



Adoption of an orphaned and temporarily captive infant by an unrelated adult female in black-and-gold howler monkey: implications for management strategies

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Received: 19 July 2019 / Accepted: 1 December 2019 / Published online: 12 December 2019
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Abstract

Conservation behavior involves the application of general principles of animal behavior for solving conservation problems. In primates, adoption of infants has been reported in several species and consists of an individual other than the biological parents taking primary care of them. Based on cases of adoption reported in howler monkeys (genus *Alouatta*), in the present study we facilitated the adoption of an orphaned and temporarily captive male infant by an unrelated adult female black-and-gold howler monkey (*A. caraya*), in the wild. The adoption process involved presenting the orphaned infant, inside a cage, to the female in the forest fragment that she occupied. We recorded the interactions between the individuals, and decided to open the cage. The female became the sole caregiver of the orphan, providing him with protection, transportation, and feeding, although she did not nurse him. The follow-up of these same individuals between 2006 and 2007 confirmed the success of the adoption. These findings indicate that carefully managed adoption can be a possible management strategy for the conservation and the welfare of howler monkeys in both nature and captivity.

Keywords *Alouatta caraya* · Behavior-based management · Orphanage management · Primate management

Introduction

Conservation behavior involves the application of the general principles of animal behavior for solving conservation problems (Blumstein and Fernandez-Juricic 2010). The conceptual model for conservation behavior proposed by Berger-Tal (2011) and accepted by Caro (2016) includes three themes, among which ‘behavior-based management’ presents two pathways that incorporate animal behavior in

active conservation. One of these pathways, wherein species behavior is considered in decision processes and protocols, provided the theoretical basis for our conservation program for black-and-gold howler monkeys (*Alouatta caraya*) in southeastern Brazil, which involved the adoption of an orphaned and temporarily captive infant by an unrelated adult female.

The genus *Alouatta* has the widest distribution among neotropical primates (Neville et al. 1988) and is considered ecologically flexible (Estrada and Coates-Estrada 1996; Bicca-Marques 2003). However, the rapidly expanding human population has resulted in increased demand for land, placing pressure on howler monkey habitat and putting these species at the risk of extinction (Estrada 2015). The black-and-gold howler monkey (*A. caraya*) has the largest distribution among the Brazilian howler monkeys (Gregorin 2006), and is also found in Bolivia, Paraguay, and Argentina (Rumiz 1990; Anderson 1997; Giordano and Ballard 2010). This species has been classified as Least Concern in the IUCN Red List of Threatened Species (Fernandez-Duque et al. 2008). However, in Brazil, *A. caraya* has suffered from population declines because of habitat loss, fragmentation,

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and disconnection, increased road construction, development of the energy matrix, agriculture, livestock farming, fires, hunting, and vulnerability to epidemics. It is suspected that this population decline will approximate to a 30% loss over three generations, which resulted in the categorization of the species as Near Threatened in the Brazilian Red List (Ludwig et al. 2015).

The adoption of infants has been reported in several species of primates, and consists of an individual other than the biological parents taking primary care of an infant (Thierry and Anderson 1986). Specifically, for howler monkeys, long-term adoptions have been reported both among individuals with a high degree of kinship after the disappearance or death of the biological mother (*A. seniculus*: Agoramoorthy and Rudran 1992; *A. caraya*: Pavé et al. 2010), and among unrelated individuals when unknown infants approached the group (*A. palliata*: Clarke and Glander 1981; *A. pigra*: Schneider et al. 1999). Temporary adoptions (when the infant returns to the biological mother after a few days) have also been described. One case occurred between individuals from the same group during a capture and marking process (*A. palliata*: Clarke and Glander 1981) and another occurred between individuals from neighboring groups following intergroup conflict (*A. seniculus*: Agoramoorthy 1998). In all these adoptions, a female raised the adoptive infant alongside her biological infant, as twins. Agoramoorthy and Rudran (1992) reported two cases of adoption by females without biological infants in wild *Alouatta seniculus*. In the first case, a female temporarily adopted her daughter's infant after the recent death of her own. In the second case, a juvenile female adopted an infant abandoned by another group, but the infant eventually died.

The cost–benefit ratio of adopting an infant may be highly variable for the adoptive mother (Pavé et al. 2010), but will always be beneficial for the infant in need of care (Clarke and Glander 1981). Therefore, based on previously reported cases of adoption in howler monkeys, in the present study we facilitated the adoption of an orphaned and temporarily captive male infant by an unrelated adult female black-and-gold howler monkey (*A. caraya*), in the wild. To the best of our knowledge, this is the first description of infant adoption as a management strategy for this species.

Methods

This study was conducted on the campus of the University of São Paulo in Ribeirão Preto, São Paulo State, Brazil. This campus covers an area of 450 ha and is one of the primary green areas in the municipality, with a mosaic of buildings and forest remnants. The predominant phytophysiology in this region is semi-deciduous dry forest belonging to the Cerrado biome (Rizzini 1963), while the Köppen climatic

classification is Aw, that is, a tropical climate with a dry winter and rainy summer. Agriculture is practiced intensively in northern São Paulo state, with sugar cane being the main crop, and represents a point of reference for Brazilian agribusiness (Ramos-Filho 2007). Thus, the biodiversity here is in quite a delicate state.

The subjects in this study were an adult female and an orphaned male infant. The female has been ranging alone in a part of the campus, called “Mata do Museu,” since 2002. There is no information about the origin of this female. The male infant was found clinging to his road-killed mother, near a forest fragment on 24 June 2004, in a municipality 20 km from Ribeirão Preto. He was collected by the Environmental Police and given to us, researchers working on the Barba Negra Project—University of São Paulo. The infant weighed 433 g and was estimated to be 4–5 months old. He was accommodated in a small cage with a length and width of 0.6 m and a height of 0.4 m, enriched with trunks and a stuffed animal (“cloth mother”). The infant received a diet of milk, fruits, and leaves for 14 days (Table 1). Neither the adult female nor the orphaned infant received specific health checks before the adoption procedures started.

The adoption process consisted of presenting the orphan, inside a cage, to the female in the forest fragment she occupied. The cage was initially placed on the ground for 3 h per day on three consecutive days. However, as coming down to the ground is a rare behavior for howler monkeys, on the fourth day we raised the cage to a height of approximately 5 m using a system of pulleys in a tree (Fig. 1a). On each day we recorded the interactions between the individuals, as well as their general behaviors, using the ad libitum method (Altmann 1974). The decision to open the cage was based on the types and amount of interactions observed (i.e., frequency and duration of affiliative interactions).

Results

During the 3 days (July 4, 5, and 6) on which the cage was placed on the ground, the female continued resting and watching the cage, but she did not descend to approach it. However, on the fourth day (July 7), the female approached the orphan 25 min after we had raised the cage. For 1 h and 40 min, the female approached and walked away from it repeatedly. Each time she moved away, the orphan vocalized. During each approach, the female stood next to the cage, allowing the orphan to touch her. The female groomed the orphan twice (Fig. 1b). In the absence of aggressive behavior, we decided to open the cage. First, the cage was lowered so that we could feed the orphan for a final time. The female tried to hang on to the cage but failed. Her hair bristled and she vocalized in our direction. After 7 min, the cage was raised with the door open. The female stopped vocalizing and moved toward the cage. Finally, after 17 min with the door open (2 h and 30 min

Table 1 Diet offered to the *Alouatta caraya* infant for 14 days, based on the diet offered to *A. guariba clamitans* infants weighing less than 500 g at the Indaial Biological Research Center, Santa Catarina State, Brazil

Schedule	Diet
12 a.m.	40 ml milk* + 5 ml honey
4 a.m.	40 ml milk* + 5 ml honey
8 a.m.	40 ml milk* + 5 ml honey + 0.5 ml of vitamin complex
10 a.m.	Banana + ½ chayote leaf**
12 p.m.	40 ml milk* + 5 ml honey + 0.5 ml of vitamin complex
3 p.m.	Banana + ½ chayote leaf**
4 p.m.	40 ml milk* + 5 ml honey + 0.5 ml of vitamin complex
8 p.m.	40 ml milk* + 5 ml honey + 0.5 ml of vitamin complex

*20 ml skim milk + 20 ml potable water

***Sechium edule*

after raising the cage for the first time), the female put her hand inside the cage and the orphan climbed onto her back.

The two individuals were observed for 3 h and 30 min, until dusk. During the remaining observations, the orphan remained mostly in a dorsal position, but he occasionally moved to a ventral position (Fig. 1c). The orphan was carried dorsally by the female whenever she moved. Four times the orphan moved away from the female, to a distance of an arm’s length; the female pulled the orphan back to her on one occasion. The orphan attempted to suckle once, but was stopped by the female. Subsequently, they both ate leaves, and the female groomed the orphan two times. Both individuals were followed for seven consecutive days to confirm that they had remained together (Fig. 2).

The female and the orphan were monitored again from April 2006 until June 2007. In December 2006, an adult male was incorporated to the dyad (Perin 2008), forming the group called G1. The orphan remained in the group at least until it reached subadult age. In 2011, the orphan, now an

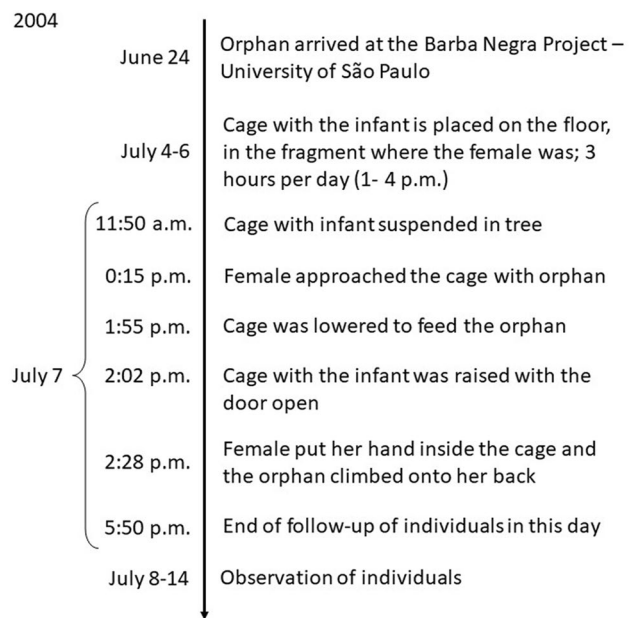


Fig. 2 Time scale of events related to the adoption of an orphaned and temporarily captive infant by an unrelated adult female, at the University of São Paulo campus, Ribeirão Preto, São Paulo State, Brazil

adult, was found to be a solitary and satellite member to the group. In 2014, he was seen with a female, and this female produced an infant. Currently (2019), there are three groups on the campus, originating from G1.

Discussion

This is the first report to describe a management strategy of facilitating the adoption of an orphaned and temporarily captive conspecific male infant by a free-ranging,

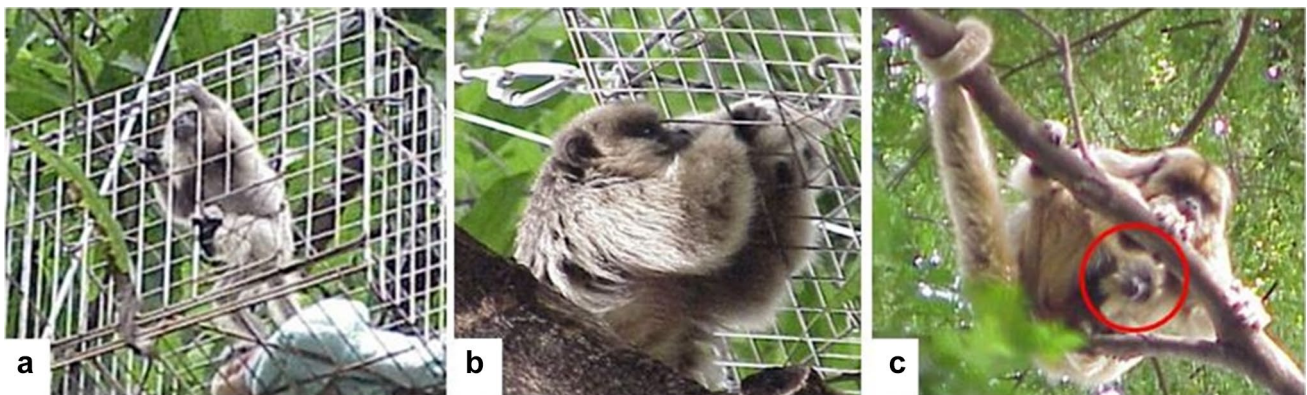


Fig. 1 The adoption of an orphaned and temporarily captive conspecific infant by an adult female *A. caraya*, at the University of São Paulo campus, Ribeirão Preto, São Paulo State, Brazil. **a** Orphan in

the suspended cage. **b** Female interacting with the orphan through the cage’s grid. **c** Orphan in ventral position, shown with a red circle. Photo: Hugo Lopes Gomes; Project Barba Negra archive

unrelated female black-and-gold howler monkey. Our management strategy considered the species' behavior when making decisions in the adoption process, according to "behavior-based management" within the conservation behavior approach (Berger-Tal et al. 2011; Caro 2016). Adoption of unrelated individuals has been reported in several species of primates (Fuccillo et al. 1983; Thierry 1985; Izar et al. 2006; Campbell 2019), including howler monkeys (Clarke and Glander 1981; Agoramoorthy and Rudran 1992; Schneider et al. 1999; Pavé et al. 2010).

Primates have intense social contact needs (Bernstein 1991), and we were aware that the female had been living alone for approximately 2 years. Although her movements towards the cage may have been a simple attempt to approach a conspecific, we wish to highlight the importance of the orphan's vocalizations (moo call: Holzmann et al. 2017) each time the female moved away from his cage. This moo call vocalization is emitted by individuals that are visually separated from the rest of the group, and by infants in distress, for example, when searching for their mother (de Oliveira and Ades 2010; Holzmann et al. 2017). In wild *Alouatta palliata*, five cases of infants in groups without their biological mothers were reported by Clarke and Glander (1981). In three of these cases, the infants were not adopted, and the authors reported that they did not seek care from other individuals. Thus, the orphan's vocalizations can be considered as a request for care, serving to keep the female in proximity to the cage and initiate care behaviors. One such behavior while the infant was still in the cage was grooming, commonly displayed by mothers and non-mothers towards babies and juveniles in groups of wild howler monkeys (Mendes 1989; Chiarello 1995; Pavé et al. 2010).

Protection is considered to be an essential element in adoptive behavior because infants and juveniles are highly vulnerable without the mother (Thierry and Anderson 1986). When we lowered the cage, the female showed piloerection and she vocalized in our direction, responses that are associated with agonistic contexts such as intra-group fights and group defense, including interspecific interactions (Sekulic 1982; Chivers and Sekulic 1986; Kitchen 2004; Albuquerque and Codenotti 2006; Hirano et al. 2008; de Oliveira and Ades 2010; Holzmann et al. 2012; Fernández et al. 2017). The female's agonistic behavior directed at us suggests a protective behavior toward the orphan.

Thierry and Anderson (1986) noted that carrying and cuddling while resting are important behaviors during adoption, either with or without nursing. In our study, the female and the orphan remained in constant contact. At 4–5 months of age, the orphan displayed typical behavioral patterns for a howler monkey of that age in terms of locomotion and resting, clinging on the female's back more than her belly (*A. seniculus*: Neville et al. 1988); *A. belzebul*: Bonvicino (1989); *A. guariba clamitans*: Miranda et al. 2006; *A. caraya*: Pavé et al. 2016).

The female provided no milk to the infant because she was not lactating, but she facilitated the orphan's access to leaves that were part of her own diet; it is possible that he would not have found or recognized them alone. Howler monkeys typically begin solid food intake between the first and third months of life (*A. seniculus*: Mack 1979; *A. palliata*: Clarke 1990 and Lyall 1996; *A. guariba clamitans*: Miranda et al. 2006 and Podgaiski and de Assis Jardim 2010; *A. caraya*: Pavé et al. 2016). In particular, *A. caraya* infants have mixed diets consisting of milk and solid foods between 2 and 10 months of age. This corresponds to approximately 81.8% of the lactation period, with weaning occurs at around 9 months (Pavé et al. 2016). The orphan ingested leaves offered by us in the cage, and had probably eaten leaves prior to his mother's death. Therefore, he survived the infant period even though he was weaned at approximately 5 months of age.

In conclusion, adopting the orphaned and temporarily captive male infant, the wild, adult female howler monkey became the orphans' sole caregiver, providing him with protection, transportation, and access to food, although she did not suckle the orphan. Follow-up observations between April 2006 and June 2007 confirmed the success of the adoption, as the orphan had reached maturity and became independent from the female. In 2008, the orphan emigrated and eventually united with a female (who also probably emigrated from G1), typical behavior of members of the genus *Alouatta*, in which both sexes migrate (Calegario-Marques and Bicca-Marques 1996). In addition, the formation of another group confirmed the important role this orphan played in the local reestablishment of the species. Our findings indicate that, with due recognition of the importance of behavior in decision-making, adoption can be considered as a possible management strategy for the conservation and welfare of howler monkeys in both nature and captivity.

Acknowledgements We would like to thank the IBAMA (Brazilian Institute of Environment and Natural Renewable Resources) staff for their assistance in approving our conservation projects with howler monkeys. We would also like to thank the referees for their valuable suggestions in improving our article. This research received no specific grant from any funding agency, or commercial or not-for-profit sectors. The Federal Law on Scientific Research on Wildlife (Instruction No. 154 of 01/03/2007, Ministry of the Environment, Brazil) and the Federal Law that establishes ethics committees in animal studies (Law 11.794 of 08/10/2008, Ministry of Science, Technology and Innovation, Brazil) are later than the date of this study. However, we declare that the study was conducted within the standards established by these laws.

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