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Early Behavioral Development of a Free-Ranging Howler Monkey Infant (*Alouatta guariba clamitans*) in Southern Brazil

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Introduction

In comparison with other mammals, the offspring of primates undergo a relatively long period of behavioral development and dependency upon their mothers. During this period, the mother is a secure base from which the infant is able to explore the environment and engage in social behavior (Vochteloo *et al.*, 1993), acquiring the ecological skills of the species and the social traditions of the family troop (Southwick and Siddiqi, 1974). Independence is the result of a long period of increasing self-sufficiency in activities such as locomotion and feeding, as well as growing sociability and distance from the mother (Altmann, 1980; Odalia-Rímoli, 1992). Mother-infant ties constitute one of the most intense types of social relationship in primates (Harlow and Zimmermann, 1958, Altmann, 1959), and have a positive effect on infant survival and development.

Howler monkeys (genus *Alouatta* Lacépède, 1799) are the most widely-distributed Neotropical primates (Chapman and Balcomb, 1998), and are also the best studied in the wild. They occupy a variety of habitat types, and are well-adapted to anthropogenic fragmentation (Crocket, 1998), although some species are declining rapidly in the wild and have been classified as threatened (IUCN, 2009). Howlers have been translocated and re-introduced at a number of

sites (e.g. Agoramoorthy, 1995), and a critical factor for such management procedures is the successful handling of females with nursing infants (Baker, 2002). Knowledge of the behavioral development of infants can obviously contribute to the efficiency of such procedures (International Primatological Society, 2007).

Studies of the behavioral development of primate infants have focused on their social behavior and spatial relationships with their mothers. In howlers, studies have been conducted on free-ranging *Alouatta guariba* (Kats and Otta, 1991), *Alouatta palliata* (Altmann, 1959; Clarke, 1990; Lyall, 1996), and *Alouatta seniculus* (Mack, 1979; Cabrera, 1997). Allomaternal care is well documented in female howlers (Calegaro-Marques and Bicca-Marques, 1993), but is rare in males (Marques and Adis, 2000). In this study, the early behavioral development of a male infant *A. guariba clamitans* was monitored in a free-ranging group in southern Brazil.

Materials and methods

Study area and subjects

The study was undertaken in Itapuã State Park (30°23'S, 51°30'W), in the city of Viamão, Rio Grande do Sul, Brazil, from August 2003 to April 2004. The climate in the region is temperate, with hot summers and no clear dry season (Cfa type of Köppen´s classification; Peel *et al.,* 2007). The home range of the study group was estimated to be approximately 8.71 ha of semi-deciduous forest on a granite hillside bordering a sandy beach, known as Pedreira (Marques, 2001; Jardim, 2005). In August 2003, the study group was composed of two adult males, one sub-adult male, one juvenile male, two adult females, and one male infant (the study subject — see below). Although the exact date of this infant's birth could not be determined, we estimated that it was between two and three months of age, based primarily on body size (Carpenter, 1934; Altmann, 1959; Kowalewski and Zunino, 2004) and the ontogeny of independent behaviors. In March 2004, another male infant was born in the troop, an adult female immigrated, and an adult male disappeared.

Observation methods

From August, 2003 to April, 2004, the behavior of the infant male subject was monitored for two days each month, except October (one day). Data were collected using focal-animal sampling with continuous recording (Altmann, 1974) from sunrise to sunset (around 9 hours of observation per day). Samples of three minutes duration were collected at ten-minute intervals, with a total of 810 samples collected over 155 hours of monitoring. During each sample, the infant's behavior and its position in relation to its mother were recorded according to the categories defined in Table 1. Other behaviors, such as drinking and rejection by the mother, were recorded in *ad libitum* fashion (Altmann, 1974). Nursing was not recorded here because of the difficulty of determining this behavior reliably.

Results

Infant-mother relationships

In the first month of observations, when the infant was two or three months old, he spent 86.8% of the day on the mother, mostly in the ventral position (Fig. 1), although he was carried on the dorsum during troop movements. In subsequent months, the infant spent increasingly less time on the mother. Ventral carrying during troop movements ceased in November (5–6 months), and dorsal carrying in December (6–7 months), although ventral and dorsal contact with the mother were recorded up to March and April, respectively. By the end of the study period, the infant was in contact with its mother less than 30 percent of the time.

Resting (*Fig. 2a*)

Initially, the infant spent most of its time at rest, and almost always rested while being carried by the mother until 4–5 months old. The infant was observed resting at a distance from its mother for the first time in November, but this only became common by the end of the study. By the age of 8–9 months, time spent resting stabilized at 55–60% of observation time.

Locomotion (*Fig. 2b*)

The earliest bouts of independent locomotion occurred in September (3–4 months old). This activity increased progressively until 6–7 months, but was subsequently irregular. Independent movement of the infant was monitored and stimulated by the mother, by moving very slowly through the trees and waiting for the infant to follow. Sometimes, the mother would move to a branch and emit a vocalization until the infant arrived. When crossing a wide gap in the trees, the mother used her own tail or body as a bridge or carried the infant on her dorsum.

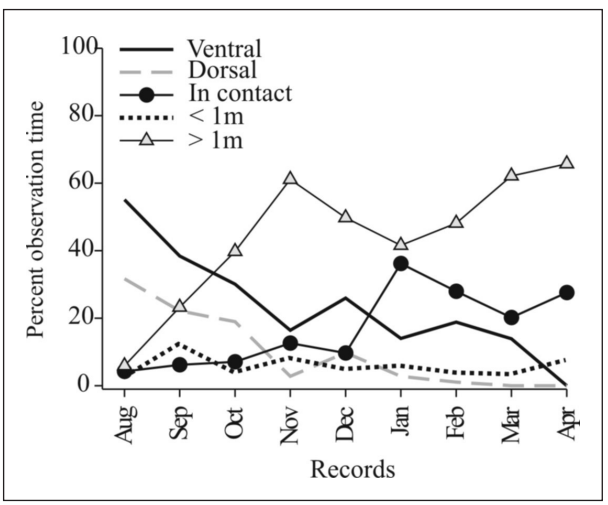

Figure 1. Mean percentage observation time spent by the *A. guariba* infant in different contact categories (see Table 1) in each month during the study period.

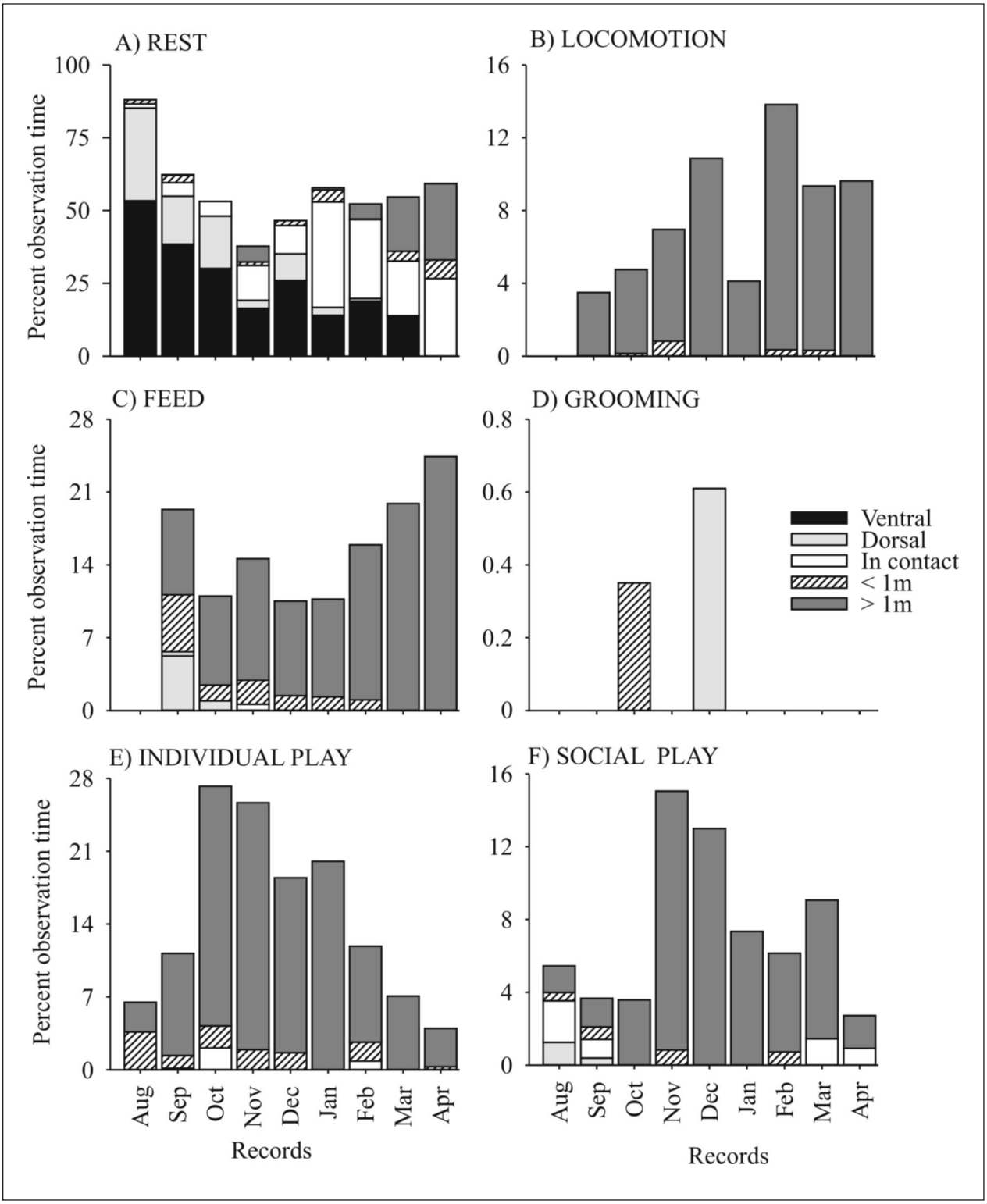

Figure 2. Percentage of time spent by the howler infant in different behaviors and in different forms of contact with its mother during the study period. See Table 1 for behavior and contact categories.

Feeding (*Fig. 2c*)
The infant also started eating solid food at 3–4 months. Initially, the infant was usually either being carried by its mother or close to her during this behavior, which allowed it to observe the items ingested by the mother and then repeat her movements. Contact declined rapidly by the following month. The howlers usually drank water from bromeliads, and this behavior was first noticed in the infant at 8–9 months, the same period when the mother began rejecting the infant when it tried to nurse.

Grooming (*Fig. 2d*)
The infant was observed grooming on two occasions. On the first, he was 4–5 months old, and mimicked his mother when grooming an adult female. On the second occasion, at 6–7 months, the infant groomed its mother.

Play (*Fig. 2e–f*)
The infant already exhibited play behavior when observations began. The highest frequency occurred at 5–6 months, reaching around 50% of the daily observation period. After this peak, the behavior tended to decline towards the end of the study. Play almost always took place when the troop was at rest. During individual play, the infant explored its immediate environment. Social play initially involved the infant's mother, and gradually involved a juvenile male. Play was also recorded with the dominant adult male.

Discussion

While the infant grew progressively independent, it maintained relatively close ties with its mother, invariably resting together, even at the end of the study. Overall, the behavioral development of the infant was similar to that recorded in previous studies of howlers (Altmann, 1959; Mack, 1979; Clarke, 1990; Kats and Otta, 1991; Lyall, 1996; Cabrera, 1997). The transition from exclusive ventral carrying in the first few weeks of life to a predominance of the dorsal position is a typical pattern in monkeys, including howlers (Altmann, 1959; Mack, 1979; Shoemaker, 1979; Kats and Otta, 1991; Lyall, 1996; Miranda *et al.*, 2005). Increasing distance from the mother is also typical. Kats and Otta (1991) confirmed a progressive increase in distance from the mother at 3–4 month of age in *A. guariba*, while Miranda *et al.*, (2005) found that contact with the mother declined to 10% of activity time by the fifth month of age. In the present study, the infant was more than 1 m from its mother for 6% of the time at 2–3 months old, increasing to 70% only at 1 year. A possible regression in this trend was recorded at 7–8 months, however, which may represent a critical period of insecurity or a regression in suckling (Horwich, 1989).

According to Mack (1979), prior to six months of age, howler infants may bite and chew the same type of object that the adults are eating, but not necessarily consume it. Maybe, the high feeding percentages observed in the first months of this study refer to an exploratory feeding which occurred in contact or near the mother. The stabilization of rest at 55–60% by 7–8 months corresponds to the typical rate of adults in this study group (Marques, 2001). This stabilization occurred at the same time as the frequency of play behavior began to decline. Both play and grooming have an important social function (Southwick and Siddiqi, 1974). One possible factor determining rates of social play in the present study was the availability of potential partners, i.e. other immature individuals. Grooming appears to be relatively common in *A. guariba* in comparison with other howlers (Kinzey, 1997); this behavior was part of the behavioral development of the studied infanWhile behavior patterns are best evaluated on the basis of a sample of different individuals, the present study provides some useful preliminary insights on

Table 1. Howler monkey infant behavioral categories based on proximity to the mother and activity.

Position	Description
Ventral	Carried by the mother in a ventral position
Dorsal	Carried by the mother in a dorsal position
In contact	In contact with the mother's body, other than the ventrum or dorsum
< 1m	Less than a meter from the mother's body
> 1m	More than a meter from the mother's body
Activity	**Description**
Rest	Sitting or lying
Locomotion	Moving independently
Feed	Handling, processing or ingesting solid foods
Grooming	Sifting through another animal's fur with the hands
Individual play	Handling objects, hanging from tail and jumping between branches
Social play	Interactions with other troop members involved mock fighting (holding, pulling, baring teeth, and biting) and chasing, often involving jumping
Drink	Ingesting water

the behavioral development of infant howlers of the species *Alouatta guariba*. The patterns observed appeared to be typical of the genus.

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Hunting Strategy of the Margay (*Leopardus wiedii*) to Attract the Wild Pied Tamarin (*Saguinus bicolor*)

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Marcelo Gordo

Introduction

Wild primate predation has been widely reported for various Neotropical cat species. Apparently, prey body size and predator body size are related, with large cats preying mainly on large primates. Remains from different species of primates have been observed in scats of different Neotropical cat species (Table 1). According to Cabrera and Yeppes (1940), primates are the favorite prey of *Puma yaguaroundi* in some regions of Central America. More recently, Miranda *et al.* (2005), found fingers and nails from *Alouatta guariba clamitans* in two fecal samples from *Leopardus pardalis* and suggests that the ocelot may be a potential predator of all Neotropical primates.

In this study, we focus on a hunting technique by the margay, *Leopardus weidii*. Morphologically, margays have arboreal adaptations, but there are no published reports of the predation strategy of wild margays. The few studies on the margay suggest that its diet is mainly composed of arboreal mammals. Mondolfi (1986) analyzed the stomach contents of margay from Venezuela and found remains of squirrel (*Sciurus granatensis*) and the wedge-capped capuchin monkey (*Cebus olivaceus*-cited as *nigrivittatus*, a junior synonym). Margay prey species in Guyana were also arboreal mammals (Beebe 1925). In captivity, margays were observed preying on *Saguinus niger* (Oliveira, 1998).

In the course of our field research on felids, we interviewed local Amazon jungle inhabitants (woodsmen and mestizo indians) in different regions of central Amazonia to learn about the biodiversity of local habitats, and in particular, the natural history of Neotropical cat species, including their prey capture techniques. Interestingly, several of the interviewees described a common predation strategy by Neotropical cats as attracting their prey by mimicking the prey species' vocalizations. More than a dozen reports of *Puma concolor*, *Panthera onca* and *Leopardus pardalis* mimicking vocalizations of agoutis (*Dasyprocta* spp.), tinamous or nambús (*Crypturellus* sp.) and solitary tinamous or macucos (*Tinamus* sp.) were made in different river basins (Madeira, Juruá and Purus) (Table 2). Until now, no scientific observations of this type of behavior have been published

Table 1. Review of primates predated by Neotropical cat species.

Predator	Prey	Location	Citation
Panthera onca	*Ateles belzebuth*	La Macarena, Colombia	Matsuda and Izawa (2008)
	Alouatta seniculus	Venezuela	Peetz *et al.* (1992)
	Brachyteles arachnoides	Intervales State Park, Southeast Brazil	Olmos (1994)
	Ateles [paniscus] chamek	Perú	Emmons (1987)
Puma concolor	*Ateles geoffroyi*	Corcovado National Park, Costa Rica	Chinchilla (1997)
	Ateles geoffroyi	Maya Biosphere Reserve, Guatemala	Novack *et al.* (2005)
	Ateles Belzebuth	La Macarena, Colombia	Matsuda and Izawa (2008)
	Alouatta pigra	Maya Biosphere Reserve, Guatemala	Novack *et al.* (2005)
	Alouatta caraya	Mutum Island, Southern Brazil	Ludwig *et al.* (2007)
	Ateles chamek	Perú	Emmons (1987)
Leopardus pardalis	*Saguinus* spp.		Goldizen (1987)
	Saguinus nigricollis	Colombia	Izawa (1978)
	Alouatta guariba	Caratinga Biological Station, Southeast Brazil	Bianchi & Mendes (2007)
	Brachyteles hypoxanthus	Caratinga Biological Station, Southeast Brazil	Bianchi & Mendes (2007)
	Cebus apella nigritus	Caratinga Biological Station, Southeast Brazil	Bianchi & Mendes (2007)
	Alouatta g. clamitans	Chácara Payquere, Southern Brazil	Miranda et al (2005)
	Saguinus fuscicollis	Perú	Emmons (1987)
	Saimiri sciureus	Perú	Emmons (1987)
Puma yaguaroundi	Primates		Cabrera & Yeppes (1940)
	Callithrix jacchus	Paraíba State, Northeast Brazil	Ximenes (1982)
Leopardus wiedii	*Cebus olivaceus*	Venezuela	Mondolfi (1986)
	Saguinus niger	(in captivity)	Oliveira (1998)
	Cebus apella	British Guiana	Beebe (1925)