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**First observation of a diurnal birth in wild
owl monkeys (*Aotus azarae*), Formosa, Argentina**

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ABSTRACT

Diurnal births are infrequent in primates and it has been suggested that giving birth at night would have certain adaptive advantages, such as decreasing the risk of predation or aggression towards mothers and offspring. We report the first diurnal birth event ever observed in owl monkeys, providing detailed descriptions of the birthing sequence. Owl monkeys are small, arboreal primates, unique in their activity patterns and uncommon in their social organization of pair-living and monogamous mating system. While providing insight into the behavioral strategies of owl monkeys during birth events, our observations contribute to a better understanding of the potential adaptive value of the timing of births.

KEY WORDS: biparental care, catemerality, parturition, placenta

RESUMEN - Primera observación de un nacimiento diurno en monos mirikiná silvestres (*Aotus azarae*) de Formosa, República Argentina. Los partos diurnos son infrecuentes en los primates, por lo que se ha sugerido que parir durante la noche tendría ciertas ventajas adaptativas, como disminuir el riesgo de predación o las agresiones a las madres y crías. Reportamos el primer evento de parto diurno observado en monos mirikiná, proporcionando descripciones detalladas de la secuencia de parto. Los mirikiná son pequeños primates arbóreos, únicos en sus patrones de actividad y poco comunes en su organización social de vida en pareja y su sistema de apareamiento monógamo. Nuestras observaciones, al proporcionar información sobre las estrategias comportamentales de los mirikiná durante los partos, contribuyen a un mejor entendimiento del potencial valor adaptativo del momento del día cuando se producen los nacimientos.

PALABRAS CLAVE: catemeridad, cuidado biparental, parto, placenta

Generally, even in diurnal primates, most births occur during nighttime (Jolly 1972), which has made it infrequent for field researchers to observe primate birthing events and the circumstances surrounding them. This pattern of nocturnal births in

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primates has been suggested to have adaptive consequences, such as reducing the risk of predation and aggression from other group members (Nguyen et al. 2017). By giving birth while other group members are resting or sleeping, mothers can reduce the risk of being displaced during or immediately after parturition, and the risk of their offspring being mistreated due to excessive attention from conspecifics (Jolly 1972; Duboscq et al. 2008).

Besides the difficulties associated with documenting births occurring at night, it is even more challenging to document them in arboreal primate species, where poor visibility often constrains researchers' ability to observe detailed behaviors during the birthing process (Deluycker 2014; Nguyen et al. 2017). Nonetheless, over the years, the number of diurnal births registered for wild arboreal primates has increased; among the neotropical primates of Central and South America there is detailed information on diurnal births in tamarins (*Saguinus imperator* (Goeldi, 1907); Windfelder 2000), howler monkeys (*Alouatta palliata* (Gray, 1849); Dias 2005; *A. belzebul* (Linnaeus, 1766); Camargo & Ferrari 2007; *A. caraya* (Humboldt, 1812; Peker et al. 2009) and titi monkeys (*Callicebus cupreus* (Spix, 1823); Ruiz et al. 2004; *C. oenanthe* Thomas, 1924; Deluycker 2014).

Documenting birthing events is of particular interest for understanding patterns of allomaternal, or biparental care, during very early stages of infant development in species where offspring are frequently carried by individuals other than the mother, such as the cases of tamarins, titi monkeys (Ruiz et al. 2004; Deluycker 2014), and owl monkeys (Fernandez-Duque et al. 2009).

Owl monkeys are small, arboreal primates species that inhabit a great portion of Latin America, ranging from Panama to the northeastern region of Argentina (Fernandez-Duque 2012), and one unique characteristic of the genus is the intensive involvement of the male in infant care (Huck & Fernandez-Duque 2013a; Fernandez-Duque et al. 2020). A major contribution to the study of the ecology and behavior of owl monkeys has been made by the Owl Monkey Project (OMP); a research and educational program that has monitored Azara's owl monkeys (*Aotus azarae* (Humboldt, 1811)) continuously in Formosa Province, Argentina, since 1996. In this species males carry the infant 84% of the time after the first week of life, and play, groom, and share food with it more often than females do (Rotundo et al. 2005) (Fig. 1). Despite the extensive demographic and behavioral study of the *Aotus azarae* population in Formosa, no birth event, diurnal or nocturnal, had ever been witnessed. We present the first report of a diurnal birth event, providing a timed and detailed description of the birthing sequence.

The study area is part of the 1500 ha Reserva Privada Mirikiná established in 2006 (latitude -26.9; longitude -58.2166), located in the gallery forests along the Pilagá River in the Argentinean Gran Chaco. The habitat presents a mosaic of grasslands, savannas, xeric thorn forests, and semideciduous forests (van der Heide et al. 2012), and the climate is subtropical with no marked wet season (1418 mm/y). An extremely wide range of temperature characterizes the year with regular $<10^{\circ}\text{C}$ daily minimum temperatures between April and September, and $>33^{\circ}\text{C}$ maximum

daily temperatures between September and March (Fernandez-Duque 2016; Pereira-Rodriguez et al. 2022). A system of intersecting transects, at 100 m intervals, covers approximately 300 ha of forest.

Owl monkeys are the only nocturnal primates in the Americas and while the species in the tropics are almost strictly nocturnal, the Azara's owl monkeys (*A. azarae*) from the Argentinean and Paraguayan Chaco shows higher plasticity in their activity patterns (Link et al. in press). In this region, individuals are cathemeral and they show bouts of activity both during the day and the night (Fernandez-Duque et al. 2010). They live in small groups ranging from two to six individuals, including an adult pair, one or two smaller immature individuals, and an infant (Fernandez-Duque 2012; Fernandez-Duque et al. 2020). In our population, the monkeys reach sexual maturity when they are between 2 and 5 years old, which is also when they disperse from their natal groups to seek reproductive opportunities in other groups (Huck et al. 2011; Corley et al. 2017).

In the gallery forest, pairs defend home ranges (mean \pm SD: 6.2 ha \pm 1.8) that remain highly stable between consecutive years. The core areas, where they spend as much as 50% of their time, slightly overlap with the ranges of neighboring groups (11% \pm 15% overlapping areas), while the border parts of the ranges of neighboring groups overlap substantially (48% \pm 15%) (Wartmann et al. 2014). Gestation length ranges from 117 to 159 days between species, but consistently across species and populations, females produce one infant per year (Hunter 1981; Wolovich et al. 2008; Fernandez-Duque et al. 2020).

Since 2000, the Owl Monkey Project has conducted 285 captures of Azara's owl monkeys. In the process, we caught 179 different individuals, whom we physically examined, sampled for biological specimens, and fitted with a bead or radio collar (Fernandez-Duque & Rotundo 2003; Fernandez Duque et al. 2017). In the absence of visible sexual dimorphism (Fernandez-Duque 2011), these procedures have made it possible to identify adult individuals in the field reliably. Since 1996 we have also collected systematic demographic data from 20-25 groups; every time a group of monkeys, or a solitary individual, is contacted, observers enter an "Avistaje" (i.e., a sighting) in the OMP database, where changes in group composition, geolocation, and behaviors noted upon encounter are recorded. During 1998-2020 we registered 224 births contacting groups an average of 24 times per year/group (n= 24 groups). The birth event was registered in a group named Colman. This group lives in a narrow island of forest (4.4 ha) naturally surrounded by grassland, with almost no overlapping of its home range with other neighboring groups (Wartmann et al. 2014). Since 1998 we have contacted Group Colman 516 times (range: 1-77 avistajes per year).

The observed birth occurred on Sunday, September 26, 2021, when the moon was in a waning gibbous phase. Two observers (J. Fredes and N. Bogado) witnessed the birth in the Colman group, which included three individuals (a breeding pair and a subadult male). Both the adult male (Aniseto) and the subadult male (ca. 3 years old, Anubis) are fitted with radio-collars of different colors, making their identification unequivocal. When the observers arrived at 11:03 hs, the female (of unknown parity

status) and the subadult male were close to each other (~50 cm), while the adult male was in another tree 8–10 m away. In the presence of the observers, the adult male started emitting alarm vocalizations and jumping from one branch to another one.

When the observers first noticed the group members, part of the infant's body was already coming out from the female's vagina. The female was in the canopy tree (at a height of approximately 5 meters from the ground), on a tree that presented a relatively dense area of vines (Fig. 2). The female was sitting on a large branch, in a position similar to when the monkeys rest, but in a more upright, vertical position. While still coming out, the newborn head, torso and arms were holding to the ventral right side of the female's body. The infant had the umbilical cord visible. The subadult male tried, with its mouth, to reach the umbilical cord while the female pulled the cord with her hand. During the process, the female urinated frequently and several drops of blood fell on the ground.

When the infant was completely out of the mother (11:32 hs), the female ate the placenta. The subadult male briefly moved around the tree, then rejoined the female and the newborn. He tried to touch the infant, but the female pushed him away with her hand. The adult male approached the female, sniffed her face, and remained in contact with her and the subadult for 30 minutes until he started moving to the northern part of their home range, followed by the other individuals. The observers did not follow the monkeys to avoid potential disruptions of their behaviors.

To our knowledge this is the first record of a birth event in wild owl monkeys, and it provides some valuable insights into the behavioral strategies that owl monkeys display during a time of considerable vulnerability.

Hence, it is worth noting that even after 25 years of continuous monitoring of the population and more than 220 births registered, this is the first time we have witnessed a birth. As in other primate species, it seems likely that it is also the case in Azara's owl monkeys that most births happen during nighttime, limiting the opportunities to witness them. This is in agreement with results from captive settings. In captivity, owl monkeys always give birth during the night (n= 479 births), when staff is absent, and births are more frequent on nights when the moon is bright than during darker ones (Hopper et al. 2019). In our population the monkeys' nocturnal activity is highly associated with moonlight; individuals show higher activity during full-moon nights, and these peaks of nocturnal activity are usually followed by mornings of low activity (Fernandez-Duque et al. 2010). During the night before the birth event, the moon luminosity was very bright (81%) towards the last portion of the night, which could explain why the female went into labor later that day.

It was unexpected that it was the subadult male who remained in close proximity to the female and who first tried to touch the newborn. In owl monkeys, siblings do not provide direct infant care; it is the father who is the principal caregiver until the infants become juveniles (Huck & Fernandez-Duque 2013b). One possibility for explaining this involvement of the subadult during the birth event is that daytime promoted a more vigilant behavior in the father. Given that Azara's owl monkeys

usually show behavioral arousal and emit alarm calls when tayras (*Eira barbara*) are nearby, it is likely that these diurnal mustelids are one of the principal predators of the monkeys in the area (García de la Chica, pers. comm). This, in turn, could explain the behavior of the adult male, who remained vigilant throughout the whole event, possibly as a form of predator avoidance.

Finally, placentophagia, the act of consuming the placenta, which is widespread among nonhuman primates, has been proposed to have a nutritional function and to reduce the risk of predation (Chism et al. 1983; Ratnayeke & Dittus 1989; Price 1990; Dias 2005; Turner et al. 2010). This is the first case of placentophagia reported in owl monkeys and it adds to our understanding of the socioecological maternal strategies in the species while providing indirect evidence on the non-mutually exclusive -nutritional and predation- explanations. The value of this brief report rests on offering details of an extremely infrequent event; as such, it is unwarranted to make generalizations to other owl monkey species.

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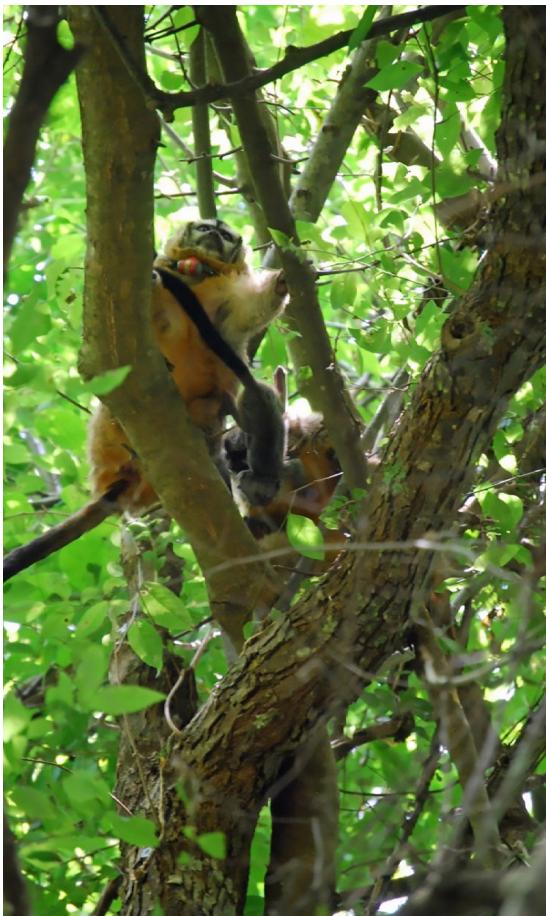


Figure 1. A radio-collared Azara's owl monkey female from Estancia Guaycolec, Formosa Province, Argentina, transferring an infant to the adult male after a nursing bout. Photo credit: M. Corley/Owl Monkey Project.



Figure 2. Photo of the tree where the birth event occurred. Photo credit: P. Hincapie/Owl Monkey Project.

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