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Terrestrial nesting behavior in the white-nosed coati, *Nasua narica*: evidence from a ground-level nest

Comportamiento de anidación terrestre en el pizote, *Nasua narica*: evidencia de un nido a nivel del suelo

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White-nosed coati, *Nasua narica*, ranges from Arizona, USA, to northwestern Colombia, from sea level to 2,879 m. It exhibits both terrestrial and arboreal behaviors, with reproductive activities typically occurring in trees. During the breeding season, bands and solitary adult males construct nests in trees, while pregnant females leave the group to give birth and raise their young in secluded tree nests. From 2016 to 2018, we conducted a mammal census in Palo Verde National Park in northwestern Costa Rica, visiting each semester for a 3-day survey. This region experiences a dry season from December to April, sometimes extending longer. During a census, we observed a ground nest with pups. We took photographs, documented notes, and measured 1 of the kits. In April 2018, we observed a female white-nosed coati with 3 kits, estimated to be under 11 days old, beneath a fallen log. The kits were partially exposed, and the female was moving them into the shade. Measurements (length in mm) of 1 kit, as all 3 appeared similar in size, were: head-body = 136, tail = 110, ear = 7, left hind foot = 26. Ground nesting by coatis may reduce intraspecific competition, especially in deciduous dry forests where few trees retain foliage. A ground nest might also be less visible than a tree nest, reducing predation risk and offering an energy-efficient option for a foraging female. In Costa Rica's dry forest, ground nesting could signal an adaptive response to particular environmental conditions.

Key words: Arboreal nests; dry forest; mammals; Palo Verde National Park; procyonids.

El pizote, *Nasua narica*, se distribuye desde Arizona, EE. UU., hasta Colombia, desde el nivel del mar hasta 2,879 m. Presenta comportamientos terrestres y arbóreos, con actividades reproductivas en árboles. Durante la reproducción, bandas y machos adultos solitarios construyen nidos en árboles. Las hembras preñadas se separan del grupo para dar a luz y criar a sus crías en nidos arbóreos aislados. Entre 2016 y 2018, realizamos censos de mamíferos en el Parque Nacional Palo Verde, en el noroeste de Costa Rica, con una visita cada semestre durante 3 días. Esta región experimenta una estación seca de diciembre a abril, a veces más. Durante un censo, observamos un nido en el suelo con crías, tomamos fotografías y medimos una de ellas. En abril de 2018, observamos una hembra de pizote con 3 crías, estimadas en menos de 11 días de edad, bajo un tronco caído. Las crías estaban parcialmente expuestas y la hembra las movía a la sombra. Las medidas (longitud en mm) de una cría, las 3 de tamaño similar, fueron: cabeza-cuerpo = 136, cola = 110, oreja = 7, pie trasero izquierdo = 26. La anidación en el suelo por los pizotes podría reducir la competencia intraespecífica, especialmente en bosques secos deciduos con poco follaje. Un nido en el suelo podría ser menos visible que uno en un árbol, reduce el riesgo de depredación y podría ser energéticamente eficiente para una hembra que forrajea. En bosques secos costarricenses, podría ser una adaptación a condiciones ambientales específicas.

Palabras clave: Bosque seco; mamíferos; nidos arbóreos, Parque Nacional Palo Verde; prociónidos.

The white-nosed coati, *Nasua narica* (Linnaeus, 1766), is a medium-sized mammal reaching lengths of up to 670 mm with a similarly long tail and weighing between 3.5 to 6.0 kg (Nowak 1999). Males are approximately 20 % larger than females (Kays 2009). Coatis typically have brown to reddish fur with yellowish tones, particularly around the neck and shoulders (Hall and Kelson 1959). The facial markings include a pale mask around the eyes, extending to a whitish muzzle, chin, and throat, with white streaks running from the muzzle above the eyes. Their ears are tipped with white, and they have whitish to yellowish patches behind the ears (Hall and Kelson 1959). The fur on their body is longer and rougher than on their head and legs (Mora 2000). Their long, sometimes faintly banded tail is typically carried upright, and their elongated nose gives them a unique profile among Costa Rican mammals (Mora 2000).

The white-nosed coati's range extends from Arizona in the United States to the Gulf of Urabá in northwestern Colombia, from sea level up to 2,879 m (Nowak 1999; Kays 2009). In Costa Rica, coatis are primarily found in lowland areas but are also present at mid-elevations (Mora 2000). Although they prefer forested habitats, coatis frequently inhabit forest edges, thickets, and other disturbed environments (Gompper 1995; Reid 2009). They typically sleep in trees but may occasionally rest on the ground between large tree buttresses or logs (Kauffman 1962).

White-nosed coatis are adept climbers and jumpers, foraging in trees for fruits and larvae (Mora 2000). On the forest floor, they search for animal prey by probing their long noses into crevices, overturning rocks, and tearing apart dead logs with their claws (Emmons and Feer 1997). They are also known to consume nectar, potentially aiding in the pollination of ecologically important trees like the Balsa (*Ochroma pyramidale*; Mora *et al.* 1999).

Socially, the white-nosed coati is among the most gregarious members of the order Carnivora (Pérez-Irineo and Santos-Moreno 2016). Coatis are diurnal and typically travel in bands of 25 or more individuals (Reid and Gómez Zamora 2022). Adult males are solitary, whereas females and younger males form bands (Kauffman 1983). Mature males leave these groups upon reaching sexual maturity, often driven away by the band members, though intergroup interactions tend to be more peaceful (Kauffman 1983). Members of a band cooperate in parental care, vigilance, and predator defense, with larger groups experiencing reduced predation rates (Gompper 1997; Hass and Valenzuela 2002).

During the breeding season, bands and solitary adult males often build nests in trees for resting and rearing young for the first 6 weeks post-birth (Kauffman 1962). Mating occurs both in trees and on the ground (Kays 2009), and females exhibit synchronized estrus within a 2-3-week period (Gompper 1995; Kays 2009). A unique lek-like mating system has been observed in Guatemala, where males display for females, who then select mates (Booth-Binczik *et al.* 2004).

Pregnant females leave the group to give birth and rear their young in a secluded tree nest or, supposedly, a rocky den (Kauffman 1962; Gilbert 1973; Eisenberg 1989; Nowak 1999). Litters typically consist of 2-5 kits, with timing varying by location: April-May in Panamá (Reid 2009) and July in Jalisco, México (Valenzuela 1998). In Arizona, coatis mate in March or April, with births in June (Hall and Kelson 1959; Gilbert 1973). The gestation period lasts 70-77 days, with kits weighing 100-180 g at birth and opening their eyes after around 11 days (Nowak 1999). Kits join their mother's band around 2-3 weeks of age (Eisenberg 1989), though this varies by location, occurring at approximately 5-6 weeks in Panamá and 6-8 weeks in Arizona (Smith 1977). The average litter size at band re-entry is 3.5 (Russell 1982).

While the white-nosed coati is commonly observed and listed as Least Concern on the IUCN Red List, its population appears to be declining in certain areas (Cuarón *et al.* 2016). Its population ecology remains insufficiently studied across various regions (Pérez-Irineo and Santos-Moreno 2016), and it is sometimes hunted for food or managed as a pest species (Velarde and Cruz 2015). Here, we present a report of ground nesting by a female white-nosed coati in the dry forest of Costa Rica, potentially indicating an ecological adaptation to specific environmental conditions.

We conducted a mammal census in Palo Verde National Park, located in northwestern Costa Rica, from 2016 to 2018. Each semester, we visited the park for a 3-day sampling session. During one of these surveys, we observed a ground nest containing coati pups in the forest (10° 20′ 53″ N, 85°

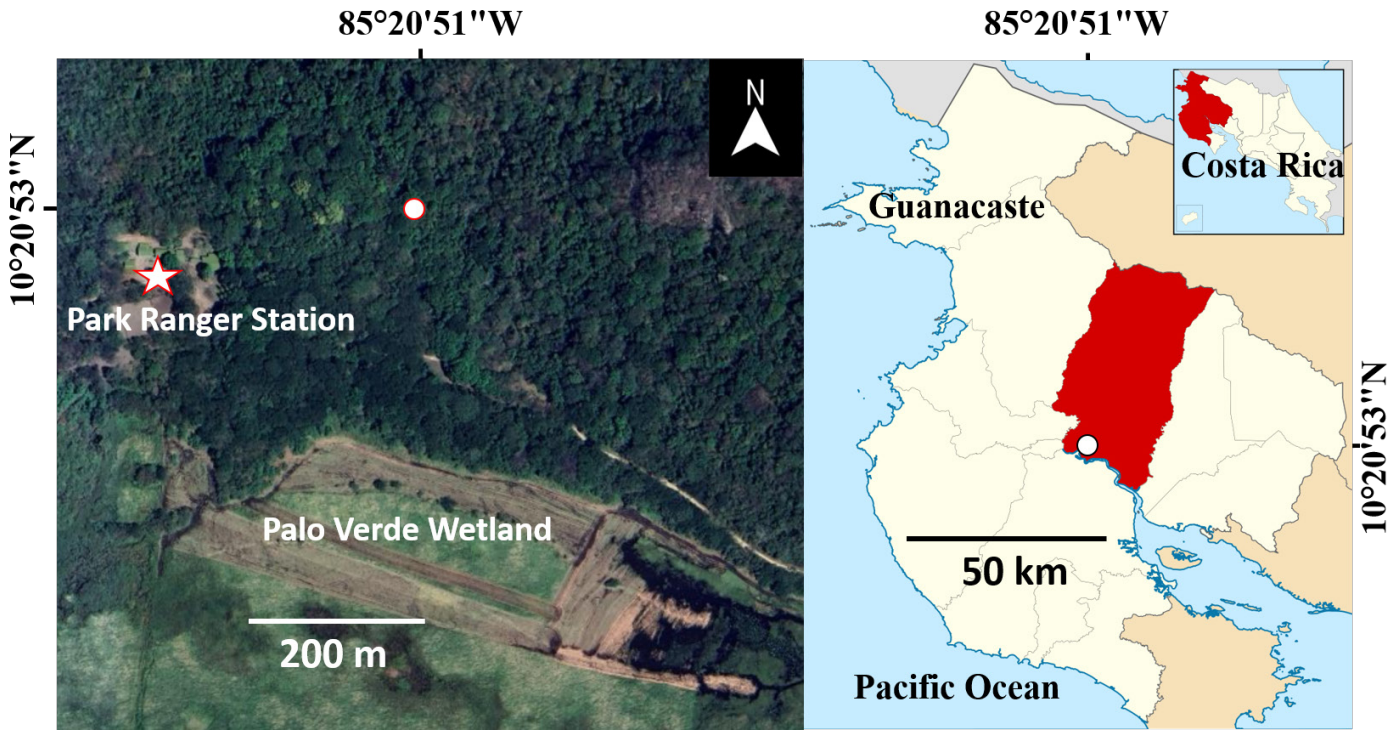

Figure 1. Observation site (white dot) where a female white-nosed coati, *Nasua narica*, was found with 3 kits at Palo Verde National Park, Bagaces County (highlighted in red), Guanacaste Province (outlined in white and shown in red on the map of Costa Rica). Figure prepared by J. M. Mora based on Google Earth (left section) and Wikipedia, under the Creative Commons Attribution-ShareAlike 3.0 license (right section).

20'51"W, 41 m; Figure 1). To document this observation, we took photographs, recorded detailed notes, and measured one of the kits. We handled the kit with clean plastic gloves and measured it with a metallic ruler.

Palo Verde National Park spans approximately 19,800 ha in the lowlands of Guanacaste Province, Costa Rica (Figure 1). The park experiences an average temperature of 27 °C, with an annual precipitation of 2,296 mm (Mora and Castañeda 2021). The dry season extends from December to April, or more months, while the rainy season runs from May to November. This region hosts a wide array of habitats, including primary and secondary deciduous dry forest, riparian forest, savannas, and wetlands (Hartshorn 1983).

We observed a female white-nosed coati with 3 small kits, estimated to be under 11 days old, as indicated by their closed eyes, beneath a fallen log in April 2018. The kits were partially exposed, and the female was actively attempting to move them into a shaded area (Figure 2a). As we approached, the female displayed aggressive behavior by charging at us and barking in a dog-like manner. We retreated, allowing her to return to her young. Meanwhile, the kits had moved further from the log (Figure 2b). The female picked up each kit one by one in her mouth, carrying them back to the shelter of the log (Figures 2c, d). While she was occupied, we took the opportunity to measure 1 of the kits as all 3 kits appeared to be of similar size. The measured kit (Figure 3) had a head-body length of 136 mm, a tail length of 110 mm, an ear length of 7 mm, and a left hind foot length of 26 mm. Due to the kits' restlessness and the female's increased agitation, we decided to leave the site.

The white-nosed coati is both terrestrial and arboreal, though its reproductive activities, including nesting and early care for young, are generally observed in trees (Eisenberg 1989; Gompper 1995; Nowak 1999; Kays 2009). While coatis frequently forage on the ground, climbing trees when sensing danger (Reid 2009), most sources describe tree nests as typical (Hall and Kelson 1959; Eisenberg 1989; Nowak 1999; Kays 2009; Reid 2009). However, our observation of a female with 3 kits in a ground nest suggests this behavior may not be entirely unusual, potentially reflecting an adaptive response to specific conditions.

The only report of nesting females not using tree nests comes from Gilbert (1973), who mentioned reproductive

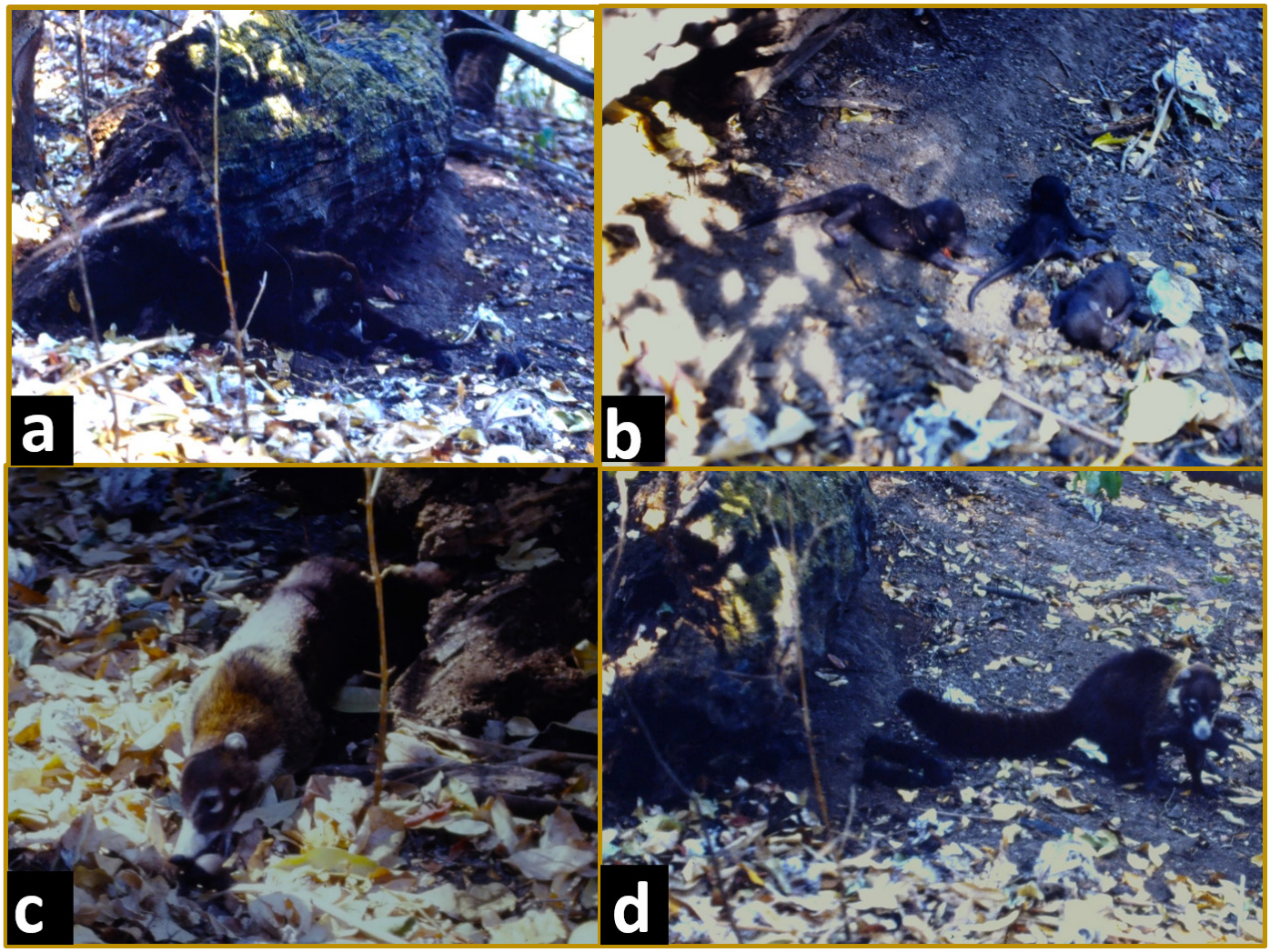

Figure 2. a) Female white-nosed coati, *Nasua narica*, in her nest. b) Kits outside the nest. c) Female picking up a kit with her mouth. d) Female carrying another kit. Palo Verde National Park, Bagaces, Guanacaste, Costa Rica. Photo by J. M. Mora.

females utilizing caves in Arizona as natal den sites. However, as noted by Ratnayeke *et al.* (1994), this account is anecdotal. These authors observed females in the same region exclusively building tree nests made of leaves and twigs in the crowns of cottonwood trees, despite the availability of numerous rock caves. In our case, the female was observed with very young kits, as indicated by their closed eyes (Figure 3) and juvenile body coloration (Emmons and Feer 1997), making it unlikely that the mother had relocated them from another site due to their young age.

The motivation for tree nesting in coatis is not fully understood but may relate to factors such as thermoregulation, litter size, or predator avoidance, possibly as a means to minimize competition for tree cavities (Olifiers *et al.* 2009). Nesting on the ground, though less common, may reduce intraspecific competition, especially in areas where tree sites are limited. The nest we documented was under a fallen log in a deciduous dry forest, with few trees retaining foliage, a characteristic of Costa Rica's dry forests (Castro *et al.* 2018; Rodríguez-Ramírez and Mora 2022). The seasonal loss of leaves could make a ground nest less conspicuous than an exposed tree nest, reducing predation risk.

During the dry season, food resources, mainly fruits, are scarcer, and nesting closer to the ground may be an energy-saving strategy for the mother, allowing her to forage nearby. Additionally, pregnant females often leave bands to give birth and use smaller home ranges during nesting season (Ratnayeke *et al.* 1994), making ground nesting a potentially resource-efficient choice. In regions such as Panamá, coati young are typically born during fruit-abundant periods, when ample food is available on the forest floor (Smythe 1970). In Palo Verde National Park; however, the observed nesting took place in April, when fruit was limited. This scarcity might make ground-level foraging more practical, enabling the female to forage near the nest while still attending to her young.

Despite potential advantages, ground-nesting coatis face increased risks from terrestrial predators, such as small felines and even adult male coatis (Nowak 1999; Hass and Valenzuela 2002). It is suggested that males may prey on young coatis during times of the year when they become more carnivorous (Nowak 1999). However, Kauffman (1962) noted that he did not believe adult coatis kill juvenile individuals. During our observation, the female displayed defensive behavior, barking and charging at us, indicating heightened vigilance, possibly against predators like the Mesoamerican Boa Constrictor, *Boa imperator*, common in the region (Astorga and Mora 2022). While coatis typically

Figure 3. One of the 3 kits of a female white-nosed coati, *Nasua narica*, in her nest at Palo Verde National Park, Bagaces, Guanacaste, Costa Rica. Photo by J. M. Mora.

defend against snakes in groups, nesting females usually remain isolated (Kays 2009; Astorga and Mora 2022).

In Palo Verde National Park, arboreal predators like the white-faced capuchin monkey, *Cebus imitator* Thomas, 1903, known to prey on coati kits, present another threat (Newcomer and De Farcy 1985). Although capuchins sometimes descend to the ground, they primarily do so near water sources or in open, disturbed areas (Rylands and Mittermeier 2013). In other parts of their range, larger felines like jaguars, *Panthera onca* (Linnaeus, 1758) and pumas, *Puma concolor* Linnaeus, 1771, are major predators, contributing to up to 50 % mortality in some populations (Pérez-Irineo and Santos-Moreno 2016), though these large predators are rarely observed in Palo Verde National Park today.

The white-nosed coati's adaptability is well-documented, even within human-influenced habitats. This flexibility suggests that coatis may alter nesting behavior in response to ecological pressures, such as seasonal changes or resource availability. Although ground nesting has not been widely reported, our observation in Costa Rica's dry forest may highlight an adaptive response to specific environmental conditions.

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