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SHORT COMMUNICATION

Construction of arboreal nests by brown-nosed coatis, *Nasua nasua* (Carnivora: Procyonidae) in the Brazilian Pantanal

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ABSTRACT. The construction of arboreal nests is rare among mammals in the order Carnivora. However, coatis (Procyonidae: *Nasua* Storr, 1780) build arboreal nests that are used for resting or birthing. Here we describe *Nasua nasua* (Linnaeus, 1766) nests located during a telemetry study of coatis in the Brazilian Pantanal. Coati nests were all "bird-like", that is, open nests having a semispherical shape. Nests were constructed of twigs, branches, and lianas sometimes interlaced with leaves. Nest volume was 30-50 cm^3 and average nest height was approximately 9.5 m. Nests were found in open "cerrado" vegetation, along forest edges, or in interior "cordilheiras" forest. The reasons why coatis build such nests are unclear, but may relate to inter or intraspecific competition for nesting sites, litter size, thermoregulation, and predation avoidance.

KEY WORDS. Brazil; mammals; ecology; Neotropical.

Selection and modification of a site for resting or giving birth is a critical choice for animals because it influences susceptibility to predators and thermoregulatory costs. Most forest dwelling birds build nests, often open or cup-shaped, to enhance offspring survival (Collias & Collias 1984). The construction and use of such nests is rare among mammals, although several mammal taxa, such as some tree squirrels, primates, and coatis (Procyonidae: *Nasua* Storr, 1780) build nests in trees that are used in two distinct contexts: reproduction and resting (Kaufmann 1962, Kappeler 1998, Steele & Koprowski 2001). While most arboreal or scansorial carnivores make nests in tree hollows and burrows (Nowak 2005), coatis are an exception, building arboreal nests that resemble those built by many avian species. While the use of constructed nests for both birthing and resting has been noted (Kaufmann 1962, Emmons 1997), coati nests have not received detailed attention. Here we describe the nests of the brown-nosed coati, *Nasua nasua* (Linnaeus, 1766) from the Pantanal of Brazil.

The brown-nosed coati is a diurnal and scansorial species widely distributed across South America (Gompper & Decker 1998). The species has a complex social structure in which adult females and immature individuals form bands. Adult male behavior is less well understood, but some males may remain with the band out of the breeding season, while others are primarily solitary for most of the year, joining the bands only during the breeding season (Gompper & Decker 1998, Martini & Beisiegel *apud* Resende *et al.* 2004, Hirsch 2007, R.C. Bianchi, pers. obs.). After the breeding season, pregnant females leave their bands and give birth in a nest, generally constructed in a tree (Emmons 1997).

Litter size in coatis can be quite large; mean litter size for *Nasua narica* (Linnaeus, 1766) that survive to leave the nest is 3.5 in Panama (Russell 1982), and females of *N. nasua* give birth to up to seven young in captivity (McToldridge 1969). In the Pantanal region, we have observed three to five coati young leaving their nests and Hirsch (2007) reports a minimum average litter size of 4.6 in Iguazu National Park, Argentina. Females abandon the birthing nests and rejoin bands with their newborns after 5-8 weeks (Cabrera & Yepes 1960, Hirsch 2007). As reported for *N. narica*, however, nest construction by *N. nasua* is not limited to the birthing season. Individuals often rest during the day or spend the nights in nests. These nests are also typically found in trees, although coatis may rest or spend the night on rock outcrops (B.T. Hirsch, pers. comm.). The use of small caves and rock crevices has also been reported for *N. narica* in Arizona, USA (Gilbert 1973).

As part of a broader study of *N. nasua* ecology conducted between 2005 and 2009, we located 11 coati nests and 16 additional putative nests in the Brazilian Pantanal region. The Pantanal is the largest seasonal floodplain in the world and it has two marked seasons – a wet season (October to March) and

a dry season (April to September). The study site was located in the Nhumirim ranch (18°59'S, 56°39'W), a 4400 ha research station of The Brazilian Agricultural Research Corporation (Embrapa). The vegetation is composed of mixed scrub with grassland ("cerrado" or woodland savannah), grassland fields, and "cordilheiras", which are patches of slightly elevated grounds (1-2 m) covered by semi-deciduous forests (Adamoli 1987).

From October to November of 2006, five radio-collared females from four distinct bands were monitored and their birthing nests located. A nest from one additional pregnant female from a fifth band was also found. Nest measurements were recorded after the weaning season when the females had abandoned their nests. Five additional resting nests were found out of the reproductive season between February and June 2008 and in January/February 2009. Sixteen additional nests were also found; however, because coatis were not observed to build and use these nests, we labeled these as putative coati nests. We recorded where the nest was located, including tree height, first fork height, tree perimeter at chest height (PCH), and tree distance from the forest edge. Nest characteristics, such as height above ground, volume (nest length x depth x height), general shape, and composition were described when possible. Measures were taken using a measuring tape, except for most of the nest height, tree height, and first fork height, which were estimated to the nearest meter by two researchers independently and a mean of the two measurements was calculated. While such approach is somewhat imprecise, it nonetheless identifies the general pattern of nest placement within the tree and tree characteristics. Because of the small sample sizes and the difficulty of differentiating between birthing and resting nests, we treat nest types jointly in our discussion of nest construction and placement.

Although the time of use of putative coati nests was unknown (none had signs of recent use such as fresh claw marks on tree trunks or green leaves interlaced with the nests), overall their size, structure, and placement were similar to that recorded for the known coati nests (Tab. I). Nests were constructed of twigs, branches, and lianas of 1-2 cm diameter sometimes interlaced with leaves (Figs 1-4). Leaves and branches used to make the nest were from the tree within which the nest was situated. Therefore, composition of the nest may vary depending on the selected tree. Lianas were common around and under the nests but not over it, so that nests were sometimes difficult to locate from below. Volumes of two nests were 31.7cm^3 (49 x 38 x 17cm) and 47.5cm^3 (44 x 45 x 24cm). Up to four nests were found on a single tree and five were found on two close trees (< 10 m apart from each other). Nest were in open "cerrado" vegetation (N = 3), along forest edges (⩽30 m from forest edge, N = 12), or 30-60 m into the "cordilheiras" (N =3). Understory vegetation below the nests varied from completely open in "cerrado" vegetation to open with sparse palms (*Atallea faleratha* and *Allagoptera leucocalyx*) and dense stands of bromeliads (*Bromelia balansae*) along the forest edges and into the "cordilheiras".

Figure 1. A coati birthing nest in the Nhumirim Ranch, Pantanal, Brazil. The nest was photographed from above just after the birthing season, when the female and its young had already abandoned the nest. Scale is an approximation.

Nests were closer to the top of the canopy than to the ground ($R_{Spearman} = 0.79$, N = 22, $p < 0.001$). Therefore, nest height may vary with forest canopy height. In the Nhumirim ranch, the canopy height of the most abundant tree species is 10 to 12 m (Ratter *et al.* 1988) and the lowest nest was five meters above ground. In Tikal, Guatemala where mean canopy height is 21 meters, *N. narica* nests were 10 to 30 m above ground

Table I. Measurements (mean ± s.d.) of 11 nests used by coatis as well as 16 additional putative coatis nests. Sample size is given in parentheses. (PCH) Tree perimeter at chest height.

Variable (m)	Known coati nests	Putative nests	Known nests + putative nests
Nest height	9.3 ± 4.4 (11)	9.8 ± 3.7 (16)	9.6 ± 3.9 (27)
Tree height	11.7 ± 5.4 (11)	11.7 ± 4.0 (10)	11.7 ± 4.0 (21)
Tree PCH	2.0 ± 3.0 (11)	3.4 ± 3.7 (10)	2.6 ± 3.3 (21)
First fork height	4.5 ± 1.7 (11)	3.6 ± 0.8 (10)	4.1 ± 1.4 (21)
Distance from the forest edge	20.4 ± 19.4 (11)	13.0 ± 9.5 (04)	18.5 ± 17.3 (15)

Note: sample size for tree features and mean distance from forest edge is reduced because more than one nest was found in the same tree or because data is missing for some of the putative nests.

Figures 2-4. (2) A coati (*N. nasua*) resting nest in the Nhumirim Ranch, Pantanal, Brazil. The nest was found out of birthing season and photographed from below. The presence of fresh leaves indicates the nest had been recently built. Scale is an approximation. (3) The same nest from a different perspective. (4) A coati and its siblings in a resting nest.

(S.D. Booth-Binczik, pers. comm.). Nest location may also be a function of site features. For instance, in Iguazú, Argentina, *N. nasua* nests were frequently built in rock cliffs (B.T. Hirsch, pers. comm.), which are absent in the Nhumirim ranch and its vicinity. When these rock cliffs were used at Iguazú, however, true nests were not constructed, as coatis would sleep in rock outcroppings without the use of any additional nesting materials brought to the site.

Coati nests were all "bird-like", that is, open nests having a semispherical shape. In constrast, G.A. Binczik (pers. comm.) found that *N. narica* most often build enclosed spheres with one or two entrances, as well as occasionally building open bowls or platforms up to 1.5 m in diameter. *Nasua narica* may be under predation pressure from *Cebus* Erxleben, 1777 monkeys, which seek coati nests and prey on juveniles (Perry & Rose 1993, Rose 1997, Rose *et al.* 2003) and similar predation on *N. nasua* nestlings has been observed in Iguazú, Argentina (B.T. Hirsch, pers. comm.). However, *Cebus* spp. does not occur at our field site and there are no reports of predators of any kind attacking coatis in nests in the Pantanal region. Reported predators of *N. nasua* include jaguar – *Panthera onca* (Linnaeus, 1758); puma – *Puma concolor* (Linnaeus, 1771); ocelots – *Leopardus pardalis* (Linnaeus, 1758), and jaguarondi – *Puma yagouaroundi* (É. Geoffroy Saint-Hilaire, 1803) (Gompper & Decker 1998), but there are no reports of these animals attacking coati nests. In the Pantanal region, coati pups might be attacked in their nests by tayras – *Eira barbara* (Linnaeus, 1758), raptors, snakes, and felids.

Leaf nests might not function to regulate temperature as well as dens made in tree hollows (see Stains 1961, Weigl & Osgood 1974, McComb & Noble 1981, Nixon *et al.* 1984). Given that there are no reports of coatis denning in tree cavities and that some individuals may not build nests but rather simply sleep or rest on tree branches, nests might not be specifically built to enhance thermoregulatory value.

Nest construction and placement may also be related to litter size. In primates, the use of nests or tree holes is related to litter size and the developmental state of infants at birth (Kappeler 1998). Most carnivores, including coatis, give birth to relatively altricial infants, so it is unclear whether the altricial developmental state of coati neonates selects for the construction of open or spherical nests, given that most scansorial or arboreal carnivore species build their nests in burrows or tree hollows. However, maximum litter size in coatis is among the largest for carnivores in general and Neotropical procyonids in particular; other arboreal and scansorial Neotropical carnivores, such as *Potos flavus* (Schreber, 1774), *Bassaricyon* spp., and *E. barbara* have one and rarely two young and build their nests in tree cavities (Nowak 2005). Among the Procyonidae, only raccoons (*Procyon* spp.) have similarly large litter sizes. Cavities large enough for litter sizes of up to seven young may be limiting, especially where coatis and raccoons co-occur and densities are high. Such scenarios might result in strong interspecific and intraspecific competition for nesting sites as selection for the use of constructed tree nests by coatis. Raccoons, for instance, rarely den in trees smaller or equal to 1m circumference because cavities are too small or not available (Endress & Smith 1993). Thus for coatis, the building of arboreal nests might derive from selection to avoid competition for tree cavities.

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