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## Non-maternal infant care in wild Silky Sifakas (*Propithecus candidus*)

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### Introduction

Four decades ago, Jolly (1966) in her classic field study, described "multiple parenting" or the extensive care of infants by non-mothers within Verreaux's sifaka groups. These observations represented the first evidence in prosimians of allocare, which among mammals is known to be most prevalent in canids (Moehlman and Hofer, 1997) and primates (Hrady, 1970). Amongst primates, most reviews have focused on anthropoids, although there is increasing recognition that allocare is extensively practiced by prosimians (MacKinnon, 2007). The aims of this brief report are to review allocare in prosimians and provide new information on extensive non-maternal infant care in wild silky sifakas (*Propithecus candidus*). This report presents the first published description and photos of allocare in rain-forest sifakas, although it is known to occur in these highly social, diurnal indriids (Wright, pers. comm.). A current literature search revealed that non-maternal infant care occurs within all three prosimian Infraorders, and all prosimian families except the monotypic Daubentonidae and Megaladapidae (see Table 1). Pro-

simians within all major social systems and activity patterns (nocturnal, diurnal, and cathemeral) engage in allocare. Although grooming and play are the most common behaviors, extreme allocare, such as nursing and carrying, does occur in a wide variety of monotocous (single offspring) and polytocous (multiple offspring) or 'litter' producing prosimians. Allo-nursing has been observed in four diverse lemur species (*Lemur catta*, *Microcebus murinus*, *Propithecus candidus*, *Varecia variegata*), but not in any Asian or African prosimians. A detailed three year *Microcebus murinus* study found that kin-selection was the most well supported functional explanation for allo-nursing (Eberle and Kappeler, 2006). Infant carrying by non-mothers has been documented in *Tarsius spectrum* as well as four diverse lemur species (*Eulemur mongoz*, *Hapalemur griseus*, *Propithecus candidus*, *Propithecus diadema*). Extreme allocare has not been observed in any African prosimians.

Although infant carrying by prosimian allo-caregivers is less extensive than in callitrichids, adult male red-bellied lemurs (*Eulemur rubriventer*) have been observed to carry infants for up to 100 days (Mittermeier *et al.*, 2006). Similarly, adult male lesser bamboo lemurs (*Hapalemur griseus*) carry infants for 20 % of the day from 3 weeks of age (Wright, 1990). Amongst anthropoids, female allocare is most often performed by nulliparous subadult and juvenile females (MacKinnon, 2007). Although this is also true of tarsiers (Gursky, 2000), a more varied pattern is apparent in prosimians (Table 1).

Previously, Patel *et al.* (2003) reported 230 occurrences of allocare with 2 infants during the first 6 months of life within a multi-male group of 8 wild silky sifakas. Non-maternal infant care was performed by all age-sex classes on all infants from the first few weeks of life until 24 weeks of age. Grooming was by far the most frequent allocare behavior followed by playing, carrying, and nursing respectively. With increasing infant age, grooming declined while play increased. Allonursing was observed on two occasions during the fourth and fifth months when a multiparous adult female allowed the offspring of a primiparous young mother to nurse simultaneously alongside her own infant (on the other nipple). Allonursing has only been found in 17 of over 620 total primate taxa (Packer *et al.* 1992).

### Methods and Results

On September 26 2006, during my annual visit to this same group of sifakas at Camp 2 of Marojejy National Park, I observed substantial allocare of a very young infant. This single 158 min. episode began as the 6 week old (Wul Frank, ANGAP Chef Secteur) infant of a young multiparous mother (BP) completed a nursing bout, left her mother, and approached the oldest adult male in the group (PF). At 07:15 AM the infant began interacting with PF, and I began continuous focal animal sampling of this infant using an established silky sifaka ethogram (see Patel, 2005; Patel *et al.*, 2003). For 108 continuous minutes, this old adult male engaged in much mutual playing, grooming, and resting with the infant. During almost half of this male allocare, the infant fell asleep in the lap of the male. Towards the end of their association, as the group began to move from this feeding site, the male actually carried the infant awkwardly on his ventrum for 4 min. as he traveled a short distance (Fig. 1, Fig. 3).

Table 1: Review of non-maternal infant care in prosimians.

Prosimian Taxon	Allocare Behavior	Non-Mother Age/Sex Class	Setting	Reference
<i>Cheirogaleus medius</i>	Play, Sleep, 'Baby Sit'	Adult: M	In-situ	Fietz and Dausmann (2003)
<i>Eulemur mongoz</i>	Carry	Adult: M	Ex-situ	Wright (1990)
<i>Hapalemur griseus</i>	Carry	Adult: M Older Sibling	In-Situ	Wright (1990)
<i>Lemur catta</i>	Groom, Nurse	Adult: F,M Subadult: F,M Juvenile: F,M	In-situ	Goeld (1992)
<i>Lemur catta</i>	Groom, Nurse	Adult: F Juvenile: F	Ex-situ	Pereira and Izard (1989)
<i>Lemur catta</i>	Contact, Groom	Adult: F Juvenile: F	In-situ	Jolly (1966)
<i>Loris l. lydekkerianus</i>	Groom, Play	Adult: M	In-situ	Nekaris (2003)
<i>Loris l. lydekkerianus</i>	Groom, Play	Adult: M	Ex-situ	Rasmussen (1986)
<i>Loris l. nordicus</i>	Groom, Play	Adult: M	In-situ	Nekaris (2003)
<i>Microcebus murinus</i>	Groom, Nurse	Adult: F	In-situ	Eberle and Kappeler (2006)
<i>Perodicticus potto</i>	Groom, Play	Adult: M	Ex-situ	Frederick (1998)
<i>Propithecus candidus</i>	Groom, Play, Nurse, Carry	Adult: F,M Juvenile: M	In-situ	This Manuscript; Patel <i>et al.</i> (2003)
<i>Propithecus verreauxi</i>	Contact, Groom	Adult: F,M Juvenile: F,M	In-situ	Jolly (1966)
<i>Tarsius spectrum</i>	Carry, Food Share, Play, 'Baby Sit'	Adult: F,M Subadult: F,M	In-situ	Gursky (2000)
<i>Varecia variegata</i>	Contact, Groom, Play	Adult: F,M	In-situ	Morland (1990)
<i>Varecia variegata</i>	Nurse	Adult: F	Ex-situ	Pereira <i>et al.</i> (1987)

Almost immediately once the male had stopped traveling, the infant scampered off the male and approached the oldest adult female in group (AF). The infant climbed on to this multiparous female who was already carrying her own infant on her ventrum (Fig. 2). For the next 50 minutes, this female engaged in continuous allocare of the other mother's infant while simultaneously caring for her own infant. Her allocare included all types demonstrated by the adult male, although she



Fig. 1: Adult male Silky Sifaka, PF, during 108 minutes of continuous allocare with a 6 week old infant. Photo Credit = Jeff Gibbs and Erik Patel

engaged in more carrying, but less play and grooming than the male. At 09:53 AM, the young mother of the allocare-receiving infant (BP), approached the older mother who was now carrying both infants. Just a few moments after the young mother was side-by-side in contact with the older mother, her infant jumped off the older allo-mother and directly on her own mother's ventrum. The infant began nursing immediately upon return to her mother.

### Discussion

These results are similar to Jolly's (1966) observations of allocare in *P. verreauxi*. However, Jolly (1966) observed infants as young as 2 weeks of age in contact with other group members. Thus far, non-maternal infant care in silky sifakas has not been observed before 3 weeks of age (Patel *et al.*, 2003). Amongst the nine species of *Propithecus*, only *P. candidus* and *P. edwardsi* (Wright, pers. comm.) have been reported to engage in allonursing. Allo-carrying has been documented in *P. candidus* as well as *P. diadema*, where a sub-adult male carried and traveled with a 1 month old infant for 70 minutes (Irwin, pers. comm.).

The widespread occurrence of allocare across diverse prosimian taxa provides an excellent opportunity for future studies to test hypotheses regarding the evolution of allocare. The extent of allocare exhibited by a species may depend on patterns of post-natal growth, life history, or social factors. Rainforest sifakas, like *Propithecus candidus*, exhibit rapid infant growth rates exceeding that of dry forest sifakas (Ravosa *et al.*, 1993). Wright (1990) compared infant growth and paternal care in several prosimian and New World monkeys, and found that species exhibiting rapid post-natal growth and high infant/maternal weight ratios tended to show the most paternal care. At that time, tarsiers appeared to be an outlier since they possess huge infant/maternal weight ratios but little paternal care had been known to occur. This paradox has been somewhat resolved since it is now known that tarsiers do exhibit some allocare, although most allocare is performed by subadult females. Recently, Ross and MacLarnon (2000) conducted a large regression analysis across 49 anthropoids and similarly found that high allocare species wean infants at a younger age and grow more rapidly post-natally than lower allocare species of the same body size. Early allocare is most prevalent amongst cercopithecines with relaxed dominance hierarchies among females and seasonal breeding, e.g. *Cercopithecus* and *Erythrocebus* (Chism, 2000). Sifakas are not known to possess strict dominance hierarchies among females (Richard, 2003), although seasonal hierarchies do occur (Wright, 1999). *Propithecus* exhibits strict reproductive seasonality as



Fig. 2: Adult female Silky Sifaka, AF, carrying both her own and another mother's young infant during 50 min. of continuous allocare. Both infants are approximately 6 weeks of age. Photo J. Gibbs and E. Patel

in all Malagasy strepsirrhines. Asian and African prosimians do exhibit some reproductive seasonality but far less strict than amongst Malagasy prosimians (Sussman, 2000). Since these social and life history characteristics associated with anthropoid allocare are generally found in prosimians (Wright, 1999; Sussman, 2000), they may also help explain the widespread occurrence of prosimian allocare.

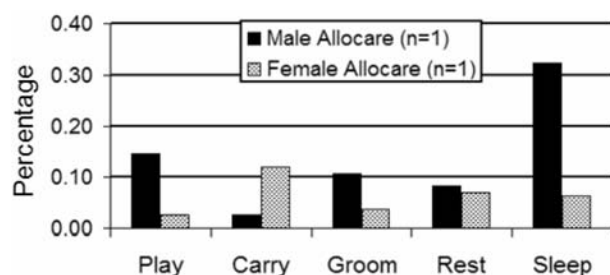


Fig. 3: Percentage of time across 5 types of allocare during 158 continuous minutes.

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## **Research experience in Vohibasia Forest, southwestern Madagascar**

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Vohibasia Forest is the northern parcel of Parc National Zombitse-Vohibasia. The protected area of the Zombitse parcel consists of 17,240 hectares of dry deciduous forest, while the Vohibasia parcel is comprised of 19,612 ha (ANGAP 2009). Gazetted as classified forest in 1962, Zombitse-Vohibasia gained park status in 2001 under the management of the World Wildlife Fund (WWF). Management of the park has since been handed over to ANGAP.

During the month of June 2005, our team attempted to collect hair samples for analysis of genetic distances between sympatric sub-populations of red-fronted brown lemurs (*Eulemur fulvus rufus*) and ring-tailed lemurs (*Lemur catta*) in the Vohibasia Forest and surrounding forest fragments (Betsako, Berenty-Ankazoabo, Anavelona). Samples were to be collected via an experimental non-capture hair trapping method devised for this study. Hair traps consisted of a scent or food-baited plastic cone with a spring mechanism for trapping hairs. While the hair traps were effective on captive lemurs and urban wildlife in St. Louis, Missouri, the method proved completely unsuccessful in the field. After placing 87 traps along ten-plus kilometers of trap-line, and nearly 20,000 trap hours, we were unable to obtain a single lemur hair sample. While there may certainly be a number of problems with this unproven

method (foreign shape, color, and smell of traps, etc.), we believe that the exploited nature of the forest played some role in our inability to collect samples. During three weeks at our initial field site, and while traversing nearly 150 kilometers, there was only one sighting of *Lemur catta* and no sightings of *Eulemur fulvus rufus*. Vocalizations of *Lemur catta* were heard on four occasions, and lemur tracks were seen on roads. The only other lemur signs were two sightings of Verreaux's sifaka (*Propithecus v. verreauxi*) from distances of 300+ meters, one sighting of fork-marked lemur (*Phaner furcifer*), and regular nocturnal vocalizations of sportive lemur (*Lepilemur* sp.). While sightings of lemur are known to be less frequent during the dry season, we felt confident that human activities played some role in reduced lemur densities and/or increased vigilance and avoidance of all humans and human activities.

It was well-agreed upon between my guides that local human populations regularly hunt the lemurs for food. Hunting parties equipped with a shotgun, spears and hatchets were occasionally encountered within the region. In one village, the mandible of a lemur was observed in the sand of the courtyard. Throughout our field work in the northern Vohibasia Forest (and preliminary visits to two other sites in middle and northern Vohibasia Forest) regular signs of other types of forest exploitation were also apparent, including small-scale logging and gem-mining. Several guides, local citizens, and the regional development officer attested to the fact that the situation could be expected to be similar in all of the outlying forest fragments as well.

While these activities are not permitted within the park and surrounding buffer zone, the director of the local ANGAP office stated that an agent had not visited that part of the forest in four years.

One cannot experience first-hand the poverty in Madagascar and begrudge the Malagasy for exploiting any available source of nutrition or income. Our experience in the Vohibasia Forest bolsters arguments that viable conservation programs must address the culture, education, and economic needs of local human populations while providing effective protection and management of classified areas.

The dry deciduous forests within and around Zombitse-Vohibasia present a very interesting opportunity for the study of forest conversion and fragmentation, with an archipelago of habitat fragments of various sizes and degrees of isolation, comprising only 2.5% of what is thought to have been one large contiguous forest prior to the arrival of man (Smith, 1997). Likewise, this region may be of extreme interest to those studying the effects of human use on animal populations in modified and exploited landscapes. However, for the researcher of primate behavior and natural history (who may require frequent, prolonged, and/or close-range observations) or of primate population genetics (or other disciplines which may require significant samples of biological material), Zombitse-Vohibasia seems to have suffered significant loss of research potential.

The local ANGAP personnel regard Zombitse-Vohibasia as most remarkable for its avian fauna. While sightings of distinctive species were fairly common, the avifauna also seemed to be extremely wary of human presence and was much more often heard than seen. Not being an ornithologist, I am hesitant to pass judgment on whe-