closer during the practice of behavioral activities [45].

## 5. CONCLUSION

A recently discovered isolated site in the Brickaville district of the Atsinanana region named Ambalafary was chosen to conduct a study on the mother-youngster relationship of a species of bamboo eating lemur named *Prolemur simus*. The study was carried out during a whole year with the aim of clarifying and filling the information concerning this species through the various phases of development of the young and the behaviors adopted by the mother towards her offspring. This in order to succeed in the conservation of this species and its long term survival and at the same time to better manage the population of *Prolemur simus* living in this site given the fragmentation and the isolation of which it is the object. As a result:

-Regarding the use of the vertical space, during phase 1 (0 to 2 months) the mother still carries her young during the displacement so the substrates used are the ground, the non-bamboo supports and the bamboos. There is no significant difference in the height chosen by the mother and the young on the trees. During phase 2 (3 to 5 months), the use of the ground as a substrate is more accentuated corresponding to a progressive acquisition of locomotor independence for the young *Prolemur simus*. For the last two phases: phase 3 (6 to 8 months) and phase 4 (9 to 11 months) the ground is not used any more in a frequent way and the young just like its mother also has its own support.

-During the wet season there was no significant difference in the choice of bamboo or other substrates for mother and young *Prolemur. simus*. The bamboo shoots erupt during this season, hence the frequent use of the ground as a substrate and for training the young to acquire locomotor independence. During the dry season, the mother and the young rarely go down to the ground because it is mainly the bamboo stalk that constitutes the basic food during this period and the most common substrates are bamboos and trees. Thus the supports used by the mother and the young are on the one hand related to their food but also among the factors conditioning the development of the young according to its age.

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