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*Articles***One reserve, three primates: applying a holistic approach to understand the interconnections among ring-tailed lemurs (*Lemur catta*), Verreaux's sifaka (*Propithecus verreauxi*), and humans (*Homo sapiens*) at Beza Mahafaly Special Reserve, Madagascar.**

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*We applied cultural anthropological, ethological, and parasitological methodologies to investigate the interplay among three primate species, ring-tailed lemurs (*Lemur catta*), Verreaux's sifaka (*Propithecus verreauxi*), and humans (*Homo sapiens*) who live within the same habitat (i.e. in sympatry) around the Beza Mahafaly Special Reserve, Madagascar. Through a fusion of these methodologies we hope to provide a holistic understanding of the advantages and disadvantages of human-nonhuman primate sympatry. Interviews and questionnaires provided us with initial insights regarding the local peoples' attitudes toward sympatric strepsirrhine primates. Origin myths indicate a close association between humans, ring-tailed lemurs, and Verreaux's sifaka, which may serve as an important basis for positive conservation perspectives among the local people. These include lemur hunting taboos and special ancestral forests that are protected against deforestation. However, paleontological data indicate that these cultural perceptions may be of recent origin.*

*Close human-nonhuman primate associations can also have negative effects. We found that some nonhuman primate behavioral activities appear associated with increasing parasite loads, and may act as potential avenues of parasite transmission. Fecal analyses revealed that groups of ring-tailed lemurs that frequented the camp, and interact on a regular basis with humans harbor more endoparasites. These lemur "camp" groups engaged in coprophagy (fecal ingestion) of human, dog (*Canis familiaris*), and zebu (*Bos indicus*) fecal matter. In contrast, analyses of Verreaux's sifaka fecal matter revealed no parasites. Verreaux's sifaka were rarely terrestrial, generally avoided humans, and were not observed engaging in coprophagy. This suggests that each strepsirrhine species' behavioral patterns and socioecology directly affect its likelihood of acquiring parasitic infections, and this is currently being studied in more depth at the site.*

We feel that incorporating local people into conservation initiatives are vital for success. This requires an understanding of human-nonhuman primate interconnections, the perspective of local peoples regarding their surroundings, knowledge of nonhuman primate behavior, and epidemiological factors.

KEYWORDS: ethnoprimateology, ring-tailed lemurs, Verreaux's sifaka

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Introduction

In many regions throughout the world where nonhuman primates naturally occur, their lives are interconnected with humans. These interconnections are the product of a broad spectrum of scenarios such as pet ownership (Jones-Engel et al. 2001; Duarte-Quiroga and Estrada 2003), logging (Chapman et al. 2000), hunting (Alvard et al. 1997; Workman 2004), crop raiding (Naughton-Treves et al. 1998), ecotourism (Fuentes and Wolfe 2002), and field-based studies by human researchers (Jones-Engel et al. 2003). As human populations grow the likelihood of human-nonhuman encounters increases. In such circumstances, humans and nonhuman primates may partially or completely overlap and ultimately compete for contested resources, including space as well as crops. Conflicts arising from contested resources between these primates often result in the poaching or killing of nonhuman primates (Wolfe et al. 1998). In addition, increased human-primate contact can act as an avenue for bi-directional zoonotic transmission (Jones-Engel et al. 2001).

The goal of ethnoprimateology is to study the interactions of humans and nonhuman primates, which live in sympatric associations (Sponsel et al. 2002) by employing cultural anthropological and primatological methodologies (Sponsel 1997). It has long been noted that nonhuman primates have been considered sacred, abhorred, or both, by their human counterparts. These attitudes are influenced by traditional (Wheatley 1999; Wheatley et al. 2002; Cormier 2002; Sicotte and Uwengeli 2002) and religious (Carter and Carter 1999; Burton 2002; Wolfe 2002) components of human societies, nonhuman primate behaviors (Naughton-Treves et al. 1998), and the context or social atmosphere of the human society (Loudon et al. in press). Thus a fusion of traditional anthropological methods (i.e. ethnoprimateology) affords the ethnographer or primatologist with the appropriate toolkit to fully understand human-nonhuman primate interactions and simultaneously provides insights into the behavior of both humans and their nonhuman primate counterparts.

Madagascar is an excellent locality to study the historical and present-day interplay between humans and nonhuman primates. Humans only inhabited the island as recently as 2000 years ago and subsequently 1/3 of all lemur species went extinct (Ganzhorn et al. 1999). Today, large regions of Madagascar have been denuded of their forests and natural habitat (Sussman 1999). Although many reserves exist, considerable anthropogenic change has occurred outside of such areas. One such reserve is the Beza Mahafaly Special Reserve (BMSR) in southwestern Madagascar. What is intriguing about BMSR is its success. This reserve has remained primarily intact, without human influence for over twenty years, whereas areas around the reserve have been fragmented and degraded by the local Mahafaly (Whitelaw et al. 2005). To date, several primatologists tackle conservation initiatives from the perspective of “how” and “why” national parks, reserves, or protected areas fail. In contrast, we were interested in the “how” and “why” this reserve is successful (Ratsirarson 2003).

A critical aspect of ethnoprimateological investigations is the behavior of the nonhuman primates and the ramifications of such behavior. Here, we focus on two nonhuman primates, the ring-tailed lemur (*Lemur catta*) (figure 1) and Verreaux's sifaka (*Propithecus verreauxi*) (figure 2). These strepsirrhines are found in sympatric associations throughout southern Madagascar. While the two species share a common ancestry, as do all extant lemurs (Karanth et al., 2005), they differ in both behavior and morphology (Tattersall, 1982). Ring-tailed lemurs can be characterized as dietary generalists consuming a wide spectrum of foods including stems, fruits, flowers, and invertebrates based on the seasonal availability of each (Sauther et al. 1999; Jolly 2003). Furthermore *L. catta* occupy all levels of the forest canopy and is the most terrestrial of the Malagasy strepsirrhines (Fleagle 1999). In contrast, sifaka are primarily arboreal, use the terrestrial substrate more infrequently, and are predominantly folivorous (Richard et al. 1993). Thus both species live sympatrically, yet exhibit distinct behavioral repertoires allowing for excellent comparisons between their socioecology and parasite ecology. In this paper we present preliminary, descriptive results of an on-going long-term project, which is currently investigating the socioecology and parasite ecology of both of these species at the BMSR. The long-term project has four

goals: to examine how each species' socioecology affects parasite type and prevalence, including seasonal fluctuations of parasites among each primate species; to examine the behaviors that ring-tailed lemurs and Verreaux's sifaka utilize to potentially eliminate, avoid, or reduce parasite infections; to determine how social rank and sex affects individual parasite prevalence for both species; and to understand how an anthropogenically-altered habitat affects all of these patterns as compared to those documented for groups living in undisturbed habitats. This project integrates primatological, cultural anthropological, and parasitological methodologies to understand how the attitudes of Mahafaly toward the reserve as well as the interactions between nonhuman primates and the Mahafaly impact the success of BMSR.



Figure 1. Ring-tailed lemur, *Lemur catta* within parcel 1 of the Beza Mahafaly Special Reserve.



Figure 2. Verreaux's sifaka, *Propithecus verreauxi verreauxi* within parcel 1 of the Beza Mahafaly Special Reserve.

Methods

Study Site and Subjects

Research was conducted at BMSR (23°30'S latitude, 44°40'E longitude) in southwestern Madagascar during a six-week period in the summer of 2004. In 1978 the local people of Firaiana (district) of Beavoha officially granted the two parcels to ESSA/Forêts, Université d'Antananarivo (Ratsirarson 2003). This reserve integrated conservation and development from the start. The local community requested and received canal irrigation, road improvements, a new school and new wells all of which were provided through support from WWF (World Wildlife Fund) and USAID (United States Agency for International Development) (Ratsirarson 2003). BMSR became a special government reserve in 1986 (Sussman 1991; Ratsirarson 2003) and is now coordinated by the National Association for the Management of Protected Areas (ANGAP). The reserve and surrounding areas is characterized by distinct wet (October-April) and dry seasons (May-August), and periodically experiences droughts (e.g., Sauther 1991, 1993, 1999; Gould et al. 1999; Ratsirarson 2003). The habitat is highly seasonal with approximately 99% of the annual rainfall occurring during the wet season (Sauther 1999). While this study focused on the socioecology of ring-tailed lemurs and Verreaux's sifaka, nocturnal white-footed

sportive lemurs (*Lepilemur leucopus*), gray mouse lemurs (*Microcebus murinus*), and gray brown mouse lemurs (*Microcebus griseorufus*) also inhabit the reserve (Ratsirarson 2003).

The local people are composed of Mahafaly, Antandroy and Tanala peoples (figure 3), (Ratsirarson 2003). Families live in straw and wood huts, with most family members coming from the surrounding areas. This is a patriarchal, agrarian society that focuses on maize, cassava and sweet potatoes (*bageda*), as well as zebu cattle, goats, sheep and chickens. Two types of herding methods are used. *Midada* allows livestock to roam freely in the forest with the owner gathering periodically. The other, *miarakandrovy* involve active herding of the animals with livestock kept near the village each evening (Ratsirarson 2003). Land is viewed as privately owned and inherited from ancestors. Tortoises and lemurs are *fady* (taboo) to hunt (Rambeloson 1988).



Figure 3. Local Mahafaly people near Beza Mahafaly Special Reserve.

BMSR consists of a campsite and two parcels of forests (Ratsirarson 2003). Parcel 1 is approximately 80 ha and is protected against accidental grazing by sheep, goats, and cattle via a barbed wire fence. This parcel is a riparian forest patch that is located on the Sakamena River, dominated by kily trees (*Tamarindus indica*) and exhibits a high forest canopy with a rich understory of saplings, lianas, and terrestrial herbs (Sauther 1991). Parcel 2 is approximately 500 ha, is not protected by a fence, and is used by the local people from the neighboring villages for grazing livestock. Parcel 2 is open and dry, and is characterized by xerophytic vegetation (Ratsirarson 2003). At the time of this research the camp consisted of a small administrative building for the ANGAP officials, a small museum, a pit latrine for visitors and

researchers, an open-air latrine used by the local Mahafaly people (the use of pit latrines is *fady*), and several mud block structures for the on-site families (figure 4). During this study two families lived at the site throughout the year⁴. These families cultivated maize and manioc in nearby fields, and raised chickens, ducks, and turkeys all of which ranged primarily within the camp area and surrounding forest. Some social groups of ring-tailed lemurs and sifaka utilize both the reserve and camp. Most sifaka and ring-tailed lemurs in this population bear color-coded collars that identify their group, and a tag number that identifies each individual (Figure 2). The ring-tailed lemurs and sifaka at BMSR has been the subject of a number of long-term studies by Drs. Robert Sussman, Alison Richard, Diane Brockman, Michelle Sauter and Lisa Gould.



Figure 4. Villagers home in the camp near parcel 1 of the Beza Mahafaly Special Reserve. Note ring-tailed lemurs on the roof.

Methods

Behavioral sampling. Each species was intensively followed for four hours per day for six weeks. Species followed were rotated daily. Thus, each lemur species was sampled for a total of eight-four hours. Average group size of ring-tailed lemur groups was 15 individuals while the average size of sifaka groups was 6. Sample size was $n = 30$ for the ring-tailed lemurs and $n = 20$ for the sifaka. We used scan sampling (Altmann 1974) to collect behavioral data on ring-tailed lemurs and sifaka. Sampled behaviors are listed in Tables 1 and 2. All-occurrence sampling (Altmann 1974) was employed to examine the context and duration of interactions between humans and nonhuman primates. A “human-nonhuman primate

⁴ By 2005 ANGAP had reduced village occupation. Today there is only one family on site and no poultry.

interaction” was defined as a behavioral interaction between the two species that exceeded 10 seconds and included such behaviors as lemurs or humans approaching one another, humans feeding the lemurs and chasing them from a human food resource (Figures 4 and 5). Glances and visual monitoring between species were not considered an “interaction.” Both methodologies were coupled with *ad libitum* sampling.

Table 1. Behaviors ring-tailed lemurs engaged in that reduce, avoid, eliminate, or increase the likelihood of obtaining certain parasitic infections at Beza Mahafaly.

Behavior	Decrease the likelihood	Increase the likelihood
Terrestrial		√
Autogroom (groom self)	√	
Allogroom (groom others)	√	
Avoid Feces/Latrine Behavior ¹	√	
Coprophagy (fecal ingestion)		√
Consumption of medicinal foods (e.g. foods high in tannins).	√	
Consumption from human trash pits		√
Geophagy (soil eating)	√	
Licking Behavior	√	
Sunbathing	√	
Latrine Behavior	√	

¹ Latrine behavior refers to the whole troop tending to defecate within the same area and sometimes even near the same spot. By doing so, the lemurs may avoid their own and other group's feces.

Table 2. Behaviors Verreaux's sifaka engaged in that reduce, avoid, eliminate, or increase the likelihood of obtaining certain parasitic infections at Beza Mahafaly.

Behavior	Decrease the likelihood	Increase the likelihood
Arboreality	√	
Autogroom (groom self)	√	
Allogroom (groom others)	√	
Avoid Feces	√	
Non-coprophagy	√	
Consumption of medicinal foods (e.g. foods high in tannins).	√	
Geophagy (soil eating)	√	
Licking Behavior	√	
Sunbathing	√	

Parasitological protocols. Ring-tailed lemurs were captured using a Telinject blow dart system and the drug mixture of Ketamine and Diazepam, as part of the long-term investigation of this population's health profiles (Sauter et al., in press). We used protocols developed over the past 17 years and 360 captures at Beza Mahafaly (see Sauter et al. in press for a complete description). After examination and the collection of biological samples, individuals were released in the area where originally captured (normally within six hours). We followed all IACUC guidelines for these captures. Fecal samples were collected either as voided by lemurs under anesthesia or during lemur behavioral follow. All fecal samples were collected fresh. We examined the fecal parasites of 70 ring-tailed lemurs and 18 Verreaux's sifaka. Methods included fecal smears and fecal floatation methodologies. Fecal smear techniques detect the presence of non-buoyant and recently shed parasites within the animal's feces. Fecal floatation was used for separating helminthes eggs, and protozoan cysts from fecal matter. This allows for the identification of buoyant endoparasites and eggs, which float to the top of a cover slip (Ash and Oribel, 1987). We

collected ectoparasites from anesthetized ring-tailed lemurs by using a tick comb for mites and tweezers to extract ticks.



Figure 5. Local villager feeding a banana to a ring-tailed lemur within camp.

Interviews. We conducted questionnaires (Benard 2000) and non-scripted interviews to examine the local Mahafaly peoples' attitudes regarding ring-tailed lemurs and sifaka and the local folklores and origin myths surrounding each nonhuman primate (see Box 1 for an example of these questions). All interviews were conducted in Mahafaly by one of the authors, Mr. Jacky Yousouff, as well as a local assistant, Mr. Emady Rigobert. Thus interviewers were well known to the local people. Interviews took place at the villages of Analafaly, Ambinda, and Manasoa. Each interview was conducted with elder men or the village president (all older, male individuals). Thus our interview data are biased toward male perspectives of the reserve and the strepsirrhines inhabiting it. This was due to local traditions of the *kabary* (Malagasy word meaning "public discussion" similar to a public hearing.). No compensation was provided to avoid influencing the answers.

Table 3. Documented parasite species harbored by the primates at Beza Mahafaly.

Parasite Species	Kingdom	Harbored by Ring-Tailed Lemurs	Harbored by Verreaux's sifaka	Harbored by Domestic animals	Transferable between species
Coccidia ¹	Protist	Yes	No	No	Yes/Potentially*
Nematode ¹ Oxyuridae, <i>Lemuricola</i> sp. (Pinworm)	Animal	Yes	No	Yes	Yes/Potentially*
Nematode ¹ <i>Lemurostrongylus</i> sp. (Strongyles)	Animal	Yes	No	Yes	Yes
Tapeworm ¹	Animal	No	No	Yes	Yes
Ticks ² <i>Haemaphysalis lemuris</i>	Animal	Yes	Yes	No	Yes/Potentially*
Mites ¹ (2 species)	Animal	Yes	No	No	Yes/Potentially*
Scabies** (<i>Sarcoptes</i> sp.)	Unknown	Yes	No	Unknown	Unknown

¹Identification by M. Hunter-Ishikawa, ²Identification by M. Reichard. *These are "species specific" parasites. They may have co-specified with their host but may use another host accidentally, temporarily, or as a reservoir. ** Mange was observed on this population of ring-tailed lemurs but it is unknown if it is due to a fungal or arthropod parasite (i.e. *Sarcoptes*). This is currently being investigated and preliminary results indicate it is likely to be *Sarcoptes* mange (Randy Junge, DVM, pers. comm.).

Box 1. Interview Questions

Is the Beza Mahafaly Reserve good? What benefits do you derive from the reserve?
 How did the reserve begin? What village owned the land before it became a reserve?
 Should animals graze in the reserve?
 What is the future of the reserve?
 What are your feelings regarding the researchers that study at the reserve?
 Are the ring-tailed lemurs (*maky*) and sifaka sacred or special?
 What is the origin of the *maky* and sifaka?
 Do *maky* and sifaka raid crops? If so, how do you prevent crop raiding?
 Do people eat *maky* or sifaka?
 How long do *maky* and sifaka live?
 What are the differences between *maky* and sifaka?
 What do the *maky* and sifaka eat?
 How many *maky* and sifaka live here?

Results

Differences in Behavior

Preliminary data indicate that ring-tailed lemurs and Verreaux's sifaka differ in their socioecology and behavior in ways that may affect each species' disease ecology. Ring-tailed lemurs are more terrestrial and may thus encounter more potential avenues of disease transmission than the less terrestrial sifaka. In comparison to sifaka, ring-tailed lemurs at BMSR form larger social groups and frequently interact with other social groups increasing the potential for parasite transfer. There were also a number of behaviors that both species engaged in that could affect parasite type and prevalence. Both species consumed food high in tannins (kily fruit [*Tamarindus indica*]), (Sauter and Ganzhorn, unpublished data), as well as dirt, and termite soil. Each morning, and throughout the day, both species were observed sitting in sunlight in a behavior known as "sunning" (Jolly 2003). Ring-tailed lemurs preferentially used specific locations to defecate, as seen in the use of "latrines" by other lemur species (Erwin et al., 2004). Soiled locations were not used by ring-tailed lemurs, other than to eliminate waste (Loudon, pers.obs).

Our preliminary observations also indicate that groups living within human-altered habitats change their behavior in ways that could affect their disease ecology. Local traditions of the Mahafaly people of the BMSR area prohibit the use of pit-latrines, instead using an open-air “toilet area.” Ring-tailed lemur groups that commonly used the camp as part of their home range were observed ingesting human feces from this traditional toilet area. They also consumed zebu (*Bos taurus*) and dog (*Canis familiaris*) feces occasionally. Each age and sex class was observed consuming feces. Interestingly, these groups actively avoided their own feces (“latrine behavior”), but would step on the feces of zebu and dogs. Ingestion of fecal matter has never been observed in groups within the reserve, despite over eighteen years of observations of their feeding ecology (Sautther et al., 1999). Sifaka were not observed eating any human refuse and feces, nor have they been observed eating the feces of domestic animals. Camp ring-tailed lemurs came into close contact with both humans and their livestock. For example, they would often feed on the forage brought by humans to feed zebu (figure 6), thus directly exposing them to zebu feces. Subsequently contact with livestock occurred with ring-tailed lemurs but not with sifaka. While sifaka were usually arboreal, they did come to the ground to cross open areas in the camp, and to feed on herbs in the reserve.

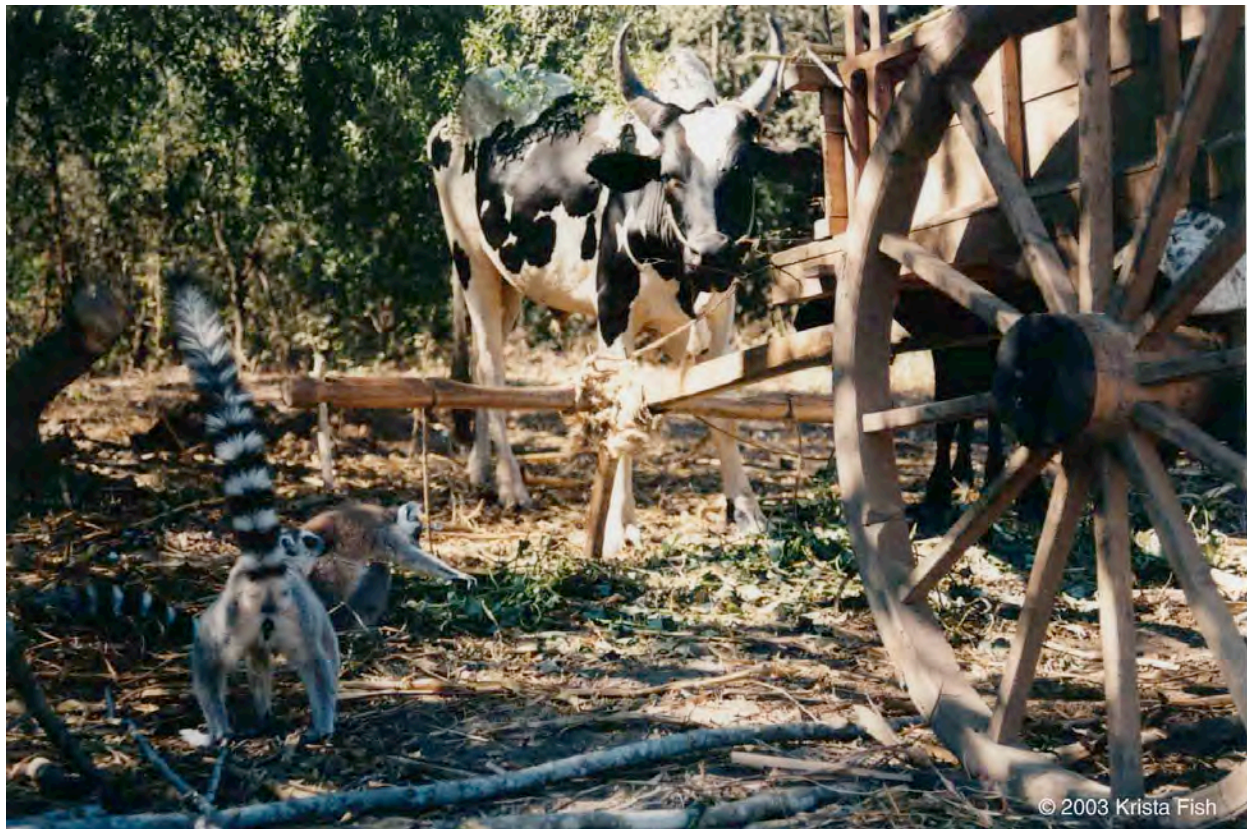


Figure 6. Ring-tailed lemurs in the camp near parcel 1 of the Beza Mahafaly Special Reserve feeding on cattle forage.

Parasitology

The preliminary study substantiated that the lemurs of BMSR harbor parasites (see Table 3). Ectoparasites were collected from ring-tailed lemurs while they were anesthetized. These parasites include two species of mesostigmatid mites (Order Mesostigmata) and one species of tick (*Haemaphysalis lemuris*). Fecal examination revealed that this population of ring-tailed lemurs harbors two species of nematodes, a pinworm (Oxyuridae, *Lemuricola* sp.), a species of strongyles (*Lemurostrongylus* sp), and one species of coccidia (probably *Cryptosporidium*; Graczyk pers.comm.). Physical examinations of anesthetized ring-tailed lemurs revealed that an unidentified species of ectoparasite is causing mange on the skin of some individuals. Mange is a contagious disease that usually results in integument inflammation and loss of hair (alopecia). At present it appears that an arthropod parasite (*Sarcoptes*) is the source of this mange (Randy Junge, pers. comm.). Of the ring-tailed lemur samples, 17 of the 70 contained endoparasites. These were two species of unidentified nematodes, which include members of the genus *Oxyuris* and *Strongyloides*. All seventy samples of ring-tailed lemurs harbored two unidentified species of mesostigmatid mites. One species of tick (*Haemaphysalis lemuris*), was also common. The Verreaux's sifaka fecal samples analyzed in 2004 did not contain endoparasites. However several endoparasites (both nematodes) as well as ectoparasites have been recovered from work done in 2005. Nevertheless, endoparasites within the sifaka samples were relatively rare. No sifaka were anesthetized during the pilot study so no ectoparasites were obtained, but ticks obtained by Dr. Diane Brockman and Alison Richard have been identified as *Haemaphysalis lemuris* (Brockman, pers.com).



Figure 7. Sifaka moving across open area in the camp near parcel 1 of the Beza Mahafaly Special Reserve.

Human-Nonhuman Primate Interactions

Each strepsirrhine species interacted with humans differently. Only one interaction was observed between humans and sifaka. A male sifaka descended to the ground to cross an open area camp to get to the forest on the other side of the camp (figure 7). One of the villager's young children was sitting in the path of the sifaka, who briefly sat down near the child and looked at him. The child immediately began crying and the sifaka continued moving toward the forest. The whole interaction took about 80 seconds. No sifaka were observed using human food or water. One individual did sit in camp chewing on a stick of wood (figure 8). In contrast, two groups of ring-tailed lemurs ranged into the camp and interacted with humans nearly daily. During this study these "camp" groups drank water from buckets at the well (figure 9), raided the research kitchen, ate discarded food at the trash pits or near huts, and consumed human feces at the open-air latrine. The local people in camp were usually quite tolerant of the lemurs, but they would chase them away if the lemurs attempted to steal food. Ring-tailed lemurs also entered local fields and ate the leaves of bageda plants on several occasions during observations. Sifaka were never observed doing this behavior. We noted 39 human-ring-tailed lemur interactions. The average interaction was 69 seconds and ranged from 2-198 seconds.



Figure 8. Sifaka chewing on wood within the camp near parcel 1 of the Beza Mahafaly Special Reserve.



Figure 9. Ring-tailed lemurs in the camp near parcel 1 of the Beza Mahafaly Special Reserve drinking water near the camp's well.

Local Perceptions and Attitudes Toward the Nonhuman Primates

A total of twelve interviews were conducted. However during each interview local people aggregated and men and village elders answered questions which were not directed at themselves. Therefore it is likely that the prestigious members of the villages influenced the answers of some of our interviewees. Regardless of these aggregations and our male-biased interviews, the attitudes, perceptions, origin myths, and reports of these nonhuman primates' behavior were almost identical. Among the three villages there existed small differences regarding how the reserve should be used.

In regards to human perception of the primates at Beza Mahafaly, both species live sympatrically with humans. However according to our informants, as well as personal observations, ring-tailed lemurs opportunistically engage in crop raiding while sifaka do not. Despite these behaviors both the ring-tailed lemurs and the Verreaux's sifaka enjoy a culturally protected status. It is this status that may be contributing to the success of the BMSR. According to our informants, harming, injuring, eating, or killing these

primate species is "*fady*" or taboo. The source of these cultural taboos remains unknown, however our informants provided us with the origin of these two primate species. According to local folklore, all three species originated from a single man and his two wives. The man captured a radiated tortoise (*Geochelone radiata*) for dinner. He gave the tortoise to his first wife and left for the day (Figure 10). His second wife became envious and subsequently, she beat the first wife repeatedly with a wooden spoon; these beatings ultimately transformed the first wife into the *maky* (ring-tailed lemur) (Figures 11 and 12). The first wife, now in the form of a ring-tailed lemur, grappled with the second wife and beat her with the wooden spoon until the second transformed into a sifaka (Figure 13). Thus according to our informants' traditional folklore the ring-tailed lemur and the sifaka were at one time humans and harming or killing these primates is forbidden and brings back luck. This protective status is further reinforced by each species morphological or behavioral characteristics. The local Mahafaly people have observed that both species exhibit a reduced rostrum, rely on vision, and utilize grasping hands that are similar to humans. Behaviorally our informants said that the *maky* and sifaka live in families, fight among each other, and utter calls to one another. The sums of these characteristics are not exhibited in other animals according to the people.

Discussion

The people that resided at the BMSR interacted with each species of nonhuman primate differently. These differences appear to be the result of each species' morphological and behavioral characteristics. Ring-tailed lemurs exhibit a wide dietary breadth consuming a broad spectrum of foods (Sauther et al. 1999). In addition, this species is highly terrestrial and extremely gregarious. Such characteristics may result in this species' ability to exist in a wide range of environments and exploit an expansive range of foods (Sauther et al. 1999). Based on the feeding ecology, Richard et al. (1989) assigned members of the genus *Macaca* into two distinct categories; "weed" and "non-weed" species. Weed species benefit from anthropogenic disturbances by utilizing secondary forests, raiding crops, and exploiting trash pits, food storages, or kitchens (Richard et al. 1989). Two groups of ring-tailed lemurs at Beza Mahafaly have utilized human settlements and while they did feed on some human foods, unlike some species of "weed



Figure 10. Mahafaly origin myth: A man captured a radiated tortoise (*Geochelone radiata*) for dinner. He gave the tortoise to his first wife and left for the day.



Figure 11. Mahafaly origin myth: His second wife became envious and subsequently, she beat the first wife repeatedly with a wooden spoon.



Figure 12. Mahafaly origin myth: these beatings ultimately transformed the first wife into the *maky* (ring-tailed lemur).

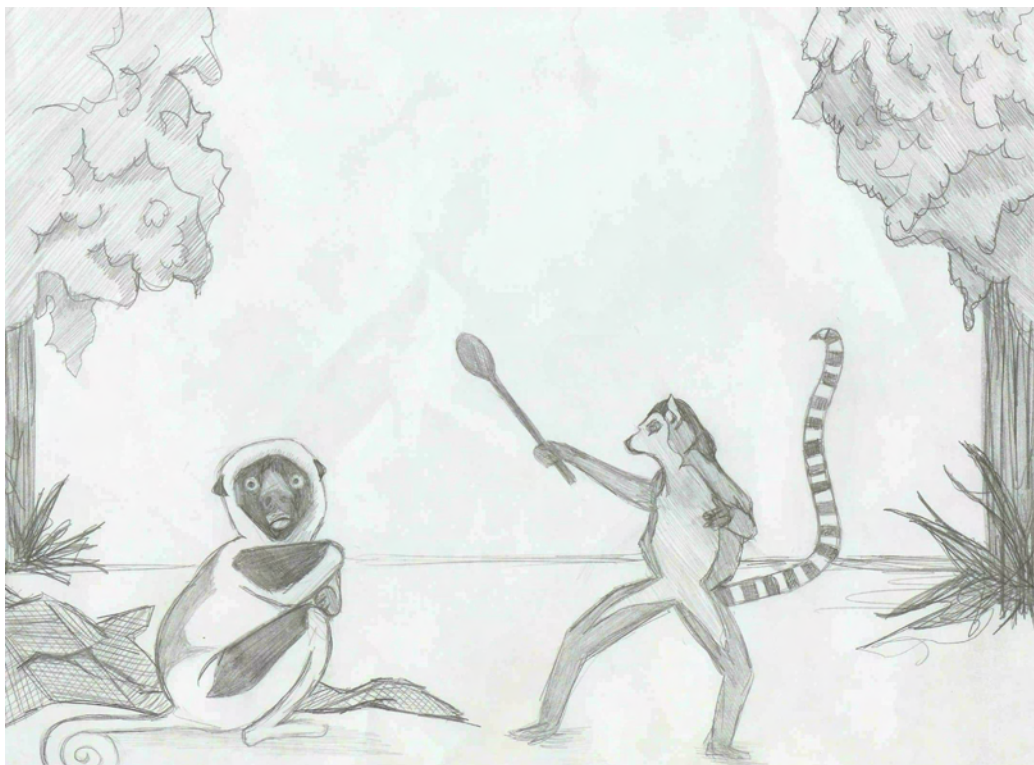


Figure 13. Mahafaly origin myth: The first wife, now in the form of a ring-tailed lemur, grappled with the second wife and beat her with the wooden spoon until the second transformed into a sifaka.

macaques,” these groups obtained the majority of their food from the surrounding forests (Sauther et al, in press). At best it appears that consuming human foods, refuse, and human waste (which has never been reported for ring-tailed lemurs before) allows them to supplement their diets. In contrast to ring-tailed lemurs, Verreaux’s sifaka are specialized arboreal vertical clinger and leapers (Richard et al. 1991; 2002). As such they spend much less time on the ground, where they could directly encounter humans. However, sifaka who used the camp as part of their home range did descend to the ground to cross open regions of the camp. This suggests that behavioral changes in anthropogenically-altered habitats may increase the potential for parasite infection in wild strepsirrhines, and is currently being studied. They were never observed consuming discarded human foods or feces, raiding trash pits, or drinking at the well. Given their highly folivorous diet (Richard et al. 1993), it is also possible that they avoid human foods as this could affect their microbial fermentation, which is especially important for folivores (Lambert 1998; Campbell et al. 2002). This combination of dietary, locomotor, and behavioral traits resulted in few human-nonhuman primate interactions as compared to the ring-tailed lemurs.

Both lemur species did exhibit some common behaviors that may be relevant to parasite prevalence and type. As noted, both species consumed kily as well as dirt and termite soil. It has been suggested that consuming these substances combats endoparasitic infections or ameliorates the pain or discomfort associated by such infections (Krishnamani and Mahaney 2000; Carrai et al. 2004; Ketch et al. 2001) or affecting cellulose digesting gut flora (Norscia et al. 2005). Soil samples are currently being analyzed for their potential anti-parasitic properties. Both species were also observed “sunning.” Research has suggested that sunning effectively eliminates ectoparasites by raising the ambient temperature beyond the threshold that the parasite can endure (Blem and Blem 2000). As noted, ring-tailed lemurs tend to use latrines, i.e. most members defecate and urinate within the same area. Such behavior could reduce transmission of fecal parasites among group members and this is currently being tested.

Each species is also distinctly different in terms of their behavioral ecology. These differences also influence ethnoprimate variables such as human perceptions and attitudes as well as each species’ parasite ecology. For example the wide dietary breadth of ring-tailed lemurs may allow this species to consume a broad spectrum of foods, which is beneficial in a harsh, arid, unpredictable environment when food resources can become difficult to obtain (Gould et al. 1999; Sauther et al. 1999; Ratsirarson 2003). As a consequence, incorporating human refuse and human feces may also provide and maintain a constant avenue of parasite transmission for species that utilize oral and fecal-oral routes. Individuals in this population were diagnosed with two species of nematodes that use oral routes (Roberts and Janovy Jr. 2000). Given that coprophagy may be a health concern, the use of feces by ring-tailed lemurs seems unusual and mal-adaptive. One possibility is that, because humans and their livestock are relatively new arrivals to Madagascar, and direct human-lemur interactions are also relatively recent, negative selection against this behavior is also recent (Fish, et al. submitted). This requires more direct analyses but points out the potential for zoonotic disease transmission to be higher for some lemur species (Wolfe et al. 1998). The ability to consume a wide spectrum of foods can also result in primate species engaging in crop raiding. Human crops are centralized, can cost less to forage, are low in secondary compounds, and are easy to digest. However crop-raiding is also a risky behavior that often results in physical injury or death (Naughton-Treves et al. 1998; Wheatley et al. 2002). For example, the ring-tailed lemurs are often chased from crops and are at greater threat from dog predation when crop-raiding (Sauther, unpublished data).

The Verreaux’s sifaka samples contained no endoparasites. While our sample size for this study is small, two other studies with much larger sample sizes at this site have also revealed few to no endoparasites in sifaka (Raveloarisoa 2000; Muehlenbein et al. 2003). One possibility is methodological. Sifaka fecal matter is difficult to process for fecal analyses and new methods are currently being employed. We know from our work in 2005 that sifaka do harbor intestinal parasites, as an adult

nematode was recovered (Sauter, unpublished data). It has also been argued that parasite prevalence may be low because of their arboreality and lower levels of human-sifaka interactions (Muehlenbein et al. 2003). These behavioral characteristics may reduce the likelihood of obtaining environmentally and socially mediated parasitic infections, and suggests that this population of sifaka is less prone to parasitic infections, but this needs to be formally tested across many seasons. The ring-tailed lemur's samples, in comparison, exhibited a much higher prevalence of endoparasites overall, with types that are more likely to be acquired by moving on the ground or transmitted socially. Ring-tailed lemur endoparasites such as coccidia are distributed throughout the hosts' habitat and utilize a fecal-oral (soil) route to locate a host. Stongyles can be placed in this category as well, however some species of stongyles will actively seek a host by honing the temperature gradient of the host against the outside environment (Roberts and Janovy 2000). It is unknown if this species uses the temperature gradient strategy. Lastly, pinworms require a host to ingest them or engage in bodily contact. It is also possible that the higher parasite prevalence and increased parasite diversity exhibited by these ring-tailed lemurs are related to differences in ecology. As ring-tailed lemurs at BMSR utilize a wider range of habitats, including areas that bring them into higher contact with domestic animals (Fish, et al. submitted), they are thus potentially exposed to a wider range of parasites. This is being currently investigated.

It is important to note that results from paleontological research in the area indicate that local people have not always viewed lemurs as *fady*. Evidence of butchery from a nearby area, Taolambiby, exists for subfossil forms (*Paleopropithecus* and *Pachylemur*) and extant *Propithecus*. There is no evidence of butchery of ring-tailed lemurs, however, which is uncommon in the Taolambiby assemblage (Perez et al. 2005). These fossils from Taolambiby date to a little over 2000 years ago (Burney et al. 2004). Today both the sifaka and ring-tailed lemur figure prominently in the local Mahafaly origin myths and are protected by cultural beliefs of *fady*. Several young villagers were unaware that the lemurs are endemic to Madagascar and occur nowhere else in the world. Once informed of this endemism, some villagers took pride in the uniqueness of these species. Our informants generally felt positive toward the reserve and claimed the forest at Parcel 1 is sacred and houses sacred animals. In addition, the reserve provides jobs for members of the neighboring villages and in times of emergency the reserve's car can be utilized. Although the results of our interviews suggested that the reserve is protected and these primates enjoy a protected status we observed traces of grazing (zebu tracks and feces) at the edges of the reserve and on rare occasions small trees are cut down. Local people may not associate the link between habitat destruction and its detrimental effects on viability of this population, and/or the traditions and origins they provided lie in the realm of the "ideal" and are not always practiced. In addition elders of Manasoa feel it is their right to graze their livestock in the reserve, as the land once belonged to this village. Nevertheless, most of the reserve remains intact with little human induced change.

While such cultural traditions currently provide these primates at Beza Mahafaly with a protective status, which is beneficial for long-term conservation initiatives, not all Malagasy groups share this perspective. The relationship between lemurs and the Malagasy vary across the island. In some areas formal *dina* or rules against hunting exists (Henkels 2002) but poaching is on the rise (Pettus 2005). For example, the results of our ethnographic fieldwork are in stark contrast to the findings by Simons and Meyers (2001) who investigated local peoples' perceptions of the aye-aye (*Daubentonia madagascariensis*) at villages near Montagne d'Ambre in northern Madagascar. According to local peoples in this region the aye-aye is *fady* and if an aye-aye enters a village it may cause sickness or death (Simons and Meyers 2001). In some villages if an aye-aye is seen, it must be killed and its body or tail must be hung from a pole at a crossroad to avoid bad luck to the village (Simons and Meyers 2001; Koenig 2005). Among villages there is variation regarding how to remedy the bad luck associated with the aye-aye, however each village believed that the aye-aye is evil. These beliefs have obvious detrimental effects on the small remaining populations of aye-ayes in Madagascar. It also points out the far-reaching effects of cultural perceptions on the survival of lemurs in Madagascar. Unfortunately, protective cultural practices such as the *fady* against harming lemurs at Beza Mahafaly may be tenuous. In

many areas of Madagascar where such *fady* have protected lemurs, these cultural traditions may be breaking down due to poverty and diet (Pettus 2005).

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