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Heterospecific coprophagy in the white-tailed deer *Odocoileus virginianus* (Zimmermann, 1780) in Costa Rica

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ABSTRACT
Animals may engage in coprophagy, including heterospecific coprophagy, where they consume the feces of other species. The white-tailed deer, *Odocoileus virginianus*, primarily feeds on plant material, such as tender forbs and shrub shoots. This report documents a case of heterospecific coprophagy by the white-tailed deer in Costa Rica, where two individuals were observed consuming domestic horse feces. The reasons for heterospecific coprophagy in ruminants like the white-tailed deer are unclear. Nutritional supplementation, microbial transfer, or other ecological factors may play a role in this behavior. However, such a behavior also poses risks, including the transmission of diseases and parasites from other species.
Keywords: Cervidae, coprophagy, dry forest, feces, herbivorous, horses

RESUMEN - Coprofagia heteroespecífica en el venado *Odocoileus virginianus* (Zimmermann, 1780) en Costa Rica
Los animales pueden involucrarse en la coprofagia, incluida la coprofagia heteroespecífica, o sea el consumo de heces de otras especies. El venado *Odocoileus virginianus* se alimenta principalmente de material vegetal, como brotes tiernos de hierbas y arbustos. Este informe documenta un caso de coprofagia heteroespecífica en el venado en Costa Rica, donde se observó a dos individuos consumiendo heces de caballo. Las razones de la coprofagia heteroespecífica en rumiantes como el venado no están claras. La suplementación nutricional, la transferencia microbiana u otros factores ecológicos podrían influir en este comportamiento. Sin embargo, este comportamiento también conlleva riesgos, como la transmisión de enfermedades y parásitos de otras especies.
Palabras clave: Bosque seco, caballos, Cervidae, coprofagia, heces, herbívoros

The white-tailed feer, *Odocoileus virginianus* Zimmermann, 1780 extends from southeastern Alaska to northern South America, with up to 38 recognized subspecies (Mattioli 2011). There is ongoing debate regarding its taxonomic classification,

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where some authors propose it is a single species, while others suggest multiple distinct species (Rodríguez-Ramírez & Mora 2022). In the latter case, the species present in Central America would correspond to *Odocoileus cariacou* Boddaert, 1784 which is broadly distributed throughout the Neotropical region (Molinari 2007).

Odocoileus virginianus inhabits a wide variety of ecosystems, preferring open areas with herbaceous vegetation where the fawn's coloration provides effective camouflage (Rodríguez 2015). In Costa Rica, the species is found primarily in lowland and mid-elevation areas, especially in open forests and brushlands, with higher densities in the Guanacaste dry forest (Mora 2000; Rodríguez 2015).

Adults white-tailed deer are light brown, with distinctive light and dark facial markings, and a white belly and underside of the tail (Mora 2000). Fawns are born with white spots on a brown coat, which disappear after three to four months (Rodríguez-Ramírez & Mora 2022). It is primarily active during the early night, dawn, and morning hours, typically in family groups or herds, although they may also be found alone (Mora 2000).

The white-tailed deer primarily feed on tender grass shoots, shrubs, young leaves, sprouts, twigs, flowers, fruits, and seeds (Mora 2000). However, their diet changes with regions and seasons; major forage plants include browse in the dry season and forbs during the wet season on San Lucas Island, Puntarenas, Costa Rica (Di Mare 1991, 1994).

During certain periods, white-tailed deer may seek essential minerals that are vital for growth, reproduction, and maintaining health throughout their life cycle (Morera et al. 2022). Since these minerals cannot be synthesized, deer sometimes obtain them from alternative sources such as freshwater, mineral-rich rocks and soils, or saline coastal waters (Rodríguez 2015; Morera et al. 2022).

An alternative method that animals use to obtain essential nutrients is coprophagy, the consumption of fecal matter (Fish et al. 2007). Animals may engage in autocoprophagy, where they consume their own feces, or allocoprophagy, where they consume the feces of conspecifics (Mora et al. 2024). Animals may also consume the feces of other species, referred to as interspecific or heterospecific coprophagy (Soave & Brand 1991; Mora et al. 2024).

Autocoprophagy is most commonly associated with lagomorphs but has been documented in various mammalian species, including rodents, dogs, horses, swine, nonhuman primates, and even humans (Soave & Brand 1991; Krief et al. 2004; Fish et al. 2007; Mora et al. 2024). Allocoprophagy has been observed in several species, including large herbivores such as the African Elephant, *Loxodonta africana* Blumenbach, 1797 (Leggett 2004),

There are also several examples of heterospecific coprophagy, including herbivorous species like the Iberian Wild Goat, *Capra pyrenaica* Schinz, 1838 (Mora et al. 2024), carnivores like the Red Fox, *Vulpes vulpes* Linnaeus, 1758 (Waggershauser et al. 2022), and primates like the Ring-tailed Lemur, *Lemur catta* Linnaeus, 1758 (Fish et al. 2007). Mora et al. (2024) provided a list of cases of heterospecific coprophagy. In domestic animals like dogs, coprophagic behavior is relatively

common (Hart et al. 2018; González-Jáuregui et al. 2021), but it appears to be rare or difficult to detect in deer (Spitzer et al. 2023; Mora et al. 2024).

In Cervidae, allocoprophagy has been documented in moose, *Alces alces* (Linnaeus, 1758) (Spitzer et al. 2023), while heterospecific coprophagy has been observed in Sika deer, *Cervus nippon* Temminck, 1838, consuming Japanese macaque, *Macaca fuscata yakui* Kuroda, 1941, feces (Nishikawa & Mochida 2010); Indian muntjac, *Muntiacus vaginalis* (Boddaert, 1785), feeding on Asian elephant, *Elephas maximus* Linnaeus, 1758, dung (Ranade & Prakash 2015); and reindeer, *Rangifer tarandus platyrhynchus* (Vrolik [de], 1829), ingesting barnacle geese, *Branta leucopsis*, droppings (van der Wal & Loonen 1998). Here, we report an additional instance of heterospecific coprophagy in cervids: the consumption of domestic horse feces by the white-tailed deer in Costa Rica.

One of our research sites is Finca Experimental Cerritos, located in Abangares County, Guanacaste, in northwestern Costa Rica (latitude -10.2925; longitude -84.988888; datum WGS84; 235 m elevation; Fig. 1). This area is state-protected, where interactions between wildlife and domestic animals, such as horses, occur. Finca Cerritos falls within the Tropical Moist Forest life zone, characterized by forests at elevations 0 – 1000 m, biotemperature above 17°C and an average annual precipitation between 2000 and 4000 mm (Holdridge 1967).

On 5 October 2024, at 11:48h while observing a group of white-tailed deer, a fawn approached a pile of domestic horse (*Equus caballus* Linnaeus, 1758) dung and began to consume it. Three minutes later its mother replicated this behavior, consuming from another pile of horse dung located about 10 m from the one of the first observation (Fig. 2). After the deer left the site, we approached to verify the behavior and confirmed that the horse dung had indeed been consumed.

Coprophagy, specifically autocoprophagy, is well documented and extensively reviewed in leporids and other mammals (Hirakawa 2001). The advantages of this behavior in both domestic and wild herbivores have been well documented (Karasov & Carey 2009; Meyer et al. 2010; Mora et al. 2024). Coprophagy may help herbivores maintain necessary gut microbial diversity and functionality, which can have broader physiological benefits, such as supporting energy balance and cognitive function (Bo et al. 2020; Mora et al. 2024). Among primates, lowland gorillas, *Gorilla gorilla* (Savage, 1847), and chimpanzees, *Pan troglodytes* (Blumenbach, 1776), have been observed consuming feces during the fruiting season of *Dialium* spp. (Caesalpiniaceae) (Krief et al. 2004; Mouele et al. 2022). These two apes practice both autocoprophagy and allocoprophagy (Krief et al. 2004; Mouele et al. 2022). The initial passage of *Dialium* hard seeds through the digestive system may soften them, and reingestion via coprophagy could allow access to the protein-rich seeds (Fish et al. 2007; Krief et al. 2004).

Heterospecific coprophagy is perhaps more challenging to explain. This behavior might be an adaptive strategy to access additional energy and nutrients (Fish et al. 2007). In general, heterospecific coprophagy has been linked to potential nutritional benefits, offering an additional source of energy, nutrients, and minerals, particularly for young animals (Soave & Brand 1991; Körner et al. 2016; Mora et al. 2024). In the case of the white-tailed deer, heterospecific coprophagy could represent a rare but nutritionally important behavior, providing individuals with vital nutrients needed in small amounts or during specific times of the year. For an herbivorous species like the white-tailed deer, this behavior may serve an essential dietary role by supplementing their primarily plant-based diet with nutrients or minerals that are otherwise scarce.

Another possibility is that deer are consuming feces to obtain the seeds they contain. Horses in the dry forests of Guanacaste, northwestern Costa Rica, eat fruits from various tree species, mainly Guanacaste, *Enterolobium cyclocarpum*, Jícaro, *Crescentia alata*, and Guácimo, *Guazuma ulmifolia*, and defecate large quantities of seeds (Janzen 1981, 1982a, b). A significant portion of these seeds survive digestion and are deposited in the horse feces (Janzen 1981, 1982a, b). White-tailed deer also feed on the fruits of these three tree species in Guanacaste. Evidence suggests that white-tailed deer are more frequently found in areas with horses than in those without, particularly in grasslands and shrublands compared to forested areas (Morera et al. 2023). This pattern may indicate that deer prefer shrubland areas because they are seeking out horse feces as a food source. Similar behavior has been observed in other species; for example, sitatunga, *Tragelaphus spekeii* Speke, 1863, and red river hog, *Potamochoerus porcus* (Linnaeus, 1758), forage for seeds in elephant, *Loxodonta cyclotis* Matchie, 1900, dung in forest clearings in the Congo Republic (Magliocca et al. 2003).

Nevertheless, the potential risks associated with coprophagy should not be overlooked. Feces from livestock can carry a variety of parasites and diseases (Spitzer et al. 2023). By consuming horse feces, white-tailed deer may expose themselves to equine parasites. Additionally, coprophagy and environmental contamination with feces have been implicated in the horizontal transmission of chronic wasting disease, a fatal prion disease that affects both wild and captive cervids (Miller & Williams 2003; Spitzer et al. 2023).

In conclusion, while autocoprophagy is well-documented in a variety of mammalian species, and its potential benefits for gut health, nutrient recycling, and microbial balance are recognized, the drivers of allocoprophagy and heterospecific coprophagy, particularly in species like the white-tailed deer, remain less clear. Nutritional supplementation and microbial transfer may play a role, especially in young or nutritionally stressed individuals, but further research is needed to fully understand these behaviors.

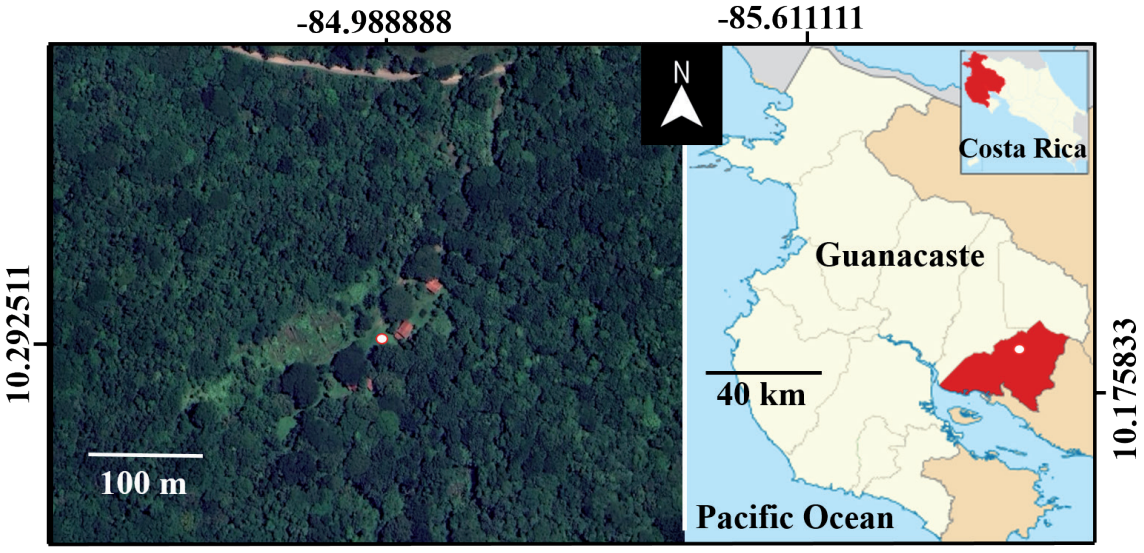

Figure 1. Observation site (white dot) where white-tailed deer, *Odocoileus virginianus*, was feeding on domestic horse feces, at Finca Cerritos, Las Juntas, Abangares County (highlighted in red) in Guanacaste Province (outlined in white but shown in red on the map of Costa Rica). Figure prepared by José Manuel Mora based on Google Earth (left section) and Wikipedia under the Creative Commons Attribution–ShareAlike 3.0 license (right section).

Figure 2. A female white-tailed deer, *Odocoileus virginianus*, feeding on domestic horse feces, at Finca Cerritos, Las Juntas, Abangares County, Guanacaste Province, Costa Rica. Photo by Juan de Dios Astorga.

LITERATURE CITED

Bo, T. B., X. Y. Zhang, K. D. Kohl, J. Wen, S. J. Tian, & D. H. Wang. 2020. Coprophagy prevention alters microbiome, metabolism, neurochemistry, and cognitive behavior in a small mammal. The ISME Journal 14:2625–2645. https://doi.org/10.1038/s41396-020-0711-6

Di Mare, M. I. 1991. Food habits of an insular Neotropical population of white-tailed deer. Applied Animal Behaviour Science 29:507. https://doi.org/10.1016/0168-1591(91)90278-6

Di Mare, M. I. 1994. Hábitos alimentarios del venado cola blanca en la Isla San Lucas, Puntarenas, Costa Rica. Ecología y manejo del venado cola blanca en México y Costa Rica (C. Vaughan and M. Rodríguez, eds.). EUNA, Heredia.

Fish, K. D., M. L. Sauther, J. E. Loudon, & F. P. Cuozzo. 2007. Coprophagy by wild ring-tailed lemurs (*Lemur catta*) in human-disturbed locations adjacent to the Beza Mahafaly Special Reserve, Madagascar. American Journal of Primatology 69:713–718. https://doi.org/10.1002/ajp.20392

González-Jáuregui, M., J. P. Esparza-Carlos, & M. F. Barber Mir. 2021. Heterospecific coprophagy: Turkey Vulture (*Cathartes aura*) feeding on cougar (*Puma concolor*) feces. Western North American Naturalist 81:626–629. https://doi.org/10.3398/064.081.0415

Hirakawa, H. 2001. Coprophagy in leporids and other mammalian herbivores. Mammal Review 31:61–80. https://doi.org/10.1046/j.1365-2907.2001.00079.x

Hart, B. L., L. A. Hart, A. P. Thigpen, A. Tran, & M. J. Bain. 2018. The paradox of canine conspecific coprophagy. Veterinary Medicine and Science 4:106–114. https://doi.org/10.1002/vms3.92

Holdridge, L. R. 1967. Life Zone Ecology. Tropical Science Center, San José.

Janzen, D. H. 1981. *Enterolobium cyclocarpum* seed passage rate and survival in horses, Costa Rican Pleistocene seed dispersal agents. Ecology 62:593–601. https://doi.org/10.2307/1937726

Janzen, D. H. 1982a. Natural history of guacimo fruits (Sterculiaceae: *Guazuma ulmifolia*) with respect to consumption by large mammals. American Journal of Botany 69:1240–1250. https://doi.org/10.1002/j.1537-2197.1982.tb13369.x

Janzen, D. H. 1982b. How and why horses open *Crescentia alata* fruits. Biotropica 14:149–152. https://doi.org/10.2307/2387746

Karasov, W. H. & H. V. Carey. 2009. Metabolic teamwork between gut microbes and hosts. Microbe 4:323–328.

Körner, M., J. M. C., Diehl, & J. Meunier. 2016. Growing up with feces: Benefits of allo-coprophagy in families of the European earwig. Behavioral Ecology 27:1775–1781. https://doi.org/10.1093/beheco/arw113

Krief, S., A., Jamart, & C. M. Hladik. 2004. On the possible adaptive value of coprophagy in free-ranging chimpanzees. Primates 45:141–145. https://doi.org/10.1007/s10329-003-0074-4

Leggett, K. 2004. Coprophagy and unusual thermoregulatory behaviour in desert dwelling elephants of North-Western Namibia. Pachyderm 36:113–115.

Magliocca, F., S. Quérouil, S., & A. Gautier-Hion. 2003. Seed eating in elephant dung by two large mammals in the Congo Republic. Revue d'écologie 58:143–149. https://doi.org/10.3406/revec.2003.5307

Mattioli, S. 2011. Family Cervidae (Deer). Handbook of the mammals of the world: Vol. 2 Hoofed Mammals (D. E. Wilson & R. A. Mittermeier, eds.). Lynx Edicions, Barcelona.

Meyer, M., J. Hummel & M. Clauss. 2010. The relationship between forage cell wall content and voluntary food intake in mammalian herbivores. Mammal Review 40:221–245. https://doi.org/10.1111/j.1365-2907.2010.00161.x

Miller, M. W., & E. S. Williams. 2003. Horizontal prion transmission in mule deer. Nature 425:35–36. https://doi.org/10.1038/425035a

Molinari, J. 2007. Variación geográfica en los venados de cola blanca (Cervidae, *Odocoileus*) de Venezuela, con énfasis en *O. margaritae*, la especie enana de la Isla de Margarita. Memoria de la Fundación La Salle de Ciencias Naturales 167:29–72.

Mora, J. L., E. Blasco, A. García-Serrano, & J. Herrero. 2024. Iberian wild goat coprophagy on dove guano. A case report and insights from food analysis. Food Webs 40:e00353. https://doi.org/10.1016/j.fooweb.2024.e00353

Mora, J. M. 2000. Mamíferos silvestres de Costa Rica. Editorial Universidad Estatal a Distancia, San José.

Morera, B., V. Montalvo, C. Sáenz-Bolaños, J. C. Cruz-Díaz, T. K. Fuller, & E. Carrillo. 2022. Osteophagia of sea turtle bones by white-tailed deer (*Odocoileus virginianus*) in Santa Rosa National Park, northwestern Costa Rica. Neotropical Biology and Conservation 17:143–149. https://doi.org/10.3897/neotropical.17.e87274

Morera, B., et al. 2023. Spatiotemporal effects of free-roaming horses on White-Tailed Deer distribution in Northwestern Costa Rica. Rangeland Ecology & Management 86:80–86. https://doi.org/10.1016/j.rama.2022.11.002

Mouele, A. M., S. Brogan, & C. Stephan. 2022. Allo-and autocoprophagy events in wild western lowland gorillas (*Gorilla gorilla gorilla*). African Journal of Ecology 60:1329–1333. https://doi.org/10.1111/aje.13003

Nishikawa, M., & K. Mochida. 2010. Coprophagy-related interspecific nocturnal interactions between Japanese macaques (*Macaca fuscata yakui*) and sika deer (*Cervus nippon yakushimae*). Primates 51:95–99. https://doi.org/10.1007/s10329-009-0182-x

Ranade, S. P., & Prakash, V. (2015). Coprophagy by barking deer *Muntiacus vaginalis* (Mammalia: Cetartiodactyla: Cervidae) in Buxa Tiger Reserve, West Bengal, India. Journal of Threatened Taxa 7:7825–7826. https://doi.org/10.11609/jott.o4367.7825-6

Rodríguez, M. A. 2015. El venado cola blanca en el bosque seco tropical de Costa Rica. Windmills International Editions Inc. California.

Rodríguez-Ramírez, M., & J. M. Mora. 2022. Analysis of the male annual antler cycle, reproductive behavior and spotted fawn presence in the tropical white-tailed deer. Therya 13:143–151. https://doi.org/10.12933/therya-22-1158

Soave, O., & C. D. Brand. 1991. Coprophagy in animals: A review. The Cornell Veterinarian 81:357–364.

Spitzer, R., et al. 2023. Coprophagy in moose: A first observation. Ecology and Evolution 13:e9757. https://doi.org/10.1002/ece3.9757

van der Wal, R., & J. J. E. Loonen. 1998. Goose droppings as food for reindeer. Canadian Journal of Zoology 76:1117–1122. https://doi.org/10.1139/z98-033

Waggershauser, C.N., P. Taberlet, E. Coissac, K. Kortland, C. Hambly, & X. Lambin. 2022. Interspecific coprophagia by wild red foxes: DNA metabarcoding reveals a potentially widespread form of commensalism among animals. Ecology and Evolution 12:e9029. https://doi.org/10.1002/ece3.9029