NOTAS SOBRE

MAMÍFEROS SUDAMERICANOS

Sociedad Argentina para el Estudio de los Mamíferos

Notas sobre Mamíferos Sudamericanos 2021, vol.3
http://doi.org/10.31687/saremNMS.21.7.1
Versión on-line ISSN 2618-4788

NOTAS SOBRE
MAMÍFEROS
SUDAMERICANOS

First record of plastic ingestion by *Cerdocyon thous* (Carnivora, Canidae) in northeastern Brazil

Adriana Bocchiglieri (1), Rayanna H. S. Bezerra (1) & Anderson M. Conceição (1)

(1) Programa de Pós-Graduação em Ecologia e Conservação (PPEC), Laboratório de Mastozoologia, Universidade Federal de Sergipe (UFS), São Cristóvão, Sergipe, Brazil. [correspondence: adriblue@hotmail.com]

Citación: Bocchiglieri, A., R. H. S. Bezerra, & A. M. Conceição. 2021. First record of plastic ingestion by *Cerdocyon thous* (Carnivora, Canidae) in northeastern Brazil. Notas sobre Mamíferos Sudamericanos 3:e21.7.1.

ABSTRACT
Cerdocyon thous is a neotropical canid often found in natural, fragmented, altered and agricultural environments. Its generalist diet includes plant and animal items, as well as items generated from human activities, such as cultivated fruits. We report the first consumption of plastic by this species in the semiarid region of Brazil, determined by three fragments found in the stomach of a road-killed individual. This finding highlights the problem of inadequate disposal of domestic waste, and the present threat of inorganic material in the food chain.

Key words: Crab-eating fox, garbage, pollution, semiarid, Sergipe.

RESUMO – Primeiro registro de ingestão de plástico por *Cerdocyon thous* (Carnivora, Canidae) no nordeste brasileiro. *Cerdocyon thous* é um canídeo neotropical frequentemente registrado em ambientes naturais, fragmentados, alterados e agrícolas. Sua dieta generalista engloba itens vegetais, animais e aqueles provenientes da atividade humana, como frutos cultivados. Relatamos o primeiro registro de ingestão de plástico por essa espécie no semiárido brasileiro através de três fragmentos encontrados no estômago de um indivíduo atropelado. Essa evidência destaca a problemática do descarte inadequado do lixo doméstico e a ameaça desse material inorgânico ao estar presente na cadeia trófica.

Palavras chave: cachorro do mato, lixo, poluição, semiárido, Sergipe.

Most plastic waste items are resistant to biodegradation, negatively affecting the environment (Narancic & O'Connor 2019). In the marine environment, plastic is the most commonly found type of waste, representing the majority of floating and benthic garbage, and has been recorded even in remote regions (Galgani et al. 2015). Plastic pollution is one of the main threats to aquatic ecosystems (Borrelle et al. 2020; Azevedo-Santos et al. 2021), and proposals that seek better management of discarded plastics have been frequently discussed (e.g., Rhodes 2018; Narancic & O'Connor 2019; Borrelle et al. 2020; Azevedo-Santos et al. 2021). However, most

Recibido el 3 de marzo de 2021. Aceptado el 18 de abril de 2021. Editor asociado: Mauro Schiaffini.

of the plastic that pollutes aquatic environments is produced and discarded from terrestrial environments (Galgani et al. 2015; Hurley et al. 2020), as it is one of the main components of garbage (e.g., Lima et al. 2018; Hurley et al. 2020). The impact of this type of waste on wildlife has been addressed in studies that report incidences of entanglement (of aquatic organisms), suffocation and consumption (Thompson et al. 2009; Kühn et al. 2015), as well as increased susceptibility to diseases (Plaza & Lambertucci 2017; Lamb et al. 2018).

Reports on the ingestion of plastic by diverse fauna groups in aquatic environments are frequent, and highlight the dangers of this interaction with the ecosystem (e.g., Gall & Thompson 2015; Kühn et al. 2015; Azevedo-Santos et al. 2021). However, this approach in terrestrial environments is still rarely discussed, with little evidence of the ingestion of plastic by terrestrial organisms, its transfer into the trophic chain (Lwanga et al. 2017), and the vulnerability of wild species to their consumption (Katlam et al. 2018). There is also a little evidence supporting the threat of microplastics to terrestrial biodiversity (Machado et al. 2018).

The use of garbage by terrestrial mammals as a food source may be related to the availability of resources and foraging strategies, reflecting on the use of domestic prey, transmission of diseases, and conflicts with humans (e.g., Beckman & Berger 2003; Sutor et al. 2010; Smith et al. 2016; Plaza & Lambertucci 2017; Harmsen et al. 2019). Garbage accumulation is a threat to diverse species, as it facilitates access to non-biodegradable residuals as plastic (Katlam et al. 2018). Plastic is the most commonly ingested item by carnivore (order Carnivora) mammals that occurs near anthropic areas (Jankowiak et al. 2016; Katlam et al. 2018).

The crab-eating fox *Cerdocyon thous* (Linnaeus, 1766) is a neotropical canid, with a wide distribution in South America. It can be found in both forested and open areas, and in degraded and agricultural environments (Lucherini 2015). The species is known to have a generalist diet, feeding on fruits, insects, crustaceans, fishes, reptiles, and amphibians, as well as small rodents and marsupials (e.g., Bueno & Motta Júnior 2004; Gatti et al. 2006; Pedó et al. 2006; Bianchi et al. 2014; Dias & Bocchiglieri 2016). Furthermore, some studies have also identified food items of anthropic origin, such as rice, beans (Facure & Monteiro-Filho 1996; Rocha et al. 2008) and cultivated fruits as a part of its diet (Facure & Monteiro-Filho 1996; Facure et al. 2003; Rocha et al. 2004). However, despite reports of garbage consumption (e.g., rice, fruits) by this canid (Facure & Monteiro-Filho 1996; Rocha et al. 2008; Bossi et al. 2019), the ingestion of inorganic items such as plastic has not been previously recorded in Brazil.

In September 2018, a young male *C. thous* (weighing 3,550 g) was found dead after being hit on a dirt road (latitude -09.66; longitude -37.68; WGS 84) in the vicinity of Grota do Angico Natural Monument, a State Conservation unit located on the banks of the São Francisco River, between the municipalities of Canindé de São Francisco and Poço Redondo, in the extreme northwest region of Sergipe (northeastern Brazil). The region is a hyper-xerophylous deciduous forest, with an arboreal-shrubby formation of Caatinga biome (Silva et al. 2013; Fig. 1).

The specimen was sent to the Coleção de Mamíferos da Universidade Federal de

Sergipe to be incorporated in the institution's scientific collection (CMUFS 0123). During taxidermy, the specimen's stomach contents were analyzed, and three plastic fragments (Fig. 2) were found tangled between grass leaves. The partial presence of the bar code in the larger fragment allowed for the identification of the material as a package of beans of the brand "Tio Luiz", a product of a cereal distributor in the region. In addition to plastic, it was possible to identify insect fragments of the orders Blattodea, Hymenoptera, and Orthoptera. We were also able to identify snake scales, fragments of dental bone and fish scales, and seeds of *Pilosocereus gounellei* (F.A.C. Weber) Byles & Rowley, an endemic cacti from the Caatinga.

The organic items found in the stomach of this individual have been frequently reported in the diet of this species in wetlands, savanna, agricultural areas, and semi deciduous forests in Brazil (e.g., Facure & Monteiro-Filho 1996; Bueno & Motta Júnior 2004; Gatti et al. 2006; Pedó et al. 2006; Rocha et al. 2008; Bianchi et al. 2014). Some of these food items have also been registered for *C. thous* in Caatinga environments (Olmos 1993; Dias & Bocchiglieri 2016), where this individual was found. However, a record of plastic ingestion is unprecedented for this canid.

Although plastic records in terrestrial mammals are not as frequent as in marine mammals, the occurrence of this item in the stomach or feces of representatives of the order Carnivora such as coatis [*Nasua nasua* (Linnaeus, 1766) and *Nasuella olivacea* (Gray, 1865)], raccoons [*Procyon lotor* (Linnaeus, 1758)], pumas [*Puma concolor* (Linnaeus, 1771)] and andean bears [*Tremarctos ornatos* (Cuvier, 1825)], was reported by Hoffmann & Gottschang (1977) in the USA, Alves-Costa et al. (2004) and Ferreira et al. (2013) in Brazil, Cáceres-Martinez et al. (2015) in Colombia, Gheler-Costa et al. (2018) in Brazil, and Bartolucci et al. (2020) in Argentina. Some of these species, which are frequently found in urban areas or areas under anthropic influence tend to explore domestic garbage in search of food, and in doing so they may accidentally ingest aluminum foil, string, paper, polystyrene, and rubber bands (Hoffmann & Gottschang 1977; Ferreira et al. 2013). They also consume cultivated fruits (Hoffmann & Gottschang 1977; Ferreira et al. 2013) revealing opportunistic eating habits.

Among canids, plastic ingestion has also been observed together with cultivated fruits in coyotes (*Canis latrans* Say, 1823), foxes [*Lycalopex culpaeus* (Molina, 1782) and *L. gymnocercus* (G. Fisher, 1814)], fennec foxes [*Vulpes zerda* (Zimmermann, 1780)], and maned wolves [*Chrysocyon brachyurus* (Illiger, 1815)] [e.g., Silva & Talamoni 2003 (Brazil); Morey et al. 2007 (USA); Brahmi et al. 2012 (Algeria); Monteiro et al. 2015 (Brazil); Beltrán-Ortiz et al. 2017 (Ecuador)]. Other garbage items such as paper, string, cotton, cigarettes, aluminum foil and glass were also recorded in Brazil (Aragona & Setz 2001; Silva & Talamoni 2003; Massara et al. 2012), USA (Morey et al. 2007; Larson et al. 2015) and Chile (García et al. 2018). The presence of these items reveals the ability of these animals to explore garbage when searching for food (Aragona & Setz 2001; Silva & Talamoni 2003; Morey et al. 2007; Aximoff et al. 2020). This finding also highlights the need for better garbage management and monitoring its impact on fauna (Aragona & Setz 2001; Aximoff et al. 2020). *Cerdocyon thous,*

when foraging in altered areas, can explore garbage in search of potential food and accidentally end up ingesting inorganic items, such as plastics.

Ingesting plastic can cause physical and physiological damage to animals (Rhodes 2018), although little is known about species' vulnerability to this threat (Machovsky-Capuska et al. 2019). Machado et al. (2018) reported that the exposure of terrestrial species to plastic can affect physiological and ecosystem processes, but the impacts on terrestrial biodiversity are not known. The growing increase in reports of plastic ingestion by terrestrial organisms highlights the need for effective policies of waste

Figure 1. Typical vegetation of semiarid Caatinga biome areas in northeastern Brazil, in a nearby area where the canid *Cerdocyon thous* was found.

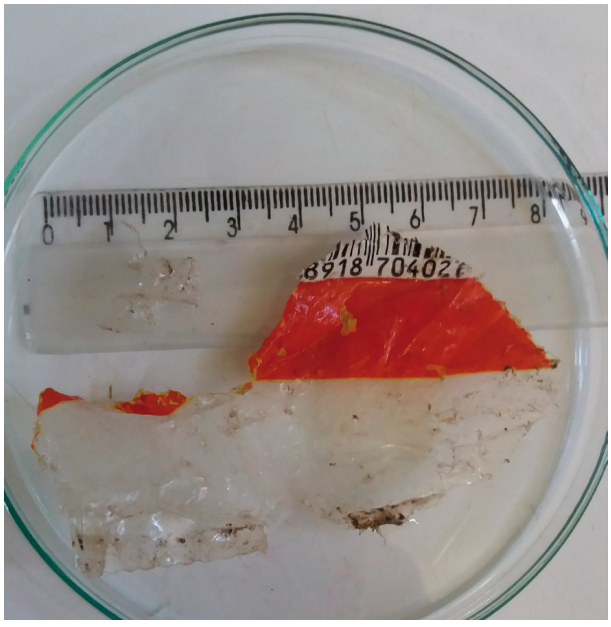

Figure 2. Plastic fragments found in the stomach of *Cerdocyon thous* in northeastern Brazil.

management, in order to minimize its disposal in the environment.

ACKNOWLEDGMENTS

This study was financed in part by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior - Brasil (CAPES) - Finance Code 001 to R.H.S.B. and A.M.C.

LITERATURE CITED

Alves-Costa, C. P., G. A. B. Fonseca, & C. Christófaro. 2004. Variation in the diet of the brown-nosed coati (*Nasua nasua*) in Southeastern Brazil. Journal of Mammalogy 85:478–482.

Aragona, M., & E. Setz. 2001. Diet of the maned wolf, *Chrysocyon brachyurus* (Mammalia: Canidae), during wet and dry seasons at Ibitipoca State Park, Brazil. Journal of Zoology 254:131–136.

Aximoff, I., W. D. Carvalho, D. Romero, C. E. L. Esbérard, J. C. Guerrero, & L. M. Rosalino. 2020. Unravelling the drivers of maned wolf activity along an elevational gradient in the Atlantic Forest, southeastern Brazil. Mammalian Biology 100:187–201.

Azevedo-Santos, V. M., et al. 2021. Plastic pollution: A focus on freshwater biodiversity. Ambio 1–12.

Bartolucci, C. S., M. de las M. Guerisoli, & G. M. Martin. 2020. Primer registro de basura en heces de puma (*Puma concolor*) en el Parque Nacional Los Glaciares, provincia de Santa Cruz, República Argentina. Notas sobre Mamíferos Sudamericanos 2:e20.0.29.

Beckmann, J. P., & J. Berger. 2003. Rapid ecological and behavioural changes in carnivores: the responses of black bears (*Ursus americanus*) to altered food. Journal of Zoology 261:207–212.

Beltrán-Ortiz, E. P., H. Cadena-Ortiz, & J. Brito. 2017. Dieta del zorro de páramo *Lycalopex culpaeus* (Molina 1782) en un bosque seco interandino del norte de Ecuador. Mastozoología Neotropical 24:437–441.

Bianchi, R. C., R. C. Campos, N. L. Xavier-Filho, N. Olifiers, M. E. Gompper, & G. Mourão. 2014. Intraspecific, interspecific, and seasonal differences in the diet of three mid-sized carnivores in a large neotropical wetland. Acta Theriologica 59:13–23.

Borrelle, S. B. et al. 2020. Predicted growth in plastic waste exceeds efforts to mitigate plastic pollution. Science 369:1515–1518.

Bossi, M. A. S., R. P. Migliorini, T. G. Santos, & C. B. Kasper. 2019. Comparative trophic ecology of two sympatric canids in the Brazilian Pampa. Journal of Zoology 307:215–222.

Brahmi, K., E. A. Khechekhouche, O. Mostefaoui, S. Doumandji, B. Baziz, & S. Aulagnier. 2012. First quantitative data on the diet of the fennec fox, *Vulpes zerda* (Canidae, Carnivora), in Algeria. Folia Zoologica 61:61–70.

Bueno, A. A., & J. C. Motta-Junior. 2004. Food habits of two syntopic canids, the maned wolf (*Chrysocyon brachyurus*) and the crab-eating fox (*Cerdocyon thous*), in southeastern Brazil. Revista Chilena de Historia Natural 77:5–14.

Cáceres-Martínez, C. H., A. A. Acevedo-Rincón, & L. R. Sánchez-Montaño. 2015. Registros de plásticos en la ingesta de *Tremarctos ornatus* (Carnivora: Ursidae) y de *Nasuella olivacea* (Carnivora: Procyonidae) en el Parque Nacional Natural Tamá, Colombia. Revista Mexicana de Biodiversidad 86:839–842.

Dias, D. M., & A. Bocchiglieri. 2016. Trophic and spatio-temporal niche of the crab eating fox, *Cerdocyon thous* (Linnaeus, 1766) (Carnivora: Canidae), in a remnant of the Caatinga in northeastern Brazil. Mammalia 80:281–291.

Facure, K. G., & E. L. A. Monteiro-Filho. 1996. Feeding habits of the crab-eating fox, *Cerdocyon thous* (Carnivora, Canidae), in a suburban area of southeastern Brazil. Mammalia 60:147–149.

Facure, K. G., A. A. Giaretta, & E. L. A. Monteiro-Filho. 2003. Food habits of the crab-eating fox, *Cerdocyon thous*, in an altitudinal forest of the Mantiqueira Range, southeastern Brazil. Mammalia 67:503–511.

Ferreira, G. A., E. Nakano-Oliveira, G. Genaro, & A. K. Lacerda-Chaves. 2013. Diet of the coati *Nasua nasua*

(Carnivora: Procyonidae) in an area of woodland inserted in an urban environment in Brazil. Revista Chilena de Historia Natural 86:95–102.

Galgani, F., G. Hanke, & T. Maes. 2015. Global distribution, composition and abundance of marine litter. Marine Anthropogenic Litter (M. Bergmann, L. Gutow, & M. Klages, eds.). Springer, Bremerhaven.

Gall, S. C., & R. C. Thompson. 2015. The impact of debris on marine life. Marine Pollution Bulletin 15:170–179.

García, C., N. Sandoval, A. Silva, J. Godoy-Güinao, & I. A. Díaz. 2018. Consumo de residuos y desechos de origen antrópico por zorros (*Lycalopex* sp.) en la Reserva Nacional Río Clarillo, Región Metropolitana, Chile. Biodiversidata 6:27–32.

Gatti, A., R. Bianchi, C. R. X. Rosa, & S. L. Mendes. 2006. Diet of the crab-eating fox, *Cerdocyon thous* (Carnivora, Canidae) in Paulo Cesar Vinha State Park, Espírito Santo State, Brazil. Mammalia 70:153–155.

Gheler-Costa, C., G. P. Botero, L. Reia, L. C. Gilli, F. H. Comim, & L. M. Verdade. 2018. Ecologia trófica de onça-parda (*Puma concolor*) em paisagem agrícola. Revista em Agronegócio e Meio Ambiente 11:203–225.

Harmsen, B. J., E. Sanchez, O. A. Figueroa, S. M. Gutierrez, C. P. Doncaster, & R. J. Foster. 2019. Ecology of a versatile canid in the Neotropics: gray foxes (*Urocyon cinereoargenteus*) in Belize, Central America. Mammal Research 64:319–332.

Hoffmann, C. O., & J. L. Gottschang. 1977. Numbers, Distribution, and Movements of a Raccoon Population in a Suburban Residential Community. Journal of Mammalogy 58:623–636.

Hurley, R., A. Horton, A. Lusher, & L. Nizzetto. 2020. Plastic waste in the terrestrial environment. Plastic Waste and Recycling (T. M. Letcher, ed.). Academic Press, London.

Jankowiak, Ł., A. W. Malecha, & A. J. Krawczyk. 2016. Garbage in the diet of carnivores in an agricultural area. European Journal of Ecology 2:81–86.

Katlam, G., S. Prasad, M. Aggarwal, & R. Kumar. 2018. Trash on the menu: patterns of animal visitation and foraging behaviour at garbage dumps. Current Science 115:2322–2326.

Kühn, S. E. L. B. Rebolledo, & J. A. Van Franeker. 2015. Deleterious Effects of Litter on Marine Life. Marine Anthropogenic Litter (M. Bergmann, L. Gutow, & M. Klages, eds.). Springer, Bremerhaven.

Lamb, J. B. et al. 2018. Plastic waste associated with disease on coral reefs. Science 359:460–462.

Larson, R. N., J. M. Dana, I. A. Wierzbowska, & K. R. Crooks. 2015. Food habits of coyotes, gray foxes, and bobcats in a coastal Southern California urban landscape. Western North American Naturalist 75:339–347.

Lima, P. M., D. A. Colvero, A. P. Gomes, H. Wenzel, V. Schalch, & C. Cimpan. 2018. Environmental assessment of existing and alternative options for management of municipal solid waste in Brazil. Waste Management 78:857–870.

Lucherini, M. 2015. *Cerdocyon thous*. The IUCN Red List of Threatened Species. e.T4248A81266293.

Lwanga, E. H. et al. 2017. Field evidence for transfer of plastic debris along a terrestrial food chain. Scientific Reports 7:4071.

Machado, A. A. S., W. Kloas, C. Zarfl, S. Hempel, & M. C. Rillig. 2018. Microplastics as an emerging threat to terrestrial ecosystems. Global Change Biology 24:1405–1416.

Machovsky-Capuska, G. E., C. Amiot, P. Denuncio, R. Grainger, & D. Raubenheimer. 2019. A nutritional perspective on plastic ingestion in wildlife. Science of The Total Environment 656:789–796.

Massara, R. L., A. Paschoal, A. Hirsch, & A. Chiarello. 2012. Diet and habitat use by maned wolf outside protected areas in eastern Brazil. Tropical Conservation Science 5:284–300.

Monteiro, G. S. et al. 2015. Adenoviruses of canine and human origins in stool samples from freeliving pampas foxes (*Lycalopex gymnocercus*) and crab-eating foxes (*Cerdocyon thous*) in São Francisco de Paula, Rio dos Sinos basin. Brazilian Journal of Biology 75:S11–S16.

Morey, P. S., E. M. Gese, & S. Gehrt. 2007. Spatial and Temporal Variation in the Diet of Coyotes in the Chicago Metropolitan Area. American Midland Naturalist 158:147–161.

Narancic, T., & K. E. O'Connor. 2019. Plastic waste as a global challenge: are biodegradable plastics the answer to the plastic waste problem? Microbiology 165:129–137.

Olmos, F. 1993. Notes on the food habits of Brazilian "Caatinga" carnivores. Mammalia 57:126–130.

Pedó, E., A. C. Tomazzoni, S. M. Hartz, & A. U. Christoff. 2006. Diet of crab-eating fox, *Cerdocyon thous*

(Linnaeus) (Carnivora, Canidae), in a suburban area of southern Brazil. Revista Brasileira de Zoologia 23:637–641.

Plaza, P. I., & S. A. Lambertucci. 2017. How are garbage dumps impacting vertebrate demography, health, and conservation? Global Ecology and Conservation 12:9–20.

Rhodes, C. J. 2018. Plastic pollution and potential solutions. Science Progress 101:207–260.

Rocha, V. J., L. M. Aguiar, J. E. Silva-Pereira, R. F. Moro-Rios, & F. C. Passos. 2008. Feeding habits of the crab-eating fox, *Cerdocyon thous* (Carnivora: Canidae), in a mosaic area with native and exotic vegetation in Southern Brazil. Revista Brasileira de Zoologia 25:594–600.

Rocha, V. J., N. R. dos Reis, & M. L. Sekiama. 2004. Dieta e dispersão de sementes por *Cerdocyon thous* (Linnaeus) (Carnivora, Canidae), em um fragmento florestal no Paraná, Brasil. Revista Brasileira de Zoologia 21:871–876.

Silva, J. A., & A. S. Talamoni. 2003. Diet adjustments of maned wolves, *Chrysocyon brachyurus* (Illiger) (Mammalia, Canidae), subjected to supplemental feeding in a private natural reserve, Southeastern Brazil. Revista Brasileira de Zoologia 20:339–345.

Silva, A. C. C., A. P. N. Prata, L. S. Souto, & A. A. Mello. 2013. Aspectos de ecologia de paisagem e ameaças à biodiversidade em uma Unidade de Conservação na Caatinga, em Sergipe. Revista Árvore 37:479–490.

Smith, J. A., Y. Wang, & C. C. Wilmers. 2016. Spatial characteristics of residential development shift large carnivore prey habits. The Journal of Wildlife Management 80:1040–1048.

Sutor, A., K. Kauhala, & H. Ansorge. 2010. Diet of the raccoon dog *Nyctereutes procyonoides* – a canid with an opportunistic foraging strategy. Acta Theriologica 55:165–176.

Thompson, R. C., Moore, C. J., vom Saal, F. S., & Swan, S. H. 2009. Plastics, the environment and human health: current consensus and future trends. Philosophical Transactions of the Royal Society B 364:2153–2166.