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First detailed record of food items in the diet of the dwarf coati (*Nasua nelsoni*) of Cozumel Island, México

Primer registro detallado de alimentos en la dieta del coatí enano (*Nasua nelsoni*) de Isla Cozumel, México

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The dwarf coati (*Nasua nelsoni*) is an endemic mammal to Cozumel Island, Quintana Roo, México. Although dwarf coati is critically threatened with extinction, there are still important knowledge gaps about its biology and ecology. We are unaware of relevant published aspects of its trophic ecology and there is no information on its feeding habits. Therefore, our objective was to report, for the very first time, details on food items in the diet of the dwarf coati. Between September 2013 and December 2014, we recorded sightings of groups and solitary individuals of dwarf coati. Some of these sightings allowed us to directly record the consumption of food items, mainly fruits, which were later identified by collecting samples of the consumed material and the fruiting plant. We recorded a total of 25 sightings of dwarf coati while consuming food items. In 88 % (n = 22) of the records, we recorded the consumption of fruit from 8 species, represented by 8 families of wild plants. Additionally, we obtained records of the species consuming sea turtle eggs (n = 1) and organic waste of anthropic origin (n = 2). The evidence of the consumption of fruit and food items of different origin supports the expectation that the dwarf coati has an omnivorous diet mainly based on fruit, which coincides with that reported for other species of the same genus, the white-nosed coati (*N. narica*) and brown-nosed coati (*N. nasua*).

Key words: Carnivore; insular endemic; pizote; procyonid; threatened species; trophic niche.

El coatí enano (*Nasua nelsoni*) es un mamífero endémico de Isla Cozumel, Quintana Roo, México. A pesar de que el coatí enano es una especie críticamente amenazada con la extinción, aún existen importantes vacíos de conocimiento sobre su biología y ecología. Se desconocen aspectos relevantes de su ecología trófica y no existe información específica sobre sus hábitos alimentarios. Por ello, nuestro objetivo fue reportar, por primera vez, detalles sobre los alimentos que conforman parte de la dieta del coatí enano. Entre septiembre de 2013 y diciembre de 2014, registramos avistamientos de grupos e individuos solitarios de coatí enano. Algunos de estos avistamientos nos permitieron registrar directamente el consumo de alimentos, principalmente frutas, que luego fueron identificados mediante la recolección de muestras del material consumido y de la planta madre. Registramos 25 avistamientos de individuos de coatí enano mientras consumían alimentos. En 88 % (n = 22) de esos avistamientos, registramos el consumo de frutos de 8 especies, representadas por 8 familias de plantas silvestres. Adicionalmente, obtuvimos registros del coatí enano mientras consumía huevos de tortuga marina (n = 1) y desechos orgánicos de origen antrópico (n = 2). La evidencia del consumo de frutas aunado al consumo de alimentos de diferente origen apoya la idea de que el coatí enano tiene una dieta omnívora basada principalmente en el consumo de frutas, lo que coincide con información reportada para otras especies del género, como el coatí de nariz blanca (*N. narica*) y el coatí sudamericano (*N. nasua*).

Palabras clave: Carnívoro; endémico insular; especie amenazada; nicho trófico; pizote; prociónido.

The dwarf coati (*Nasua nelsoni*) is a mammalian carnivore of the Procyonidae family, endemic to Cozumel Island, Quintana Roo, México. It is a species classified as Endangered, according to Mexican legislation (SEMARNAT 2010), and listed in Appendix III of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES; Valenzuela-Galván *et al.* 2014). In México, the species has been considered as a priority in terms of conservation among terrestrial mammals of the order Carnivora (Valenzuela-Galván and Vázquez 2007). The dwarf coati is an insular species similar to its continental congener, the white-nosed coati (*Nasua narica*), but with significantly less weight, and smaller size and tooth length, compared to the latter (Valenzuela-Galván *et al.* 2014). It is a species that faces severe conservation problems related to the introduction of exotic species, loss of natural habitat, stochastic events (mainly hurricanes) and to its low population size, which is estimated has not recovered from historical genetic bottlenecks, and hence further reduction of its population is possible (Cuarón *et al.* 2004, 2009; McFadden

et al. 2010; Flores-Manzanero et al. 2022). Available genetic information about the dwarf coati strongly supports that its taxonomic position as a distinct species should be considered (something that has been recently debated; see Valenzuela-Galván et al. 2023 and Ruiz-García et al. 2023). Also, its status in the IUCN Red List of Threatened species should be recognized as a Critically Endangered species, and its population managed in accordance, or at the very least as an Evolutionary Significant Unit (*sensu* Moritz 1994; Flores-Manzanero et al. 2022).

Despite its endemism and vulnerability, it is a species for which little is known about its natural history, biology, behavior, and ecological aspects. Research efforts have focused on determining its population size (Cuarón et al. 2004) and more recently spatio-temporal ecology (Rodríguez-Luna 2015) and conservation genetics (Flores-Manzanero et al. 2022). Conservation work has resulted in the creation of an extensive system of state and federal protected areas and the recognition of the entire Cozumel Island and surrounding sea as a Biosphere Reserve of UNESCO's Man and Biosphere Program (Cuarón et al. in press). However, there is still an important knowledge gap about its trophic niche. Regarding its feeding habits, it is considered that they could be similar to those of *N. narica* (Cuarón et al. 2009): an omnivorous species that feeds mainly on fruits and arthropods (Valenzuela-Galván et al. 2014). Nevertheless, fieldwork is still needed to demonstrate this.

Knowledge about the feeding habits of animals helps to understand ecological niche relationships, since they play an important role in segregation, competition, coexistence (Schoener 1974), population dynamics (Taper and Marquet 1996), habitat use and even the social organization of a species (Mills 1992; ; Manfredi et al. 2004; Casella and Cáceres 2006). Besides, it is valuable information to support conservation actions. Therefore, our objective in this work was to report the very first records of food items ingested by the dwarf coati of Cozumel Island, obtained through direct observation.

The study area was Cozumel Island, Quintana Roo, México (Figure 1). It is an oceanic island located in the Mexican Caribbean Sea with *ca.* 478 km^2 and extreme coordinates 20° 16' 18.2" – 20° 35' 32.28" N and 86° 43' 23.3" – 87° 01' 31.1" W (Cuarón 2009). The vegetation on the island consists of a well-defined gradient that begins from the eastern coastal strip with coastal dune vegetation followed by areas of tasistal (*Acoelorhaphe wrightii*), mangrove (*Rhizophora mangle*, *Laguncularia racemosa*), tropical dry forest and medium sub-deciduous forest in the central portion of the island, which is the predominant vegetation type (Téllez et al. 1989; Figure 1). Climate type is AmW(I), warm humid with abundant rains in summer; average annual temperature is 27.5 °C and average annual precipitation is 1,403 mm (INEGI 2016).

Between September 2013 and December 2014 in Cozumel Island, we carried out a study on the spatial ecology of the dwarf coati for which it was necessary to capture and radio tag several individuals of the species (Rodríguez-Luna

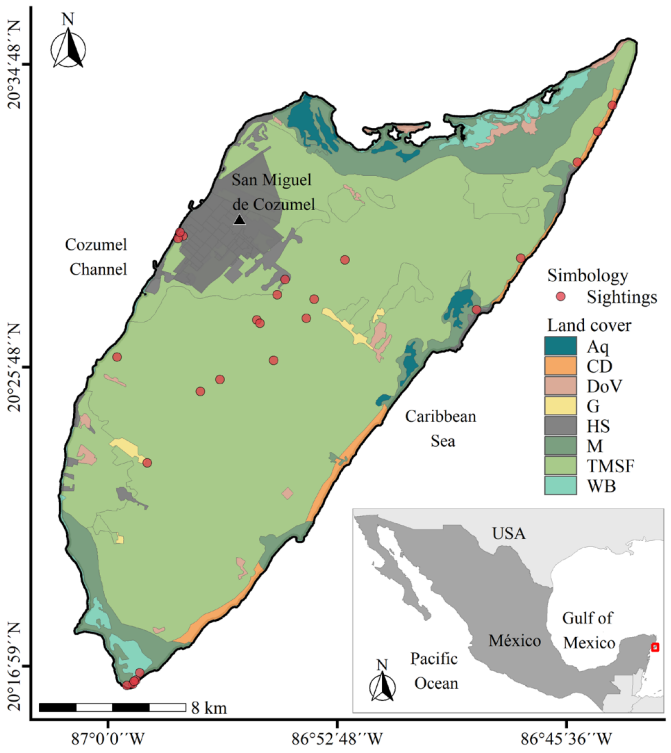

Figure 1. Study area in Cozumel Island, Quintana Roo, México, and spatial locations of the sighting points (red dots) where we recorded the food intake by the dwarf coati (*Nasua nelsoni*). In the figure we show the town of San Miguel de Cozumel (black triangle) and the land cover according to freely available information on Land Use and Vegetation (sVII) from the Instituto Nacional de Estadística y Geografía (INEGI), available at https://www.inegi.org.mx/temas/usosuelo/#Descargas. Land cover is described as: Aq, aquatic vegetation; CD, coastal dune; DoV, area devoid of vegetation; G, grasslands; HS, human settlements; M, mangroves; TMSF, tropical medium sub-deciduous forest; WB, water bodies.

2015). During the development of the fieldwork to obtain radiotracking locations, we recorded sightings of groups and solitary individuals of the species at different places on the island. For some of the sightings we observed individuals of dwarf coati foraging and even consuming food items. For each of these sightings, we recorded the geolocation, vegetation type, and, when possible, we took photographic evidence with a portable camera (Nikon™ mod. P100). When we recorded an observation of the consumption of fruits, we collected samples of them as well as of the fruiting plant for the subsequent identification of the species. For plant identification, we used the Catalogo de Flora de la Península de Yucatán of the Centro de Investigación Científica de Yucatá A. C. (https://www.cicy.mx/sitios/flora%20digital/index.php), as well as reference material with specialized support from personnel of the Laboratorio de Ecología de Plantas from the Cozumel campus of the Universidad Autónoma de Quintana Roo.

We obtained a total of 25 georeferenced sightings of dwarf coati where we observed the consumption of food items by the species (Figure 1). Most of the sightings (56 %; n = 14) occurred in areas covered by tropical medium sub-deciduous forest, 32 % (n = 8) occurred in coastal dune areas, 8 % (n = 2) in secondary vegetation and one sighting (4 %) occurred on a beach in the east coast with no apparent vegetation (Table 1).

We were able to identify the consumption of fruits (Figure 2) of 8 wild plant species, represented by 8 genera, 8 families and 7 orders (Table 1): *Xylopia frutescens* Aubl., *Byrsonima bucidifolia* Standl., *Cordia sebestena* L., *Coccoloba uvifera* (L.) L., *Diospyros salicifolia* Humb. & Bonpl. ex Willd., *Cascabela gaumeri* (Hemsl.) Lippold, *Scaevola plumieri* (L.) Vahl and *Jacquinia arborea* Vahl.

In addition, we recorded 1 sighting in which a dwarf coati consumed sea turtle eggs (most probably of *Chelonia mydas*, since the majority of nests at Cozumel are from this species) on an open beach and 2 sightings of the species consuming organic food waste of anthropic origin (Figure 3).

Our records of dwarf coati consuming fruits, sea turtle eggs and organic waste of anthropic origin, represents the first report of food items identified in detail in the species diet. Other species of the genus *Nasua* have a high consumption of fruits (Gompper 1995; Gompper and Decker 1998). The white-nosed coati (*N. narica*) consumes predominantly fruits, but also invertebrates and small vertebrates in variable proportions, both in the northernmost part of

Figure 2. Photographic records of dwarf coati of Cozumel Island (*Nasua nelsoni*), prior to the consumption of fruits (marked in red circles) of species a) *Xylopia frutescens* and b) *Diospyros yucatanensis*.

Table 1. Records of food items consumed by the dwarf coati (*Nasua nelsoni*) of Cozumel Island, México by vegetation type. * Indicates this is the first time this species and plant family is reported to be consumed by a species in the genus *Nasua*. Vegetation types are designated as follows: CD, coastal dune; DoV, area devoid of vegetation; TMSF, tropical medium sub-deciduous forest; SV, secondary vegetation.

Food type	Order	Family	Species	Number of records	Percentage of records	Vegetation type
Fruits	Asterales	Goodeniaceae*	*Scaevola plumieri**	1	4	CD
	Boraginales	Boraginaceae*	*Cordia sebestena**	2	8	CD
	Caryophyllales	Polygonaceae	*Coccoloba uvifera*	2	8	CD
	Ericales	Ebenaceae	*Diospyros salicifolia*	2	8	TMSF
		Primulaceae	*Jacquinia arborea*	1	4	CD
	Gentianales	Apocynaceae*	*Cascabela gaumeri**	2	8	CD
	Magnoliales	Malpighiaceae	*Byrsonima bucidifolia*	4	16	TMSF
	Malpighiales	Annonaceae	*Xylopia frutescens*	8	32	TMSF
Sea turtle eggs	-	-	-	1	4	DoV
Anthropic waste	-	-	-	2	8	SV
			Total	25	100	4

its distribution in the United States of America (Wallmo and Galliziolli 1954; Kaufmann *et al.* 1976), México (Delibes *et al.* 1989; Valenzuela-Galván 1998; Valenzuela-Galván *et al.* 2014) and in the southernmost part of its distribution in Central America (Kaufmann 1962; Smythe 1970; Gompper 1995, 1996). On the other hand, the brown-nosed coati (*N. nasua*) also feeds mainly on fruit and consumes a variable proportion of invertebrates in its diet (Gompper and Decker 1998; Alves-Costa *et al.* 2004; Alves-Costa and Eterovick 2007; Hirsch 2009; Aguiar *et al.* 2011; Bianchi *et al.* 2013; Ferreira *et al.* 2013).

Among the 8 species that we report in the diet of the dwarf coati, fruits from 5 families have a previous record of consumption in *Nasua spp.*: Polygonaceae, Ebenaceae, Primulaceae, Malpighiaceae and Annonaceae (Russell 1982; Valenzuela-Galván 1998; Hirsch 2009; Bianchi *et al.* 2013), but for 3 species and plant families, our study reports for the first time their consumption by a species in the genus *Nasua* (Table 1). We also recorded the consumption of sea turtle eggs in the northern part of the east coast of Cozumel Island. Nest predation is well known by people who are related to sea turtle (*i.e.*, *Chelonia mydas, Caretta caretta, Eretmochelys imbricata*) conservation work on the island; however, there are no previous published data on nest predation in the study area by the dwarf coati, although consumption of sea turtle eggs by *N. narica* has been reported for different zones across its geographical distribution (Fowler 1979; Valenzuela-Galván 1998; García *et al.* 2003; Ruthig 2019). Finally, we recorded individuals of dwarf coati feeding on organic waste of anthropic origin inside garbage containers in the southern portion of the island (Figure 3), although we were unable to identify the elements ingested. Coati's omnivorous diet allows it to obtain food supplementation in urban environments, where they frequently feed on organic waste of anthropic origin (Alves-Costa *et al.* 2004; Hirsch 2009); this represents one of the factors that can favor the establishment of the

Figure 3. Photographic record of dwarf coati of Cozumel Island (*Nasua nelsoni*), prior to the consumption of organic waste of anthropic origin in the southern part of the island.

species and even the maintenance of stable population density over time in urban areas (Barreto *et al.* 2021).

Thus, with our records of the consumption of fruits, sea turtle eggs, and organic waste of anthropic origin, the idea that the dwarf coati has an omnivorous diet based mainly on fruit consumption is reinforced. This fact coincides with information reported for other species of the genus *Nasua*. However, the detailed study of the feeding habits of the species must be deepened to contribute to the knowledge of its basic ecology and sustain conservation actions for this critically endangered endemic species.

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