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Things that go 'Munch' in the Night: Behavior, Range, and Feeding Ecology of a Mother and Offspring Daubentonia Madagascariensis

Inga Roen
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Things that go 'munch' in the night: Behavior, range, and feeding ecology of a mother and offspring *Daubentonia madagascariensis*

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Spring 2014
ACKNOWLEDGMENTS

If somebody would have told me two years ago that I would find myself with an opportunity to study the aye-aye in Madagascar, I would have had a hard time believing them. A big thanks to all of my family and friends who supported me from the beginning in my fortuitous journey to this island and eventually into the Sangasanga Forest.

This study would not have been possible without the guidance and logistical and academic assistance of Jim, Barry, and Mamy.

Thanks to Dr. Ed Louis and the Madagascar Biodiversity Partnership for graciously assisting me with setting up this study and giving me the chance to study such a unique and amazing animal. To the staff and volunteers of Kianjavato Ahmanson Field Station – thank you for being such a welcoming community. For keeping me well-fed on 3 delicious meals a day – thanks to the kitchen staff (and an extra thank you for saving the left-overs for when we came back from the field at 1AM famished).

Regardless of the nocturnal aspect, following the Aye-Aye is dirty, sweaty, and sometimes bloody work. A thousand thanks to my fearless guides - Toupha (RANDRIAMBOLOLONA Stéphan Justin), Daga (RAZAFINDRAZEFA Fortuna Elizé), Dada (ELPHANGER Hubert), Dédé (Jean de Dieu), Boniface (KAMISILAHY ZARATIANA Boniface), and Nicolas (ANDRIANJAFY Nicolas) – for waking up in the dead of night to brave the leeches, spiders, snakes, and thorns of the Sangasanga forest (and remind me to go slower each of the many times that I slipped).

Thank you to my advisor, Nico, for being patient as I adapted to nocturnal study, for answering my many questions, and for being entertaining at 3AM.

Last but not least, thanks to my taxi-brousse-buddy and tent-site-mate Tina for keeping me sane during my struggle to become nocturnal.
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Abstract:

This study of *Daubentonia madagascariensis* behavior, diet, and range was conducted during the late rainy season in the Sangasanga and Tsiazon'amboa rainforest fragments of the Kianjavato Classified Forest near the village Kianjavato in the Ambositra–Vondrozo Forest Corridor in eastern Madagascar. Research was conducted under the guidance and with the assistance of the Madagascar Biodiversity Partnership. Though multiple studies have described the behavior of juvenile *D. madagascariensis* individuals in captivity, few researchers have followed them into their natural habitat. In this study, behavioral observations and GPS data were collected and analyzed for a mother *Daubentonia madagascariensis* individual and her infant when he was present during 12 nocturnal follows. Behavioral data was collected through behavior scans every 5 minutes, along with types of food consumed to find the diet composition. GPS data was collected every 20 minutes. Ad libitum behavior data was collected on juvenile behavior and vocalizations. I recorded behavioral and food data that support previous studies on aye-aye behavior and preferred foods. I found the home range as 14.7 ha using the collected GPS data. The juvenile did not appear to forage with his mother as much as might be suggested by his young age. I suggest further studies of more and younger juveniles in the wild, as well as continued study on the juvenile mentioned here as he moves into adulthood and other potential study topics.
Introduction:

Though perhaps not quite as charismatic as the leaping Ring-tail or the cuddly Sifaka, the Aye-aye holds a special place in the biodiversity of Madagascar as one of the most unique and understudied lemur species. As the many niches and habitats of this island nation are continuing to be over-exploited and degraded, *Daubentonia madagascariensis* is threatened not only by the ongoing deforestation (through such methods as slash-and-burn agriculture (known locally as *tavy*)), but also by poaching for food, as crop pests, and due to cultural beliefs that brand them as a creature of evil.

Low population density coupled with these threats has brought the aye-aye onto the IUCN Red List and to the attention of conservationists worldwide. Due to the solitary and reclusive nature of *D. madagascariensis*, it is difficult to make an accurate estimate of the overall population and species range, and there is a general lack of knowledge about behavior and survival of the species in the wild.

This study seeks to gain increased understanding of the behavior and range of an adult female aye-aye and her juvenile offspring in the wild (a subject about which there is little previous research to be found), in the interest of contributing to the small but growing pool of non-captive aye-aye observations. Through further research, the misconceptions held by the aye-aye's most prominent predator (the human) may be challenged and the threats to the survival of this misunderstood species may be lessened.

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**Background:**

**Madagascar Biodiversity Partnership and the Kianjavato Ahmanson Field Station**

This research was undertaken at the Kianjavato Ahmanson Field Station (KAFS), a satellite of the American NGO Madagascar Biodiversity Partnership (MBP). MBP is operated through Omaha's
Henry Doorly Zoo and Aquarium (OHDZA) under the direction of Dr. Edward Louis Jr. The OHDZA-MBP works towards sustainability and conservation of flora and fauna in Madagascar through lemur and tortoise conservation and genetic research, sustainable development projects, reforestation, and education at a range of sites including Antsiranana, Andasibe, Lavavolo, and Kianjavato (MBP, 2010).

The Kianjavato Ahmanson Field Station is located in the Ambositra–Vondrozo Forest Corridor (established in 2008) of rainforest in Madagascar, near the village of Kianjavato (Schwitzer et al., 2013, p. 95). Historically, much of the forest surrounding Kianjavato was a coffee plantation and thus the forest now is composed of fragments of primary forest alongside bamboo and other secondary regrowth (Schwitzer et al., 2013, p. 95).

The lemur species known to be present in the Kianjavato forest region include the greater bamboo lemur (*Prolemur simus*), the southern black-and-white ruffed lemur (*Varecia variegata editorum*), Jolly’s mouse lemur (*Microcebus jollyae*), the grey bamboo lemur (*Hapalemur griseus griseus*), Peyrieras' wooly lemur (*Avahi peyrierasi*), the red-bellied lemur (*Eulemur rubriventer*), the red-fronted brown lemur (*Eulemur rufifrons*), and the aye-aye (*D. madagascariensis*) (Schwitzer et al., 2013, p. 95).

The main threats to the lemurs located in the forest have been assessed as slash-and-burn agriculture and hunting pressures (Schwitzer et al., 2013, p. 95). The species currently undergoing monitoring and research at the Kianjavato Ahmanson Field Station are *P. simus*, *E. rubriventer*, *E. rufifrons*, *V. variegata editorum*, and *D. madagascariensis*. The field station relies on volunteers to assist in much of the lemur monitoring, reforestation, and education projects being undertaken (MBP, 2010) and employs other staff members and guides from the local area (personal observation).

The Sangasanga forest fragment (Map 1), located immediately north of the village within the Kianjavato classified forest, is primarily composed of the forest cover on and surrounding the Sangasanga mountain. The Tsiazon'amboa fragment borders the Sangasanga forest immediately to the
Northwest, located in the corridor of forest between Tsitola and Sangasanga (Randimbiharinirina, personal communication). The forest is managed by FOFIFA, who work in conjunction with MBP's conservation and research efforts. The forest area surrounding Sangasanga mountain was selected as the field site for this research because of the current presence of a collared female *D. madagascariensis* individual and her juvenile offspring.

*Daubentonia madagascariensis*

The aye-aye (*Daubentonia madagascariensis*) is the world's largest nocturnal primate and one of the most physiologically distinctive lemur species of Madagascar (Mittermeier, 2010, p. 597). It is the only extant member of its taxonomic family and genus, and it displays a unique conglomeration of traits and an overall odd physical appearance that has lead it to be put in several taxonomic contexts since its discovery (Mittermeier, 2010, p. 597).
The conglomeration of anatomical traits that the aye-aye displays make it a biological and aesthetic marvel. It is covered in a coat of short white hairs interspersed with longer black-brown, white-tipped guard hairs that give it an overall gray-brown appearance with a whitish face (Mittermeier et al, 2010, p. 604). The countenance of the aye-aye is accented by large, reflective eyes (with a nictitating membrane (third eyelid) thought to protect the eyes from airborne wood debris while foraging for insects) and prominent, highly mobile black ears. Also notable are the continuously growing, rodent-like incisor teeth, a trait held by no other primate (Mittermeier et al, 2010, p. 604). The aye-aye also has the largest brain in proportion to its body of any strepsirrhine primate (a group including the lemurs of Madagascar and lorises of Asia) (Kaufman et al, 2005), inguinal mammae (nipples located near the groin) (Mittermeier et al, 2010, p. 604), and a long and bushy squirrel-like tail. The hands are relatively large for the species' body size and are made more unusual by the presence of long fingers with claws (*D. madagascariensis* is the only extant Malagasy lemur with typical claws) (Soligo & Müller, 1999). An exceptionally extended skeletal middle finger is also apparent, used in tapping to echolocate and extract insect larvae from decayed wood (Mittermeier et al, 2010, p. 606).

Aye-ayes are believed to be largely solitary, the main exceptions being rare tandem foraging, mating instances, and the time that a mother spends with her juvenile offspring (Mittermeier et al, 2010, p. 606). Females undergo continuous oogenesis, meaning that they produce eggs throughout their lifetimes (Gron, 2007). Every two to three years, a single infant is produced. The mating season does not appear to be restricted to particular times of the year (Mittermeier et al, 2010, p. 606). Almost all that is known about interactions between aye-aye juveniles and their mothers comes from studies performed on captive populations, which suggest that juveniles remain dependent on their mother until 18 months to two years of age (Gron, 2007).

The diet of the aye-aye varies with the season, but overall components are seeds, insect larvae, nectar and fungus. They have also been found to consume certain crop foods when available, including
mangoes, avocado, litchis and coconut. Tree cankers have also been shown to contribute significantly to the *D. madagascariensis* diet during parts of the year in certain areas of the island. (Gron, 2007).

*D. madagascariensis* resides in the wild solely in Madagascar, believed to be present throughout almost the entire island with the exception of the dry southwest (Mittermeier, 2010, p. 604). The only other known member of family Daubentoniidae was *Daubentonia robusta* (what is believed to have been a similar animal two to five times larger than the present-day aye-aye), of which fossils have been found in the southwest (Gron, 2007). *D. madagascariensis* is known to exist at low population densities in a variety of habitats including rainforests, agricultural fields, and deciduous forests in a range of conditions from pristine to degraded (Mittermeier, 2010, p. 606). The average home range of a female in the wild is 30-40 ha, while the range of the male can extend to 125-215ha (Mittermeier et al, 2010, p. 606). While male ranges have been found to overlap those of other males and females, female ranges are not known to overlap those of other females (Gron, 2007).

Due in part to its particularly odd physical appearance, the aye-aye is viewed in many areas of the country as an omen of evil or bad luck, to the extent that they are essentially taboo (*fady*) (Simons & Meyers, 2001). The aye-aye is the only lemur associated with negativity in almost all regions where it is found (Simons & Meyers, 2001). In a study that took place about the *fady* in northern regions of the island where the aye-aye is considered a bad omen, a sighting of one is often believed to result in a human death in the village unless the animal is killed and hung on a pole outside of the village (Simons & Meyers, 2001). When an aye-aye is seen to actually enter a village, it is thought necessary to abandon the village or risk falling ill and dying from the evil brought by the animal (Simons & Meyers, 2001). *Fady* surrounding aye-ayes contribute significantly to the cultural perception of the species.

Due to low population density and threats from deforestation, poaching, and the traditional belief that they bring bad luck, *D. madagascariensis* is a species of concern for conservationists.
(Mittermeier, 2010, p. 606). *D. madagascariensis* was listed as 'Near Threatened' by the IUCN Red List as of 2008, but the new lemur conservation strategy published in 2012 suggests a re-categorization as Endangered because of population size reduction (Schwitzer et al., 2013, p. 17). As misconceptions about aye-ayes as evil make them the only lemur species widely considered in a negative light, conservation efforts are encouraged to focus on educating Malagasy people on the rarity and importance of *D. madagascariensis* in national biodiversity (Simons & Meyers, 2001).

**Study Animals**

The focal animals observed in this study were a mother and her offspring *D. madagascariensis*. The adult female, named 'Bozy', was first captured and collared with a radio telemetry collar in the Sangasanga forest on June 9, 2011. Since then, her collar has been replaced 5 times due to her propensity to chew it off. She is known to have had 2 offspring during the time of observation – 'Mena' and 'Volamena'. Male Mena (b. September 19 2011, Sangasanga) was collared at around 1 year of age, but his collar was found some months later to have been chewed off and contact with him has not yet been reacquired. The second offspring was the male Volamena (b. 18 June 2013, Sangasanga). He is scheduled to be collared in September of 2014, with the hope that his dispersal from his mother can be recorded. (Randimbiharinirina, personal communication)

At the time of this study, Bozy was well-habituated to humans and had been followed at multiple times since her first collaring. Volamena had not been observed extensively previous to this study and thus is not considered habituated to human presence. (Randimbiharinirina, personal communication)
Methods:

Overview

After gaining permission from FOFIFA and the Kianjavato commune, behavioral and range data were collected for the adult female *D. madagascariensis* 'Bozy' and her male juvenile offspring 'Vلامена' (when he was visible) in the Sangasanga and Tsiazon'amboa forest fragments near Kianjavato, Fianarantsoa, Madagascar for this study during a three-week period from April 7, 2014 to April 28, 2014, the end of the rainy season. 12 nocturnal follows were conducted, the first taking place on the evening of April 8, 2014 and the last on the night of April 25, 2014 (early morning of April 26, 2014). The juvenile Vلامена was specifically observed for the first week (4 nights) of study from near dusk to midnight with GPS data also collected from Bozy on two of the nights when she was foraging alone. The next two weeks (4 nights each) focused on Bozy, with the first week spent collecting data from near dusk to midnight and the second collecting data from near midnight to near dawn.

This study was conducted in the presence of my advisor and 6 guides. For the first two weeks, we entered the forest from the village of Kianjavato each night of the study between 5:00PM and 6:00PM. A radio telemetry system was used to locate the radio collar on Bozy (Image 1).

![Image 1: Radio telemetry system and antennae](image1.jpg)
**Research Questions**

1. What is the activity schedule of the mother aye-aye? How does it differ pre- and post- midnight? What is the activity budget of the mother aye-aye?

2. What are the foraging habits of the mother and offspring aye-aye? What are their diets composed of?

3. What is the home range of the mother aye-aye and her offspring?

**Behavior and Diet Observations**

The method used to determine behavior for an activity budget and diet composition was a survey that was conducted every 5 minutes during the nocturnal follow period. At each observation point, the behavior of the focal animal was recorded, along with auxiliary information including the estimated height of the animal in the tree, vernacular tree name and estimated DBH. During the second two weeks of study, when Bozy was the focal animal, the behavior of Volamena was noted as well when he was visible, along with the estimated distance in meters between Bozy and Volamena.

Behaviors were recorded using an ethogram of 21 possible behaviors grouped into 6 overarching groups (Table 1): Out of sight (OOS), moving (M), resting/inactive (RS), feeding (FE), grooming (GR), and social behaviors (SOC). Vocalizations were recorded ad libitum, but in cases where the only noted activity was vocalizing, it was considered a social behavior even if the animal appeared to be alone. Other notable behaviors (such as aggression or presence of another *D. madagascariensis* individual) were also recorded ad libitum.

<table>
<thead>
<tr>
<th>OOS (Out of sight)</th>
<th>OOS</th>
<th>Out of sight</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>UPT</td>
<td>Up tree</td>
</tr>
<tr>
<td></td>
<td>UPN</td>
<td>Up nest (In nest)</td>
</tr>
<tr>
<td>M (Moving)</td>
<td>LN</td>
<td>Leaving Nest</td>
</tr>
<tr>
<td></td>
<td>M</td>
<td>Moving</td>
</tr>
<tr>
<td>Activity Type</td>
<td>Code</td>
<td>Description</td>
</tr>
<tr>
<td>--------------------------</td>
<td>------</td>
<td>--------------------------------------------------</td>
</tr>
<tr>
<td>Back nest</td>
<td>BN</td>
<td></td>
</tr>
<tr>
<td>Moving vahy</td>
<td>MV</td>
<td></td>
</tr>
<tr>
<td>Moving tree</td>
<td>MT</td>
<td></td>
</tr>
<tr>
<td>Jumping</td>
<td>JP</td>
<td></td>
</tr>
<tr>
<td>RS (Resting/inactive)</td>
<td>RS</td>
<td>Resting</td>
</tr>
<tr>
<td></td>
<td>UP</td>
<td>Upside down</td>
</tr>
<tr>
<td></td>
<td>H</td>
<td>Hanging</td>
</tr>
<tr>
<td>FE (Feeding)</td>
<td>FE</td>
<td>Feeding, foraging, or testing for larvae</td>
</tr>
<tr>
<td></td>
<td>TL</td>
<td>Test larvae (tapping to locate larvae)</td>
</tr>
<tr>
<td>GR (Grooming)</td>
<td>GR</td>
<td>Grooming</td>
</tr>
<tr>
<td></td>
<td>GU</td>
<td>Grooming upside down</td>
</tr>
<tr>
<td>SOC (Social behaviors)</td>
<td>GB</td>
<td>Grooming baby</td>
</tr>
<tr>
<td></td>
<td>GM</td>
<td>Grooming mother</td>
</tr>
<tr>
<td></td>
<td>BG</td>
<td>Being groomed</td>
</tr>
<tr>
<td></td>
<td>PL</td>
<td>Playing</td>
</tr>
<tr>
<td></td>
<td>VOC</td>
<td>Vocalizing*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>*Vocalization that occurred simultaneously with another activity is recorded ad libitum</td>
</tr>
</tbody>
</table>

Table 1: Ethogram for *D. madagascariensis* (adapted from Randimbiharinarina, n.d.)

When an animal was observed to be feeding, the food item was recorded. When it was not possible to directly observe the animal feeding, the sounds of feeding and the debris fruits and fibers that fell from the occupied tree were used as a proxy if possible by which to identify food source.

When analyzing scan survey data, behavioral observations recorded as 'Out of Sight' (OOS) were excluded from the total to prevent introducing bias into the data analysis. The proportion of OOS recordings over each collective study period (pre- and post- midnight) was plotted against time to observe if there was a particular time of the follows when the animal was especially difficult to view.

To formulate the activity schedule for Bozy, the number of observations of each category of activity was added for each 15 minute period for which there were observations of activity. The number of observations of each behavior during each 15 minute period was then expressed as a percentage of
the total number of observations during each time period of the same length. To calculate the activity budget, the sum of survey scan counts for each behavior was expressed as a percentage of total scan survey counts (again, excluding OOS observations).

To analyze feeding data, the number of instances of feeding on each recorded food source was expressed as a percentage of the total instances of feeding during the scan survey (per individual).

**Range**

For the purposes of this study, because Volamena is a juvenile and shares the nest and space of his mother, the range of Bozy and Volamena is considered as a single unit. The range of Bozy and Volamena during the observed times of the study was calculated by taking a GPS reading at the time that the focal animal was first located during each follow, and then once every 20 minutes for the remainder of the follow period. When the animal was out of sight during the scheduled location recording interval, the GPS data was taken at the next interval when they were in sight. Range data was collected with Volamena as the focal animal for 1 pre-midnight follow and Bozy as the focal animal for 6 pre-midnight follows and 4 post-midnight follows.

The GPS data was analyzed by entering the points into Google Earth Pro and using the polygon and ruler tools to create and measure a Minimum Convex Polygon (MCP) surrounding all of the recorded observations of Bozy and Volamena.

**Results:**

**Activity Schedule and Budgets**

The total amount of behavioral observation (counting OOS instances) during the 8 follows during the second two weeks of the study was 40 hours for Bozy. She was located between 5:30PM and 6:30PM each night of the study, and was still located at or in her nest at the time of arrival in all cases but one (April 16).

The schedule of the proportion of observations recorded as 'OOS' in Bozy's behavior shows
that, while there are peaks in the data, the proportion of out of sight observations does not rise about 50% until the end of the post-midnight schedule due to a high number of 'Up in nest' observations.

Figure 1: Schedule with proportion of observations OOS, pre-midnight

Figure 2: Schedule with proportion of observations OOS, post-midnight

OOS observations were eliminated to generate the schedules shown in figures 2 and 3. Spikes in
feeding behavior are noted during the pre-midnight observations, with a large proportion of feeding behavior at the beginning of the post-midnight period, as well. The data at the end of the post-midnight schedule displays the time when Bozy was returning to her nest, as the 'up in nest' observations were recorded as OOS, and constituted 100% of observations as dawn neared.

Activity Schedule: Bozy

Pre-midnight

Figure 3: Activity Schedule for Bozy, pre-midnight

Activity Schedule: Bozy

Post-midnight

Figure 4: Activity Schedule for Bozy, post-midnight
For the analysis of the activity budget, during the pre-midnight period, 25.3% of observations were recorded as OOS. During the post-midnight period, 67.5% of observations were OOS (about 50% of all OOS observations in the post-midnight period were when Bozy was 'up in nest'). With the omission of OOS observations, the largest amount of time was spent feeding, followed by moving and then resting.

![Activity Budget Chart]

**Figure 5: Overall Activity Budget of Bozy**

**Diet Composition**

4 types of food sources were observed being consumed by Bozy during the course of this study (scientific names retrieved from Manjaribe et al., 2013): Sandramy (*Canarium boivinii*) seeds (Image 2), Ravanala (*Ravenala madagascariensis*) seeds (Image 3), nectar from the Ravenala (*Ravenala madagascariensis*), and larvae from 6 different tree species (Image 4). The species from which larvae were observed being consumed were Sandramy (*Canarium boivinii*), Ravanala (*Ravenala*,
*madagascariensis*), Rotra (species unknown), Ramy (*Canarium madagascariense*), Korofanborana (species unknown), and Varongy (*Ocotea nervosa*).

![Diet Composition: Bozy, April 14 to April 26](Diagram)

**Figure 5: Diet Composition of Bozy, April 2014**

Only five instances of feeding was recorded for Volamena (four on the evening of April 8, when he was the focal animal), all were noted as being seeds from the Sandramy (*C. boivinii*).
Home Range

The MCP of the home range of Bozy and Volamena was found to be 14.7 ha using Google Earth Pro (Map 2).

Map 2: Partial Home Range of Bozy and Volamena with MCV polygon, 4 known nest sites marked with red pointers

During the course of the study, four nests were observed being utilized by Bozy (and occasionally Volamena) (Map 2).

Table 2: Nest locations of Bozy known to have been utilized April 8, 2014 to April 26, 2014

<table>
<thead>
<tr>
<th>Nest #</th>
<th>Site Name</th>
<th>Vern Tree</th>
<th>Scientific Tree (Source: Manjaribe et al., 2013)</th>
<th>Estimated DBH (cm)</th>
<th>Estimated Height of Nest (m)</th>
<th>GPS</th>
<th>Elevation (m)</th>
<th>Known Dates Used</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Tsiazon'amboa</td>
<td>Tavia with vahy</td>
<td>Sideroxylon betsimisarakum</td>
<td>30</td>
<td>11</td>
<td>S 21°22'14.8&quot;</td>
<td>225</td>
<td>8/4, 9/4, 10/4, 11/4, 14/4, 17/4, 23/4, 24/4, 25/4, 26/4</td>
</tr>
<tr>
<td>2</td>
<td>Sanga Sanga</td>
<td>Sandramy with vahy</td>
<td>Canarium Boivini</td>
<td>80</td>
<td>14</td>
<td>S 21°22'16.0&quot;</td>
<td>254</td>
<td>15/4</td>
</tr>
<tr>
<td>3</td>
<td>Tsiazon'amboa</td>
<td>Rahiaka with vahy</td>
<td>Chrysophyllum Boivinanum</td>
<td>80</td>
<td>13</td>
<td>S 21°22'14.4&quot;</td>
<td>306</td>
<td>17/4</td>
</tr>
<tr>
<td>4</td>
<td>Tsiazon'amboa</td>
<td>Tamenaka with vahy</td>
<td>Species unknown</td>
<td>80</td>
<td>11</td>
<td>S 21°22'10.4&quot;</td>
<td>311</td>
<td>25/4, 26/4</td>
</tr>
</tbody>
</table>

*Vahy species: Uvaria combretifolia
*all identified using collared D. madagascariensis ♀ Bozy
**Ad libitum behaviors**

Out of 24 total recorded instances of vocalization for Bozy during the 5 minute scans, 9 occurred while feeding, 4 while resting, 4 concurrent with movement, and 7 without another noted activity. There was no apparent pattern noticed in whether Volamena or another individual was present during the time of vocalization. All vocalizations are described by the researcher as low grunting noises.

During the first week of study, Volamena was only found to leave the nest on one of the four nights that pre-midnight follows were attempted. Volamena was only observed to be visibly foraging and traveling for the entire follow period with Bozy on the first night of study, when he was the focal animal, and then only sporadically – during the second week of study, he was observed at the nest (appearing to remain in or near the nesting tree when Bozy left), and then later in the evening, once per follow, for an observation period between 15 minutes and an hour. During the third week of study, Volamena was only visible briefly towards the end of the night as he arrived at the nesting tree.

**Discussion:**

**Activity Schedule and Budgets**

The high proportion of 'Out of Sight' observations pre-midnight can be attributed to the difficulty of studying a nocturnal canopy-dweller such as *D. madagascariensis*. The animal was found to be difficult to view and difficult to track during movement, especially as the forest in which the study took place was thick in vines and boulders and very steep in places. This made movement of researchers very cumbersome at times and necessitated the use of such a large number of guides.

The high proportion of OOS recordings post-midnight can easily be attributed to the propensity of Bozy to return to her nest long before dawn. The sky began to get noticeably lighter around 5:30AM.
She returned to her nest by 4:00AM at the latest, with her earliest return being at 2:00AM. Because it was not possible to view the activities of the animal within the nest, it was necessary to record those periods of time as OOS. It is also unknown if Volamena was perhaps in the nest during the night, as Bozy may have returned to participate in some form of parental care.

The activity schedule of Bozy, especially pre-midnight, shows spikes of feeding interspersed with peaks of movement (and an accompanying spike of OOS observations during times of movement spikes, as it was difficult to keep pace with the animal as she traveled through the canopy). Long periods of feeding likely provided energy needed for movement to other feeding trees throughout the night.

**Diet Composition**

Though *D. madagascariensis* is specifically adapted for feeding on insect larvae, the majority of feeding observations of Bozy consisted of seeds as the food source. It has been noted in previous studies that when fruits, such as those of the Sandramy and Ravenala are available for consumption, they will tend to be favored over larvae, perhaps as it takes more complex foraging skills and energy expenditure to find larva (Gron, 2007).

Because only 5 feeding observations were made for Volamena, it is not pertinent to compare his diet composition with Bozy. The observation that all of Volamena's feeding instances were on Sandramy seeds and not larvae can be explained by the concept that it takes juveniles over a year to master the skills necessary to forage successfully for larvae while he is still only 10 months old (Gron, 2007), or perhaps simply that those were five random instances of feeding and they all happened to be the favored Sandramy seed.
Home Range

The home range found of 14.7 ha is smaller than the average range of female *D. madagascariensis* individuals in the wild, which has been reported as 30-40ha (Mittermeier et al, 2010, p. 606). However, given that this study took place during only 3 weeks, it is likely that Bozy and Volamena did not fully exploit their range during the study period. Nests tended to be used for multiple nights in a row (consistent with multiple studies including Ancrenaz et al, 1994), indicating that large movements do not occur on a nightly basis, and that movement across the entire home range may take longer than the length of the study period. A longer study period would be necessary to uncover a larger portion of the home range.

Ad libitum behaviors

On all three of the nights that Volamena was not found to leave his nest before midnight, it is noted that it was raining. Juvenile *D. madagascariensis* may not leave their nests while foraging, especially if there is a chance that the mother is still lactating and could provide them with the nutrition that they need (Randimbiharinirina, personal communication). On the fourth night of the first week of observations, it was raining even more consistently than before and neither Bozy nor Volamena were observed leaving the nest before 8:00PM, when the follow session was abandoned.

While grunts of contentment during feeding have been noted as a form of vocalization in *D. madagascariensis*, most of the known vocalizations are social in nature (Winn, 1994). Though no other individuals were noted to be present during the other times of vocalization, due to the difficult nature of viewing the entire forest canopy and the lack of a GPS collar on Volamena, it is possible that some of the grunts were communicating to another aye-aye that was simply not visible to the researchers. It is particularly likely that Volamena may have been within auditory distance of Bozy's calls, as it is has been found that infant aye-ayes do not forage far from their mothers (Andriamasimanana, 1994).
The fact that Volamena was not previously habituated to the presence of humans may have contributed to him not being present during many of the follows of Bozy. His lack of foraging with his mother could also be an indicator that he is nearing the end of his time of dependency on her and will be dispersing soon. Considering that Bozy's previous infant, Mena, is known to have transitioned to independence sometime around one year of age, it seems likely that Volamena may also disperse from his mother around that time.

**Conclusion:**

It was found that the behavior of Bozy was difficult to study in its entirety because of the high proportion of OOS observations. However, for the time that she was able to be observed, most of her time was spent feeding, followed by moving and resting. Activity before midnight was found to consist of more active behaviors, including social interactions with the juvenile Volamena. The diet composition of Bozy was unable to be compared to Volamena, but the majority of her feeding was found to show that seeds of Sandramy and Ravenala were preferred over the complex foraging involved in seeking out insect larvae. The home range of Bozy and Volamena (14.7 ha) was found to be smaller than the average female range (30-40 ha), which is to be expected during such a short study period.

Overall, this study clearly displays the difficulties in studying these unique and solitary animals. By their very nature, they are easy to miss in the forest, leading to broader implications in the difficulties of estimating their true population density and size. This study was significantly constrained by time, as more significant results could have been found if the study period were longer than 3 weeks. In addition, more information could have been gained by performing longer follows (from dusk until dawn, which would allow a study of the entire nightly path length as well).
This study is preliminary in nature, but it is moving into a territory little explored by researchers of *D. madagascariensis*: the behavior and interactions of a mother and juvenile in the wild. Though my intentions were to further study the dependency of the juvenile on the mother, the lack of his presence during most of the follows indicated that he is likely nearing the end of his time in direct contact with her. His lack of a GPS collar made it near impossible for our team to locate him once he left his collared mother. Further studies of juvenile behavior in animals that are younger and more dependent than Volamena would likely prove more accessible, as the infant would tend to be in much closer contact with the parent throughout the follows. Also notably, once Volamena's collar is affixed around September, it may be possible to study how his dispersal from his mother occurs from her range, and how he comes to live in the Kianjavato forest alongside his mother and the other collared male there. Male aye-ayes are known to have much larger, overlapping ranges than females.

The study of behavior and parental care in wild aye-ayes is little studied, but it is necessary to understand how they interact if we want to preserve the presence of the species in a non-captive environment. As the threats of deforestation, poaching, and the implications of the aye-aye *fady* continue to mount, priority should be given to these little-understood primates to protect them from effects that could permanently damage a population that is naturally at low density and low numbers. Though aye-ayes have proven adaptable to degraded and agricultural habitats in the past, their natural diets, ranges, and behaviors must dictate the protection of the habitats in which they evolved to preserve the species in its natural state for future generations.
Bibliography:


