

The Journal of the American Association of Zoo Keepers, Inc.

Animal Keepers' Forum

AKF

*Special Issue on
Prosimians*

November/December 2015, Volume 42, Nos. 11 & 12



325 ABOUT THE COVER

326 FROM THE PRESIDENT

328 COMING EVENTS

330 PROSIMIAN TAXON ADVISORY GROUP

331 THANK YOU SPONSORS

FEATURED ARTICLES

- 332** Creation of a Mixed-species Group of Red Ruffed (*Varecia rubra*) and Ring-tailed Lemurs (*Lemur catta*)
Jessa Franck-McCauley
- 334** Coquerel's Sifaka: Parental behaviors as observed in first-time parents
Amy K. Thompson
- 340** RH: Nutritional therapy and insulin resistance
J. Jason Williams Ph.D. and Jan C. Ramer, D.V.M., Dipl. A.C.Z.M.
- 344** Reproductive Management of Ruffed Lemurs (*Varecia variegata* and *Varecia rubra*) in Zoos
Mylisa A. Whipple, M.S.
- 348** Cultivating a Sustainable Browse Program for Coquerel's Sifaka
Shannon Farrell
- 352** The AKO Project: The importance of storytelling in lemur conservation
Caitlin Kenney
- 356** The Night is Alive with Nocturnals. How about at your zoo?
Dean Gibson

- 362** Mouse Lemur (*Microcebus murinus*) Husbandry at the Duke Lemur Center
Bevan Clark, DLC Technician II and Andrea Katz

- 366** Lorises in Zoos:
History, conservation, and management
Helena Fitch-Snyder

- 370** Managing Aye-aye (*Daubentonia madagascariensis*) on a Natural Photoperiod (NPP)
Dean Gibson, Mindy Settles, Joe Milo, and Julie McKinney

- 376** Diagnosis and Treatment of Lice in Black-and-White Ruffed Lemurs (*Varecia variegata*)
Kathryn Sippel, Kelsey Miller and Judilee C. Marrow

- 378** When Tactile Training Comes in Handy: Helping a red-ruffed lemur (*Varecia rubra*) recover from four metacarpal fractures
Bethany Wall

- 383** Looking at Lemurs: Confirming pregnancies in ring-tailed lemurs (*Lemur catta*) via voluntary ultrasound
Emily Ellison and Laura Laverick

- 385** Using Operant Conditioning to Manage Reproduction in Coquerel's Sifaka (*Propithecus coquereli*)
Mylisa A. Whipple

- 388** PTAG Behavioral Husbandry Advisory Committee: How can we help?
Liz Kellerman and Meg Dye

- 391** Opportunities for Expanding the Enrichment Process
Meg H. Dye

- 393** Duke Lemur Center "Cheat Sheet"

394 TRAINING TALES

- Husbandry Challenges Associated with Managing an Individual with Diabetes in a Ring-tailed Lemur (*Lemur catta*) Troop
Matt Stierhof

Coquerel's Sifaka: Parental behaviors as observed in first-time parents

Amy K. Thompson
Graduate Student, Miami University, Department of Biology
College of Arts and Science, Oxford, OH, USA

Amy is enrolled in Miami University's Advanced Inquiry program. This program, a unique partnership between Miami University, Project Dragonfly, and the Cincinnati Zoo and Botanical Garden, focuses on developing inquiry-based teaching skills while encouraging students to affect positive social change in their local communities.

Introduction

Coquerel's sifaka (*Propithecus coquerelli*) are a medium-sized lemur species endemic to the dry deciduous forests of northern Madagascar. These tree-dwelling prosimian primates are more closely related to bushbabies, lorises and tarsiers than to modern monkeys, apes or humans (Jolly, 1966). Currently, Coquerel's sifaka (pronounced: "she-FAHK") are listed as endangered by the International Union for Conservation of Nature mostly due to habitat loss from unsustainable agricultural and timber harvesting practices (IUCN, 2013). While eating lemurs was once considered taboo, a growing threat to their survival is hunting for the illegal bushmeat trade (Kinver & Gill, 2011).

Coquerel's sifaka move around on the ground by bipedal, sideways hopping, but most of their time is spent in the trees where they use a form of locomotion known as vertical clinging and leaping (Jolly, 1966). In the wild, Coquerel's sifaka eat mostly leaves, fruit, flowers and bark. In captivity, they receive a variety of vegetables, leafy greens, fruits, seeds, beans, mini leaf-eater biscuits* and fresh browse multiple times a day (Miller, personal communication, 2012). A diurnal species, Coquerel's

sifaka are awake during the day and spend the night sleeping up in the trees to evade predators (Jolly, 1966). Coquerel's sifaka prefer to live in social groups ranging in size from a single adult pair to many individuals, with an average group size of five animals (Richard, 1978; Bastian & Brockman, 2007).

In lemur society, females are the dominant sex and males are submissive (Kappeler, 1991; Kappeler, 1993; Dunham, 2008). This social system is thought to have developed as an adaptation to the high cost associated with reproduction and childbirth and the limited availability of food resources in their natural habitat (Dunham, 2008; Grieser, 1992). Females get first choice when feeding and may initiate aggression if access to the food is threatened (Kubzdela et al., 2005). Most of the time, males submit to females and serve the social role of protecting and defining territories for their group. Male aggression, though rare, peaks during the breeding season when females are in estrus (Brockman, 1999).

In the wild, sifaka breeding occurs between January and March and following a 155-165 day gestation mothers give birth, typically to a single infant, in June and July (Bastian & Brockman, 2007; Miller, personal communication, 2012). This is the dry season when food resources are most scarce (Bastian & Brockman, 2007), so taking care of an infant is metabolically expensive (Dwyer, 2011; Grieser, 1992). Infants instinctually grip their mother's chest for the first few weeks of life and

Image 1. View from the Jungle Trails African Building lobby into the Coquerel's Sifaka exhibit. Photo courtesy of Amy Thompson



gradually transition to riding on her back for the next six months (IUCN, 2013). Infants reach mature size by one year of age (IUCN, 2013; Mittermeier et al., 2008).

As with most primate species, the female sifaka is the primary infant caregiver (Wright, 1990). Since wild sifaka females seem to be very intent on the business of survival, they rarely respond to an infant's desire to play except when resources are plentiful (Richard & Heimbuch, 1975). Some females will allow males to participate in childrearing activities such as holding and grooming, but these interactions are not presumed common because sifaka do not maintain pair bonds (Bastian & Brockman, 2007; Brockman, 1999; Grieser, 1992). Grieser (1992) was able to show that male Coquerel's sifaka display more paternal care behaviors than any other lemur species, which would seem to suggest that at least some males take an interest in caring for their offspring.

Based on the recommendation of the Sifaka Species Survival Plan (SSP) managed by the Association of Zoos and Aquariums (AZA), the Cincinnati Zoo acquired a pair of Coquerel's sifaka in 2011, a 3-year-old female ("Wilhelmina") and an 8-year-old male ("Rinaldo"), with hopes that the pair would breed (Johnson, 2012). For long-term survival of the captive population and maintenance of genetic diversity, these cooperative programs are essential.

On 03 September 2012, the female gave birth to a single infant with the sire present. The group size was 1.1 so no additional animals were present. Though the pair was observed breeding between 02 March 2012 and 01 April 2012, keepers did not suspect that the female was pregnant, however, during a routine check of the animals in their off-exhibit holding area, keepers discovered a newborn infant clinging to the female's chest (Ulrich et al., personal communication, 2012). During the next 24 hours, keepers watched the pair closely for signs of aggression or infant neglect (Miller, personal communication, 2012). Satisfied that things were going smoothly, zoo managers decided to keep the family group together and keepers were able to weigh the infant and determine gender (male) on 04 September 2012 (Miller personal communication, 2012). The weight, recorded at 98 grams, was within



Image 3. Dam with infant. Photo by Amy Thompson.

the acceptable range (85-115 grams) of a day-old infant (Dulaney, personal communication, 2014). This birth marked the first of its kind for the species at the Cincinnati Zoo and was also the first infant for the pair. At the time of his birth, the newborn and his parents were three of approximately 54 sifakas found in U.S. zoos (Johnson, 2012).

Bastian & Brockman (2007) note that male-infant interactions can be difficult to assess in captivity because some institutions separate the dam and newborn from the rest of their social group for a short period of time post parturition to monitor the infant's well-being (Bastian & Brockman, 2007). Keepers at the Cincinnati Zoo and Botanical Garden did not find it necessary to separate the dam and her newborn from the sire following the infant's birth. This gave both parents uninterrupted and equal opportunity to interact with the infant.

Image 2. View of man-made branches and vines, natural bamboo poles, concrete floor, and painted walls in the exhibit. Photo courtesy of Amy Thompson.





Image 4. Sire.



Coquerel's Sifaka.



1.1 Coquerel's Sifaka.



Mother-Infant Eye Contact



Coquerel's Sifaka Family.



Dam and Infant.



Dam and Infant

Upon initiating this study, the researcher conducted a review of literature focused on learning more about the interactions of both wild and captive adult Coquerel's sifaka with their infants. This information helped the researcher develop an observational study appropriate for collecting data on sifaka parental behaviors observed at the Cincinnati Zoo. The question that the researcher wanted to know more about was: Would the Coquerel's sifaka pair at the Cincinnati Zoo exhibit parental behaviors similar to those observed in the wild and in other captive situations, or would the dam and sire be unique in the way that they cared for their infant? The goal of this study was to assess, compare, and contrast male and female behaviors, targeting the occurrence of the four parental care behaviors previously identified by Bastian and Brockman (2007): grooming, holding, carrying, and playing with the infant.

It was anticipated that the findings of this study would be useful to zoo keepers and zoological managers who rarely have time in their busy schedules to personally conduct lengthy observational studies. By partnering with volunteers, students, and interns, keepers have an opportunity to capture important behavioral information about their animals that could be used to refine husbandry practices. This study will also expand upon our limited knowledge of paternal care behaviors in Coquerel's sifaka, particularly within zoos, and could be shared with other organizations interested in captive lemur management and species conservation.

Methods

The Coquerel's sifaka were housed in the Cincinnati Zoo's Jungle Trails African building. An observational study of this family group was initiated on 30 September 2012 and terminated on 10 November 2012. A total of seven observation dates were classified as observation periods I through VII (Figures 1-4). The infant was 27 days old at the initiation of the study and 68 days old at the completion. During the observational period, the group was housed exclusively in the indoor display of the Jungle Trails African building with access to off-exhibit holding areas during daily exhibit cleaning and maintenance by the keeper staff (Ulrich, personal communication, 2012).

For 60 minutes, once a week, the lemur family was observed by the researcher through the glass of the public viewing window in the lobby of the Jungle Trails African Building. The exhibit dimensions were 19 feet deep from the exhibit glass to the back wall by 26 feet wide from side to side by 16 feet high from floor to ceiling (Hutson, personal communication, 2012). For climbing, the exhibit featured floor-to-ceiling, man-made tree structures, branches, and vines inter-mixed with natural bamboo poles (Images

1 and 2). The floor of the exhibit was concrete. The walls and ceiling, also made of concrete, were painted with a forest mural. Pools in the exhibit, which may have been designed to hold water, were empty during the observation period. Food, including fresh browse, was offered in hanging PVC bowl-style feeders, scattered about the exhibit, or suspended from branches. Water was available *ad libitum*. Keepers provided the Coquerel's sifaka family group with daily environmental enrichment and conducted training sessions with the animals in their exhibit.

An ethogram was developed for capturing behavioral data. Instantaneous scan sampling of individual animal behavior was conducted every five minutes for periods of 60 seconds. Focal animal sampling documented occurrences of significant or interesting behaviors or interactions that occurred between instantaneous scan sampling data collection points. All instances of infant independent exploration, characterized by non-physical contact with an adult, were recorded. Out of thirty-four initially identified behaviors, only the four parental behaviors identified by Bastian & Brockman (2007) were targeted for further analysis. Those parental behaviors were: 1) infant grooming (licking or cleaning the infant's fur), 2) infant carrying (contact with infant while moving from place to place), 3) infant holding (contact with the infant while stationary), and 4) infant play (attention getting behaviors such as nudging, grabbing, pawing, or tugging). Microsoft Excel was used to analyze relevant data and produce figural representations of this information.

Results

During the observation period, which included seven separate observation dates, there was never an instance of male initiated aggression towards the female or infant. The female, however, was aggressive towards the male on one occasion when he attempted to reach for and groom the infant. This show of aggression (alarm vocalization and posturing) was very brief and the male was allowed to again approach the infant for grooming a few seconds later.

Of the targeted parental care behaviors (grooming, carrying, holding, and playing with the infant), only the female displayed all four (Figure 1). While the male held and groomed the infant, he did not play with the infant or carry it (Figure 2). Over time, the trend for infant grooming, play, and holding all decreased for the female, while infant carrying increased (Figure 3). When the four, targeted parental interactions are summed for both the male and female, both sexes show a decreasing trend in frequency of occurrence for parent-infant interactions over time (Figure 3).

During observation period IV, the male and female showed the most similar distribution of total time spent interacting with the infant. Thirty-six percent of parental interactions occurred between the male and the infant while sixty-four percent of parental interactions occurred between the female and the infant. During all other observations periods, the female overwhelmingly dominated the observed percentage of parent-infant interaction.

With increasing age, the infant spent more time independently exploring away from his parents (Figure 4). During these bouts of independent exploration, the infant was never more than approximately two feet away from reestablishing physical contact with either the dam or the sire. Distance ventured away from the adults ranged from a few inches to a couple of feet, but not more than that for the duration of the study. As the infant explored more independently, the data showed a general decrease in frequency of adult-infant interaction (Figure 4).

On average, the male had 1.7 bouts of infant grooming behavior per hour, 0.0 bouts of infant carrying per hour, 0.3 bouts of infant holding per hour, and 0.0 bouts of engagement in play per hour for the observation period (Table 1). The female averaged 3.9 bouts of infant grooming

behavior per hour, 4.9 bouts of infant carrying behavior per hour, 4.3 bouts of infant holding per hour, and 0.3 bouts of engagement in play per hour for the observation period (Table 1).

Discussion

Some studies suggest that paternal care is rare in primates and even more so in prosimian primates including lemur species (Grieser, 1992; Sussman & Garber, 2007). Furthermore, Trivers (1972) suggests that paternal care should evolve only where paternal certainty exists. A general lack of pair bonding in the species would seem to predict the absence of male-infant care, but this is not always the case (Bastian & Brockman, 2007; Brockman, 1999; Grieser, 1992).

In this study, the male can be certain of his paternity because he was the only mate available to breed the female. Observations of the sire holding and grooming the infant show that two of the four, targeted parental care behaviors were met, which supports the findings of prior studies where paternal care was expressed in this species (Bastian & Brockman, 2007; Dwyer, 2011). The data collected as part of this study is consistent with research revealing that males are capable of providing at least a minimal level of infant care (Bastian & Brockman, 2007; Dwyer, 2011; Grieser, 1992). Even if the male's paternity were in question, he may be able to increase his odds of siring future offspring with the dam if he helps her care for the newborn infant (Grieser, 1992).

It is important to realize that the typical husbandry protocol following the birth of a captive Coquerel's sifaka would be to separate the dam and infant from other group members for at least one week post-birth to allow for infant monitoring (Bastian & Brockman, 2007; Miller, personal correspondence, 2012). Bastian & Brockman (2007) predicted that infant directed caregiver aggression is likely underestimated because of this separation. Since no separation period took place at the Cincinnati Zoo, opportunities for male-infant interactions were constantly available and, luckily, when these interactions did occur, they were all docile in nature. Data gathered as part of this study refute Bastian & Brockman's (2007) reasoning for the underestimation of infant-targeted aggression.

In the wild, female Coquerel's sifaka struggle to meet metabolic needs while raising infants in a resource poor environment and may require

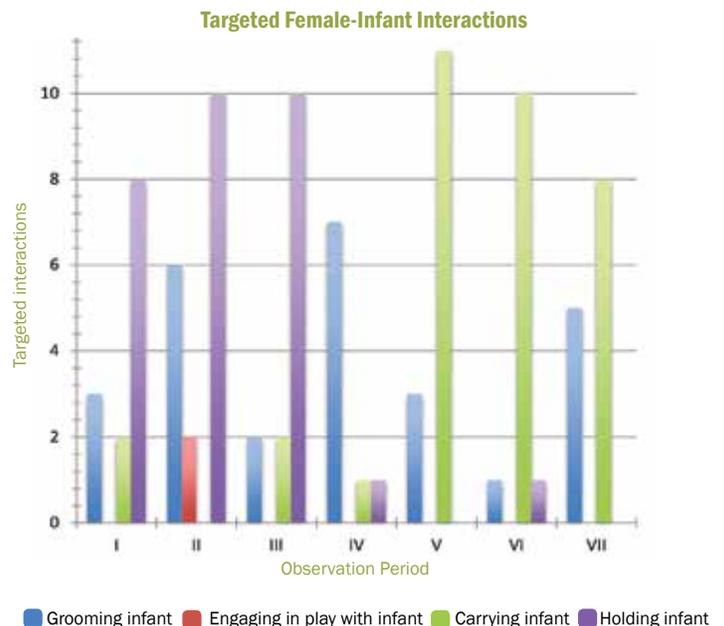


Figure 1. Occurrence of targeted female-infant interactions (grooming, play, carrying, and holding) as they occurred during each of the seven observation periods.

Targeted Male-Infant Interactions

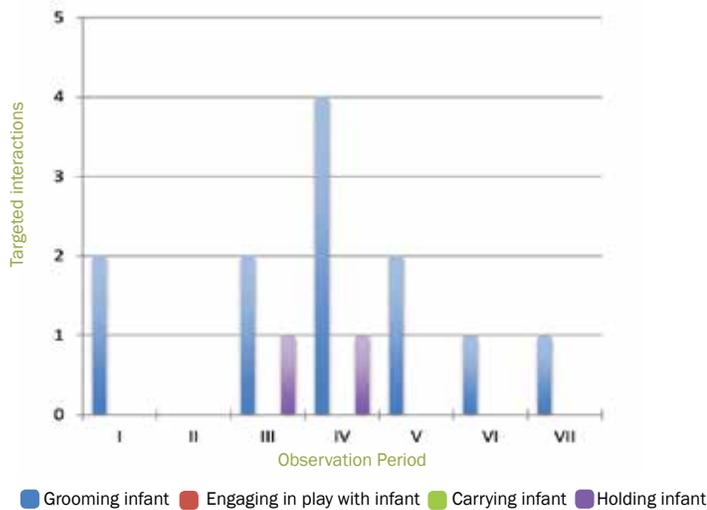


Figure 2. Occurrence of targeted male-infant interactions (grooming, play, carrying, and holding) as they occurred during each of the seven observation periods.

more help in general (Dunham, 2008; Grieser, 1992). In captivity, food resources are plentiful, predators are absent, and round-the-clock veterinary care is available. Though evolutionarily programmed to act a specific way, captive sifaka mothers are not taxed as heavily to meet their physiological demands. The influence of a “comfortable” captive environment should be taken into account when trying to explain observed differences in parental care as compared to studies done on wild populations where resource availability is undoubtedly more sporadic.

When comparing behavioral data, one might expect to see the expression of more similar behaviors when comparing day-to-day captive behaviors to behaviors observed in the wild during the wet season when food is plentiful. In other words, the resource-depleted environment of the dry season in Madagascar does not compare to the resource richness of captivity. Richard & Heimbuch (1975) reported that females only play with infants during the wet season when resources are plentiful. Thus, female play-based interactions, like those observed between the dam and infant in this study should be expected in the captive environment, but may not be seen as often in the wild.

Data collected in this study showed that mother-infant interactions were more frequent than father-infant interactions during the infant’s first few months of life, presumably because the infant still needed to nurse, and only the dam could provide this service (Wright, 1990). Over time, mother-infant interactions decreased for the targeted parental behaviors of infant grooming, infant holding, and infant play. Infant carrying, however, increased over time. Perhaps less time spent nursing allowed for more mobility and should be examined in future studies.

Occurrences of targeted male-infant interactions, though existent, were not abundant. The only targeted behavior the male performed with any great frequency was infant grooming (Figure 2). Looking at observation period IV, the percentage of caregiver behaviors for the male most closely mirrored the expression of caregiver behaviors for the female

Trends in Total Targeted Interactions

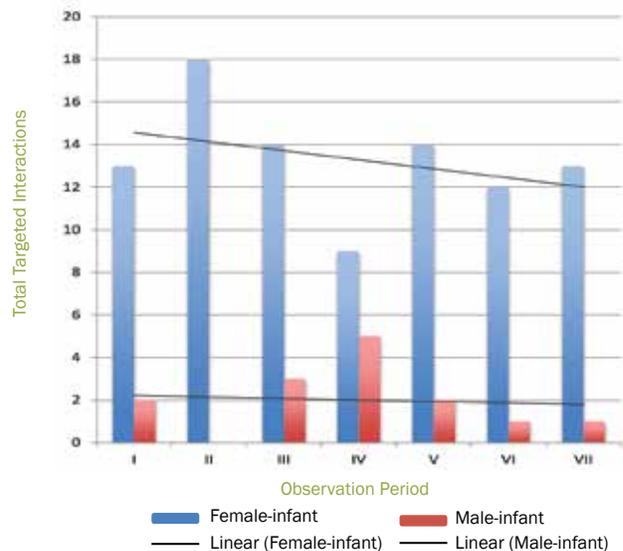


Figure 3. Total targeted female-infant and male-infant interactions for each observation period as shown with a linear trend line.

(Figures 1 & 2). During this observation period, the family of lemurs sat together and had an extended grooming session in which the male held and groomed the infant for more than five minutes. Conspecific grooming in Coquerel’s sifaka seems to reinforce social bonds and is a parental behavior worthy of tracking.

Previous research suggests that older males are more likely than younger males to hold, groom, and carry infants (Bastian & Brockman 2007). Future studies should explore this finding further, but the current study cannot support or negate this observation. From an animal care perspective this study is important because even though they were first-time parents, both sifaka exhibited appropriate parental care behaviors without the necessity of human intervention post-birth.

The relationship between individual interactions, group dynamics, and species persistence in the wild is currently unclear for Coquerel’s sifaka. The pool of data containing information about parental care behaviors is also limited for the species. Questions about whether paternal-infant care is a male reproductive strategy should drive further research. Also, future research studies should track sifaka infant survival rates when males are known to have participated in parental care. When a sire’s offspring survives, his genes continue in the population, so from a reproductive standpoint, anything males can do to ensure their infants survival has evolutionary benefits. In this study, the male spent a substantial amount of time grooming and holding the infant. Both are necessary but time-consuming parental functions. Also, any time a male sifaka assumes important parental responsibilities, it likely benefits the survival of the metabolically-taxed reproductive female. For the long-term survival of the species, parental investment benefits everyone.

An additional limitation of this study is that it only reports data following one birth and does not compare data from a larger sample. Also, the study began when the infant was 27-days-old and it would be nice to have observational data collected during the first month post-birth. Given the timeframe and scope of this particular study, further data

Adult/Infant Interaction as Compared to Infant Independent Exploration

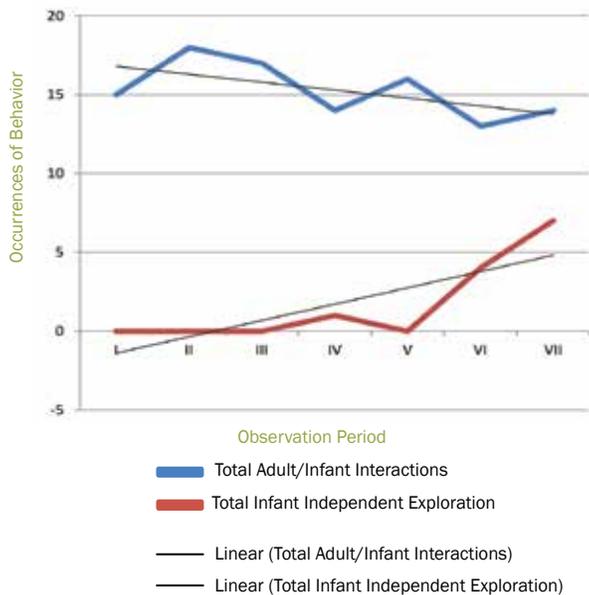


Figure 4. Comparison between total time that the infant spent interacting with an adult and the total amount of time the infant spent independently exploring, free of physical contact with an adult.

collection was not possible. In 2013, the Cincinnati Zoo's sifaka pair did go on to produce another infant, therefore it is hoped that other researchers might continue this project as long as the pair continues to successfully produce offspring. Any data collected could be used to supplement the current body of literature on the subject.

Conclusion

Much of the knowledge gained about this species has, and will continue to come from observations made of captive animals. Knowledge gained by studying captive sifaka should be applied towards the conservation of their wild counterparts in Madagascar. Overall, it is anticipated that this study will contribute to the pool of knowledge pertaining to Coquerel's sifaka behavior, and it will inspire further research as well. Clearly, understanding how all of these factors interrelate is key to the survival of the species in the wild, and essential to their continued success in the captive breeding program.

In addition to captive animal management strategies and ongoing research programs, habitat protection will also be vitally important for the long-term survival of Coquerel's sifaka in the wild. Most of Madagascar's original forests have already been cleared for agriculture and other developments (IUCN, 2013). The loss of Madagascar's biological diversity would be devastating. Madagascar is currently recognized as a world biodiversity hotspot and conservation projects aimed at saving lemur species should be amplified.

The results of this study should serve as a reminder for keepers about the many benefits of partnering with volunteers, students, and interns when you have questions about the animals that you care for. These arrangements provide opportunities for capturing important behavioral information and can be used to refresh and refine traditional husbandry practices.

Acknowledgements

I wish to extend a special thank you to the Jungle Trails Keeper Staff, especially Janet Hutson, Matt Miller, Stephanie Schuler, and Vicki Ulrich

who took time out of their busy schedules to answer my many questions. Also, thanks to Megan-Kate Ferguson, Curator of Animal Development and Training for providing information about sifaka behavior, and Mike Dulaney, Curator of Mammals, for reviewing my manuscript. Finally, thanks to my classmates in the Dragonfly program for providing support, encouragement, and feedback along the way, and for helping to edit my many drafts.

* Mazuri® Leaf-Eater Primate Diet Mini-Biscuit #5672. Catalog #: 0001448.

Sifaka photos by Author

References

- Bastian, M.L. and D.K. Brockman. 2007. Paternal care in *Propithecus verreauxi coquereli*. *International Journal of Primatology* 28(2): 305-313.
- Brockman, D.K. 1999. Reproductive behavior of female *Propithecus verreauxi* at Beza Mahafaly, Madagascar. *International Journal of Primatology* 20(3):375-398.
- Dunham, A.E. 2008. Battle of the sexes: Cost asymmetry explains female dominance in lemurs. *Animal Behavior* 76(4):1435-1439.
- Dwyer, E.M. 2011. Development of two captive infant *Propithecus verreauxi coquereli*. Washington University in St. Louis, Environmental Studies Program, unpublished Senior Honors Thesis.
- Grieser, B. 1992. Infant development and parental care in two species of sifakas. *Primates* 33:305-314.
- IUCN. 2013. IUCN Red List of Threatened Species. Version 2013.2. <www.iucnredlist.org>. Downloaded on 14 April 2014.
- Johnson, J. (2012, September 20). Cincinnati Zoo marks birth of rare type of lemur. Retrieved from <http://news.cincinnati.com/article/AB/20120920/NEWS/309200129/Cincinnati-Zoo-marks-birth-rare-type-lemur>
- Jolly, A. 1966. *Lemur Behavior*. Chicago: Chicago University Press.
- Kappeler, P.M. 1991. Patterns of sexual dimorphism in body-weight among prosimian primates. *Folia Primatologica* 57:132-146.
- Kappeler, P.M. 1993. Variation in social-structure—the effects of sex and kinship on social interactions in three lemur species. *Ethology* 93:125-145.
- Kinver, M. and V. Gill. (2011, November 1). Eroding taboos seeing lemurs end up on dinner tables. BBC News. Retrieved from <http://www.bbc.co.uk/news/science-environment-16138206>
- Kubzdela, K.S., Richard, A.F., and M.E. Pereira. 2005. Social relations in semi-free-ranging sifakas (*Propithecus verreauxi coquereli*) and the question of female dominance. *American Journal of Primatology* 28(2):139-145.
- Mittermeier, R.A., Ganzhorn, J.U., Konstant, W.R., Glander, K., Tattersall, I., Groves, C.P., and R.M. Rasoloarison. 2008. Lemur diversity in Madagascar. *International Journal of Primatology* 29(6):1607-1656.
- Richard, A.F. 1978. Behavioral variation: case study of a Malagasy lemur. Bucknell University Press.
- Richard, A.F., and R. Heimbuch. 1975. An analysis of social behavior of three groups of *Propithecus verreauxi*. In: Lemur Biology, I. Tattersall and R.W. Sussman (eds.). New York: Plenum Press: 313-333.
- Sussman, R.W., and P.A. Garber. 2007. Cooperation and competition in primate social interactions. *Primates in perspective* 636-51.
- Trivers, R.L. 1972. Parental investment and sexual selection. In: B. Campbell (Ed.) *Sexual Selection and the Descent of Man, 1871-1971* (pp. 136-179). Chicago: Aldine-Atherton.
- Wright, P.C. 1990. Patterns of Parental Care in Primates. *International Journal of Primatology* 11(2):89-102. 🐒