Therya Notes

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AMMAC
Asociación Mexicana de Mastozoología A.C.

THERYA NOTES tiene como propósito difundir exclusivamente notas científicas con información original e inédita relacionada con el estudio de los mamíferos en todas las disciplinas que contribuyen a su conocimiento. Es un foro abierto para profesores, investigadores, profesionales y estudiantes de todo el mundo, en el que se publican notas académicas en español e inglés. THERYA NOTES es una revista digital de publicación cuatrimestral (tres fascículos por año) que recibe propuestas para publicación durante todo el año. Tiene un sistema de evaluación por pares a doble ciego y es de acceso abierto.

En la Portada

La martucha, *Potos flavus*, es un mamífero arbóreo de tamaño mediano que se alimenta principalmente de frutos, flores, néctar y hojas. Se tienen registros de consumo de frutos y otras partes de 119 especies de plantas pertenecientes a 50 familias, pero los reportes del consumo de plantas de la familia Araceae son escasos. En este fascículo se presenta el primer registro de consumo de la aracea *Monstera egregia*, por un ejemplar de martucha. (Fotografía de Martín Alarcón Montano)

El logo de la AMMAC: "Ozomatli"

El nombre de "Ozomatli" proviene del náhuatl,se refiere al símbolo astrológico del mono en el calendario azteca, así como al dios de la danza y del fuego. Se relaciona con la alegría, la danza, el canto, las habilidades. Al signo decimoprimero en la cosmogonía mexica. "Ozomatli" es una representación pictórica delmono araña (*Ateles geoffroyi*), la especie de primate de más amplia distribución en México. "Es habitante de los bosques, sobre todo de los que están por donde sale el sol en Anáhuac. Tiene el dorso pequeño, es barrigudo y su cola, que a veces se enrosca, es larga. Sus manos y sus pies parecen de hombre; también sus uñas. Los Ozomatin gritan y silban y hacen visajes a la gente. Arrojan piedras y palos. Su cara es casi como la de una persona, pero tienen mucho pelo."

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Notes on the coexistence of sympatric northern raccoons and white-nosed coatis in a dry forest of northwest Costa Rica

Notas de coexistencia simpátrica entre mapache y pizote en el bosque seco al noroeste de Costa Rica

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Differential resource use of sympatric species that co-exist is poorly known. Considering sympatric procyonid species inhabiting the dry forest of northwest Costa Rica (Santa Rosa National Park) we hypothesized northern raccoon (*Procyon lotor*) occurrence is relatively high in cover types where white-nosed coati (*Nasua narica*) is absent. We deployed 56 camera traps from June 2016-June 2017 to compare distribution and occurrence in cover types at each location. Additionally, we examined activity patterns derived from these and 45 other cameras in the same area monitored irregularly from 2011-2016. Over the course of a year, both species were detected only in Riparian Forest. Northern raccoons photo rates were higher in Mangrove and Beach Forest cover-types, with no records in Primary and Secondary Forests, whereas white-nosed coati's records were higher in Secondary Forest and absent in Mangrove and Beach Forest or Grassland with Trees cover-types. Raccoons were nocturnal, and coatis were diurnal, throughout 24-hr diel period, and coati photo rates (1.37/100 trap nights [tn]; n = 20,416 tn) were more than twice those of raccoons (0.48). Differences observed for these species in the distribution of photos by cover type, time of day, and photo rates might suggest local allopatry in Santa Rosa National Park, likely the result of interspecific avoidance but perhaps also due to differences in food habits and predation, and competition with other species. Other techniques should be used to investigate these factors, but cameras can provide important insights into elusive species' ecology.

Key words: Activity; camera; cover type use; distribution; *Nasua narica;* photo rates; *Procyon lotor*; sympatry.

El uso de recursos por especies simpátricas que coexisten es poco conocido. Considerando las especies de prociónidos simpátricos en el bosque seco de Costa Rica (Parque Nacional Santa Rosa), planteamos la hipótesis que la presencia del mapache (*Procyon lotor*) es relativamente alta en tipos de cobertura donde el pizote (*Nasua narica*) está ausente. Colocamos 56 cámaras trampa entre junio de 2016 y junio de 2017 para comparar la ocurrencia y actividad del pizote y el mapache en diferentes tipos de cobertura, incluyendo éstas y otras 45 cámaras monitoreadas de manera irregular entre 2011 y 2016. En un año, ninguna cámara registró ambas especies, con la excepción del bosque ribereño. Las tasas fotográficas de mapache fueron mayores en el manglar y bosque de playa, no obteniendo registros en bosque primario y secundario. Los registros de pizote fueron mayores en bosque secundario y ausentes en el manglar y bosque de playa o pastizales arbolados. El mapache mostró mayor actividad nocturna mientras el pizote diurna, observando tasas fotográficas de pizotes (1.37/100 noches de trampa [tn]; n = 20.416 tn) que fueron más del doble que los mapaches (0.48). Las diferencias en los registros fotográficos para cada especie por tipo de cobertura y horario sugieren un patrón de alopatría local. Esta segregación interespecífica entre pizote y mapache puede atribuirse a diferencias en alimentación, además de competencia. Finalmente, este estudio mostró que las cámaras pueden proporcionar información valiosa sobre la ecología de las especies crípticas como este estudio.

Palabras clave: Actividad; cámara; distribución; *Nasua narica*; *Procyon lotor*; simpatría; tasas fotográficas; uso del tipo de cobertura.

Temporal avoidance and differential resource use are among the variety of ways in which sympatric species can co-exist and thus minimize competition (Arlettaz 1999; Kronfeld-Schor and Dayan 2003). The potential for competition is increased for species within a particular guild, and especially for species that are closely related taxonomically (MacArthur and Levins 1967). Studies of sympatric carnivores in the same taxonomic family and guild can provide revealing insights into ecological co-existence (*e.g.*, Powell and Zielinski 1983; Johnson *et al.* 1996; Santos *et al.* 2019).

Northern raccoons (*Procyon lotor*) and white-nosed coatis (*Nasua narica*) are the only terrestrial Procyonids that also can climb trees in the dry forests of northwestern Costa Rica (Carrillo *et al.* 2000). Both species are omnivorous and reportedly feed on fruits, nuts, invertebrates, turtles, turtle and bird eggs, and frogs; northern raccoons also feed on crustaceans and fish, while coatis also feed on small mammals, and eggs of lizards (Eckrich and Owens 1995; Reid 1997; de la Rosa and Nocke 2000; Wainwright 2007). The species are similar in size (4-5 kg; Wainwright 2007), as well, and the possibility of interspecific competition seems reasonable.

Here we begin to elucidate factors that allow for co-existence between these 2 sympatric procyonid species in a dry forest of northwest Costa Rica. We derived aspects of their space use, activity patterns, and relative abundance from camera trap data collected during long-term studies of jaguars (*Panthera onca*; Montalvo *et al.* 2020). We aimed to assess patterns of relative activity and cover-type use in an area where both species co-existed and thus identify if interspecific avoidance might be a means of co-existence. For sympatric species that are taxonomically related, of similar size, and with overlapping omnivorous diets, we expected that activity pattern overlap would be low but hypothesized that raccoons would have relatively higher occurrence in the lowlands near the beach whereas coatis would be more common in the upland forests.

Study area. We collected procyonid photos in the Santa Rosa National Park located in Northwest Costa Rica (10° 53´ N, 85°46′W). This 387 km^2 area is dominated by one of the few seasonally dry forests remaining in Central America (Jimenez *et al.* 2016). It has undergone a large-scale restoration effort that was initiated in the 1980's and involved protected area status, the recovery of abandoned pastures by active fire suppression, protection from many human activities, and the recovery of large vertebrate populations (Janzen and Hallwachs 2016). The sector contains evergreen forests dominated by live oak (*Quercus oleoides*), many other species that co-occur in the adjacent mixed deciduous forest where oaks are rare, and more typical species from tropical dry forest (Powers *et al.* 2009). Several areas of Santa Rosa are covered with a mosaic of pasture and secondary growth in various stages of regeneration and have different land use histories, past land use intensities, and different occurrences of discrete anthropogenic events such as fire (Kalacska *et al.* 2004). Mangrove forests occur in the lowlands near the coast at stream and river outlets.

Mean annual rainfall in Santa Rosa (~1,600 mm) is highly seasonal; the wet season (months with an average > 100 mm of rain; average maximum temperatures ~ 29-31 °C) is May to November, and the dry season (with almost no rain and maximum temperatures > 35 °C) is December to April (Janzen 1993; Waylen *et al.* 1996). During the dry season, many forest patches lose their leaves though a few evergreen-forest patches retain them. Most of the rivers and streams in the study area run dry and the remaining waterholes become important providers of free water for wildlife (Campos and Fedigan 2009).

Photograph collection. To compare procyonid cover type use and occurrence, part of our survey effort included one period (June 15, 2016 to June 13, 2017) when we had a constant camera trap effort using 56 automatic trail cameras (Bushnell®, Trophy Cam models 119436, 119446, 119456) in a grid array over an area of 87 km^2. Half of the cameras (1 camera per site) were at a trail location that jaguars (*Panthera onca*) were likely to use, and the other half at an off-trail location an average of 0.59 km ± 0.25 SD away from the nearest trail camera (Figure 1). For assessment of procyonid activity patterns, we used a larger camera trapping data set (all within the grid array) from 2011-2017 (including the survey noted above) to increase sample size. Cameras were deployed at a total of 101 different sites, including waterholes, on pathways (*e.g.*, roads, human trails, and animal paths) and at random sites within the forest, for 34-365 days during each year. Camera placement often differed from 1 year to the next and the duration of continuous camera deployment at individual sites each year was affected by camera malfunctions, limited battery life in combination with logistics of camera checks, vandalism, and initial study design for deployment.

For all surveys, each camera was attached to a tree at a height of approximately 40 cm and set to be active for 24 hr/day. Cameras were set either in video mode (30-sec video, minimum 1 sec between successive videos) or photograph mode (3 consecutive photos with a minimum delay of 1 sec between consecutive triggers). Once deployed, cameras were checked on every month or so to replace batteries and change SD memory cards, if necessary. This research followed ASM guidelines (Sikes *et al.* 2016).

Photographs or videos were considered independent photo events of a species if they were: 1) taken at least 30 min apart (*e.g.*, a series of 3 photos of the same animal[s] taken in consecutive seconds = 1 photo event); 2) consecutive photos of the same species could be identified as different individuals (spots, scars, sex) and not part of the same group (*e.g.*, > 15 min apart, going in opposite directions = 2 photo events); or 3) photos of the same species separated by photos of a different species (*e.g.*, species A, followed 2 min later by a species B, followed 5 min later by species A = A species with 2 photo events and another species B with 1 photo event).

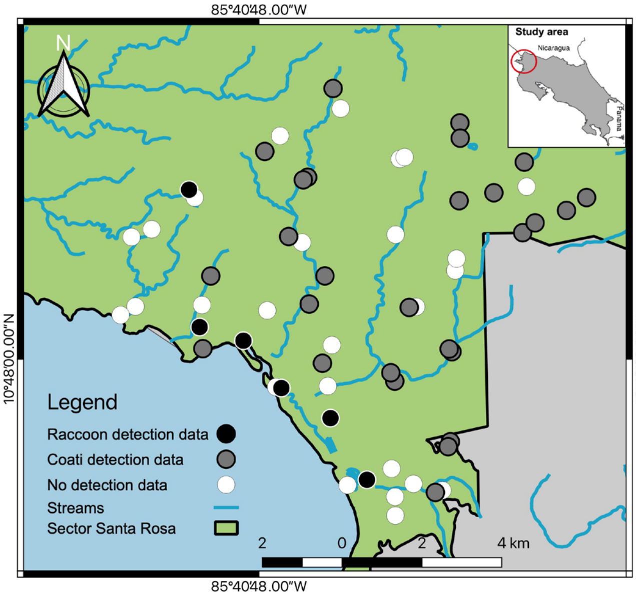

Figure 1. Detections of Northern raccoons (*Procyon lotor*) and white-nosed coatis (*Nasua narica*) during June 15, 2016, to June 13, 2017 at camera trap locations in Santa Rosa National Park, northwest Costa Rica.

Data analyses. We pooled cover types at capture sites into 5 categories: Primary Forest; Secondary Forest, including early and later stage forests, some mixed with lesser amounts of primary forest; Mangrove and Beach Forest; Riparian Forest, sometimes with some secondary forest; and Grassland with Trees, sometimes with some secondary forest. Chi-square tests (Snedecor and Cochran 1972) were used to compare the frequency distribution of photos of each species taken at trap sites in different cover types, as well as photo rates (number of independent photos/100 trap nights) for each species among cover types. We also used Chi-square tests to compare species-specific differences in the photo rates between species.

For comparison of relative activity patterns, we used the times that the first photo of an independent photo event was taken. To quantify relative activity patterns (Ridout and Linkie 2009) we used the R software package activity 1.3 (Rowcliffe 2019), and a Wald test to contrast temporal distribution aggregation differences for circular data smoothed with 10,000 bootstrap resamples to calculate confidence intervals (Rovero and Zimmermann 2016).

Coatis were photographed at almost half of the camera stations (27 of 56) throughout the study area, but raccoons were photographed at only 7, mostly near the coast (Figure 1). During June 2016-June 2017 photo rates of coatis (1.37; 280 independent photos/20,416 trap nights) in our study area were 2.9x's those of raccoons (0.48; 98 independent photos/20,416 trap nights; $x^2 = 88.45$, d. f. = 1, $P < 0.001$).

At any given trap, only 1 of the species was ever photographed; that is, at no single camera were both species photographed over the course of the year. A comparison of the number of trap sites in different cover types where a species was photographed (Table 1) indicated that each species was captured at traps in 3 of 5 cover types, but both species were only photographed in the Riparian Forest cover-type and thus the overall distribution of captures differed by species ($x^2 = 42.04$, d. f. = 8, $P = < 0.001$). Comparing photo rates of each species among cover types (Table 2), the rate for raccoons was higher in Mangrove and Beach Forest (3.43 independent photos/100 trap nights[raccoons] *vs* 0 independent photos/100 trap nights[coatis]; $x^2 = 572.2$, d. f. = 4, $P < 0.001$), and for coatis was highest in Secondary Forest (0 independent photos/100 trap nights[raccons] *vs* 2.73 independent photos/100 trap nights[coatis]; $x^2 = 151.5$, d. f. = 4, $P < 0.001$). Raccoons also were photographed in the Grassland with Trees cover-type, and coatis in Primary and Secondary Forests.

Table 1. Distribution of northern raccoons (*Procyon lotor*) and white-nosed coatis (*Nasua narica*) captures at camera trap sites in different cover types in Santa Rosa National Park, northwest Costa Rica during June 15, 2016 to June 13, 2017. $x^2 = 42.04$, 8 d. f., *P*-value < 0.001.

	Number of cameras sites at which procyonid species were captured			
Covertype	**Only northern raccoon**	**Only white-nosed coati**	**Neither**	**Total**
Secondary Forest	0	11	6	17
Mangrove and Beach Forest	5	0	1	6
Grassland with Trees	1	0	6	7
Primary Forest	0	13	7	20
Riparian Forest	1	3	2	6
Total	7	27	22	56

Table 2. Photo rates (No. independent photo events/100 trap nights; $n = 20{,}416$ trap nights in total) of northern raccoons (*Procyon lotor*) and white-nosed coatis (*Nasua narica*) in different cover types in Santa Rosa National Park, northwest Costa Rica during June 15, 2016 to June 13, 2017. [a] $x^2 = 572.2$, 4 d. f., $P < 0.001$. [b] $x^2 = 151.5$, 4 d. f., $P < 0.001$.

Cover type	**Northern raccoon** [a]	**White-nosed coati** [b]
Secondary Forest	0.0	2.73
Mangrove and Beach Forest	3.43	0.0
Grassland with Trees	0.09	0.0
Primary Forest	0.0	1.26
Riparian Forest	0.14	1.16

Relative activity patterns derived from photographs indicated that although raccoons were clearly nocturnal and coatis were diurnal (only 30 % overlap), both species we recorded as having some activity throughout the 24 hr diel period (Wald (x^2) statistic = 0.942, d. f. = 1, $P = 0.331$), showing a pattern of temporal segregation with no statistical evidence (Figure 2).

Of the 6 species in the family Procyonidae resident in Costa Rica, the olingo (*Bassaricyon gabbii*), the cacomistle (*Bassariscus sumichrasti*), and the kinkajou (*Potos flavus*) are considered terrestrial as well as arboreal, nocturnal, and solitary (de la Rosa and Nocke 2000; Wainwright 2007). Both, the crab-eating raccoon (*Procyon cancrivorus*) and the northern raccoon, though mostly nocturnal and solitary, are terrestrial as well as arboreal. The white-nosed coati is both terrestrial and arboreal like the raccoons, but is diurnal and, unlike any of the other Procyonids, is social (females and young, but not adult males; de la Rosa and Nocke 2000; Wainwright 2007).

In general, northern raccoons in Central America are said to be uncommon in mature evergreen forest (Reid 1997) but are otherwise widespread "in a variety of habitats, including primary and secondary forests (generally at low elevations), swamplands, mangrove forests, beaches, abandoned and cultivated farms, and urban habitats" (de la Rosa and Nocke 2000). White-nosed coatis are also widespread, and can be found in dense tropical rain forests, deciduous and evergreen forest, secondary growth, and more temperate scrub lands (Reid 1997; de la Rosa and Nocke 2000). Results from our study, where the species are sympatric, concur with these general patterns; we found that raccoons were more common near the coast and coatis more in upland forests. In coastal sites of Western Costa Rica, crabs are a particularly common prey of raccoons (Carrillo *et al.* 2001; Timm *et al.* 2009; Yaney-Keller *et al.* 2022), and raccoons preferred mangrove forests where coatis preferred palm stands (Yaney-Keller *et al.* 2022). Inland from coastal areas, Cove *et al.* (2014) found that forest cover had a negative influence on detection probabilities for coatis and their distribution

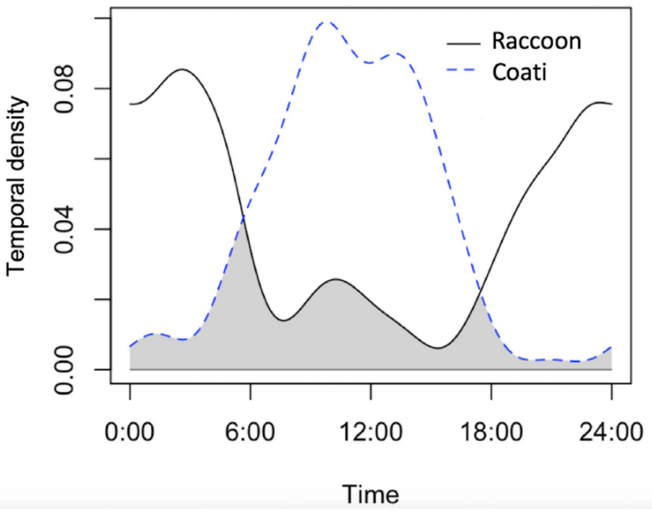

Figure 2. Northern raccoons (*Procyon lotor*) and white-nosed coatis (*Nasua narica*) activity overlap (gray shaded area = 30 % overlap, but not statistically different; Wald (x^2) statistic = 0.942, d. f. = 1, $P = 0.331$) as estimated from camera-trapping records collected during 2011-2017 in Santa Rosa National Park, northwest Costa Rica.

was likely influenced by agricultural food resources (*i.e.*, pineapple), and that their raccoon model contained minimal support for habitat covariates influencing detection but suggested that potential avoidance of agricultural food resources (perhaps an artifact of limited raccoon detections or avoidance of areas of high use by tayras and coatis; Cove *et al.* 2014). In an inland site in Sonora, México, coatis showed selection for oak forest and oak-pine forest while raccoons showed selection for the natural grassland (Sáenz Amador 2015). From a compilation of camera trapping studies throughout Central America in which both species were "captured" (Table 3), our ratio of raccoon captures to coati captures (0.35) was a median value within a wide range (< 0.1-7.39). Importantly, the 2 locations where photo rates of raccoons were higher than for coatis were in coastal areas (elevation = 0-10 m).

Activity patterns of co-occurring raccoons and coatis in other areas are similar to those we found. In Southern Costa Rica, Costa Rica coatis were 91 % diurnal, but raccoons were 96 % nocturnal (Botts *et al.* 2020), and in Sonora, México, coatis were mostly crepuscular while raccoons were active mostly at night (Sáenz Amador 2015).

The few studies of coexisting brown-nosed coatis (*Nasua nasua*) and crab-eating raccoons (*Procyon cancrivorus*) in South America parallels that of their northern counterparts. In one study, there was high diet overlap between species but raccoons, and not coatis, consumed fish and crustaceans (Aguiar *et al.* 2011). In Brazil for both species, there was 45 % overlap in active periods, with raccoons more nocturnal and coatis more diurnal (Bianchi *et*

Table 3. Photos rates (number of events/100 trap nights), and ratios of photo rates, of co-occurring northern raccoons (*Procyon lotor*) and white-nosed coatis (*Nasua narica*) in Central America. *Includes both *Procyon lotor* and *P. cancrivorus.*

Location	Latitude (°N)	Elevation (m)	No. of trap nights	Photo rate raccoon (r)	Photo rate coati (c)	Ratio r/c	Reference
Sierra Zapote Reserve, northwestern Costa Rica	10.2	260-350	2,135	0.05	14.60	< 0.01	Marín Pacheco *et al.* 2022
Lapa Verde Wildlife Refuge, northcentral Costa Rica	10.5	50-100	1,584	0.13	3.79	0.03	Mattey Trigueros *et al.* 2022
Piedras Blancas National Park, southern Costa Rica	8.7	0-350	1,440	0.35	5.76	0.06	Beal *et al.* 2020
Los Tuxtlas Biosphere Reserve, southern Veracruz, México	18.3	100-700	936	0.75	13.57	0.06	Flores-Martinez *et al.* 2022
Ecoparque Panama protected area, central Panamá	9.1	50-100	2,400	0.17	2.13	0.08	Springer *et al.* 2012
Yaxchilan, Chiapas, México	16.9	< 320	3,973	0.50	5.29	0.09	Arroyo-Gerala *et al.* 2024
Sierra Madre del Sur (SMS) ecoregion, Guerrero, México	17.8	350-1500	24,974	0.16	1.66	0.10	Ruiz-Gutiérrez *et al.* 2020, 2023
Montes Azules, Chiapas, México	16.2	~200	3,841	0.78	3.91	0.20	Arroyo-Gerala *et al.* 2024
San Juan–La Selva Biological Corridor, northern Costa Rica	10.5	30-60	6,356	0.33	1.13	0.29	Pardo Vargas *et al.* 2016
Northeastern Sonora, México	30.9	~900-1,500	14,700	4.66	13.70	0.34	Sáenz Amador 2015
Santa Rosa National Park, northwest Costa Rica	10.9	3-350	20,416	0.48	1.37	0.35	This study
Private reserves w/forest and coffee plantations, southwest Guatemala	14.5	1700-1900	630	1.90	4.90	0.39	Escobar-Anleu *et al.* 2023
Marqués de Comillas, Chiapas, México	16.1	140-200	2,824	1.06	2.48	0.43	Arroyo-Gerala *et al.* 2024
Osa-Golfito region, southwest Costa Rica	8.7	0-450	12,276	4.16*	8.06	0.52	Vargas Soto *et al.* 2022
Barra del Colorado Wildlife Refuge, northeastern Costa Rica	10.6	10-40	1,611	0.37	0.68	0.54	Arroyo-Arce *et al.* 2016
Barbilla-Destierro Biological Corridor, central Costa Rica	10.0	300-800	16,904	0.94	1.63	0.58	Salom-Pérez *et al.* 2021
Cinchona, central Costa Rica	10.3	800-1450	1,556	0.39	0.51	0.76	Villegas-Arguedas 2022
Osa-Golfito region, southwest Costa Rica	8.7	25-1,500	753	10.2	10.9	0.94	Yaap *et al.* 2015
La Encrucijada Biosphere Reserve, Chiapas, México	14.7	0-10	5,400	4.35	3.91	1.11	Hernández Hernández *et al.* 2018
Cabuyal and Zapotillal estuaries, northwest Costa Rica	10.7	0-20	1,498	11.82	1.60	7.39	Yaney-Keller *et al.* 2022

al. 2016), and in a third area, activity was reported as diurnal for coatis and nocturnal for crab-eating raccoons (Dutra *et al.* 2023). Finally, pygmy raccoons (*Procyon pygmaeus*) and dwarf coatis (*Nasua* [*narica*] *nelsoni*), both endemic to Cozumel Island, México, were both cathemeral with 78 % overlap in activity (Lara-Godínez *et al.* 2023), both species, however, have very limited distribution on the island, with the raccoons in a few coastal sites and coatis so rare as to preclude habitat designations (McFadden *et al.* 2010).

Differences we observed in the distribution of photos by cover type, camara location, and time of day for the procyonid species were notable and might suggest local allopatry, likely the result of interspecific avoidance. We recognize that there were limitations to our data analyses because of low numbers of photos, and inequal survey sampling across cover types. Previous modeling (Montalvo *et al.* 2023) indicated that photo rates of raccoons were higher at cameras located on trails than off trails, but likely did not vary between seasons. For coatis, photos rates were higher at cameras located off trails *vs* on trails and, like raccoons, likely did not vary between seasons. Sample sizes for our study were too small to assess location- or season-specific differences in raccoon and coati distribution related to cover-types, species-specific food habits and predation, or competitive interactions with other species, but such analyses certainly would be of interest in future, more extensive studies. Other techniques should be used to investigate these factors, but cameras can provide important insights into elusive species' ecology.

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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°

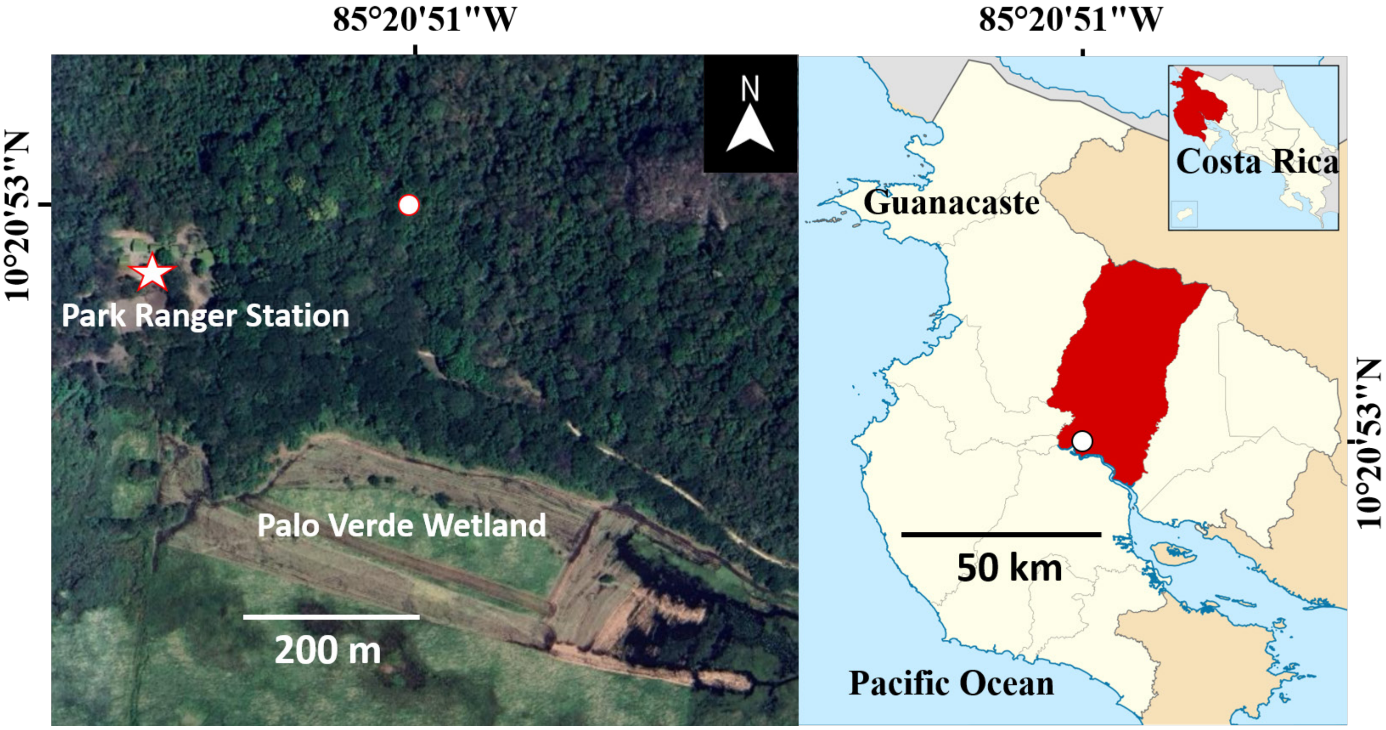

Figure 1. Observation site (white dot) where a female white-nosed coati, *Nasua narica*, was found with 3 kits at Palo Verde National Park, Bagaces County (highlighted in red), Guanacaste Province (outlined in white and shown in red on the map of Costa Rica). Figure prepared by J. M. Mora based on Google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

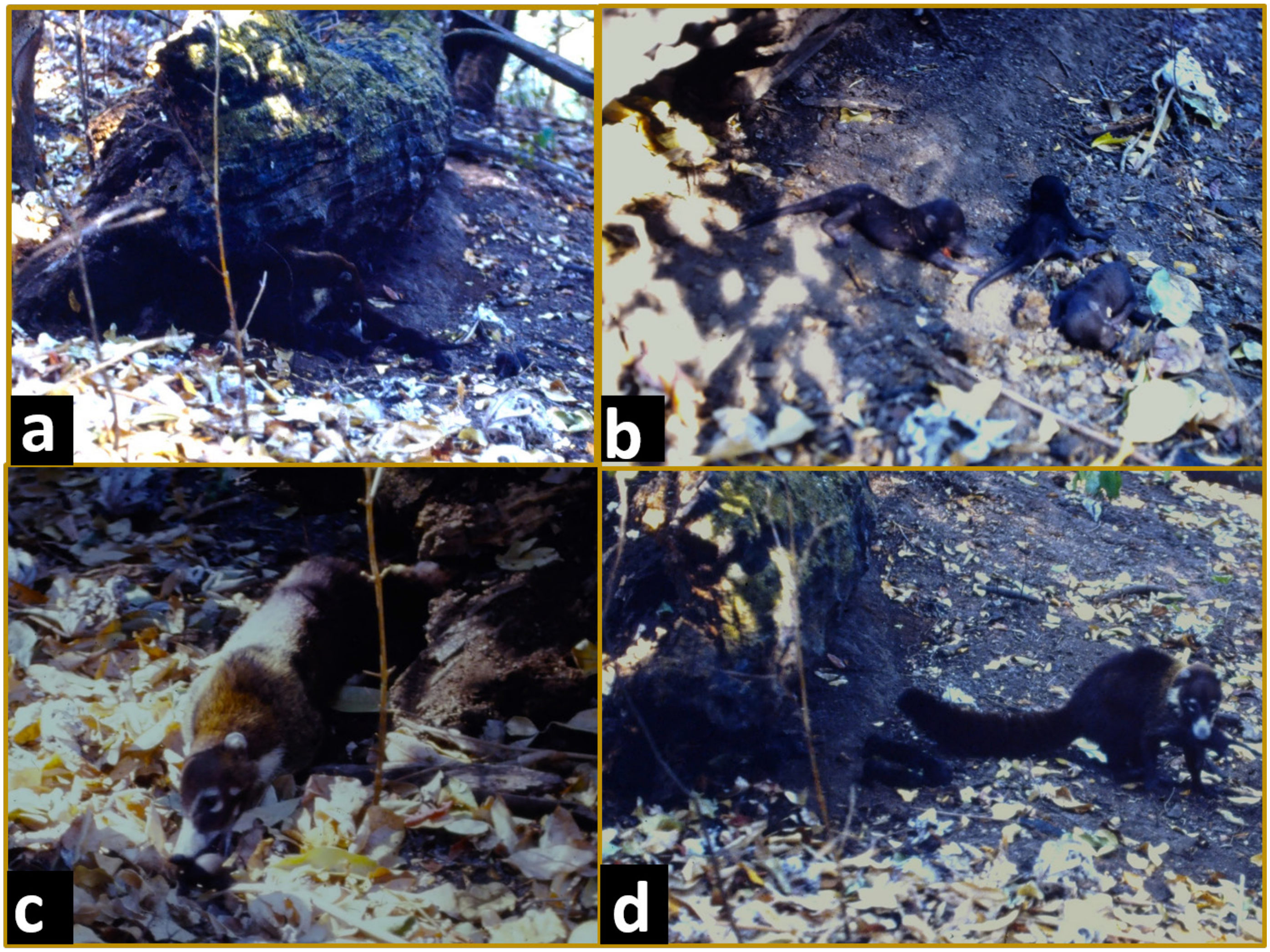

Figure 2. a) Female white-nosed coati, *Nasua narica*, in her nest. b) Kits outside the nest. c) Female picking up a kit with her mouth. d) Female carrying another kit. Palo Verde National Park, Bagaces, Guanacaste, Costa Rica. Photo by J. M. Mora.

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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First record of ocelot *Leopardus pardalis* in a pine-oak forest of the Sierra Madre Occidental, Durango, México

Primer registro de ocelote *Leopardus pardalis* en un bosque de pino-encino de la Sierra Madre Occidental, Durango, México

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The ocelot, *Leopardus pardalis*, is one of the 6 species of felines distributed in México. It is currently listed as Endangered of Extinction according to NOM-059-SEMARNAT-2010. Therefore, this work aimed to report the presence of the ocelot in the ejido Chavarría Nuevo, Durango, México. A random sampling was carried out in a pine-oak forest in the ejido Chavarría Nuevo, Pueblo Nuevo, Durango, using camera traps. Eight cameras were installed, and the sampling effort was calculated as the number of camera traps multiplied by the number of days sampled (1,200 trap-days). Separate photographs recorded several animal species; however, the ocelot was captured only in 4 photographs. Based on the time of the day when the photographs were captured, in addition to the size and body constitution, the photographs were identified as belonging to the same individual; however, the sex could not be determined. In mammal monitoring studies, this is the first record of ocelot in the study region, an area of great importance regarding forest use in México. The presence of this species suggests that the forest is in good health, as in these areas the presence of the feline is mainly associated with its feeding on prey such as rabbits, badgers, and birds.

Key words: Camera traps; feline; new record; pine-oak forest; Sierra Madre Occidental.

El ocelote, *Leopardus pardalis*, es una de las 6 especies de felinos que se distribuyen en México. Actualmente se encuentra en peligro de extinción conforme a la NOM-059-SEMARNAT-2010. Por lo que el objetivo del presente trabajo fue reportar la presencia del ocelote en la región del ejido Chavarría Nuevo, Durango, México. Se realizó un muestreo aleatorio mediante cámaras trampa en el ejido Chavarría Nuevo, Pueblo Nuevo, Durango en bosque de pino-encino. Se colocaron 8 cámaras y se obtuvo el esfuerzo de muestreo con el número de cámaras por el número de días muestreados (1,200 días trampa). Se obtuvieron fotografías independientes con el registro de varias especies de fauna; sin embargo, el ocelote se observó solo en 4 fotografías, conforme las horas en que fueron tomadas las fotografías, además del tamaño y conformación del cuerpo se identificó como un mismo individuo; sin embargo, no fue posible apreciar el sexo. En trabajos de monitoreo de mamíferos, este sería el primer registro de ocelote para la región, un área de gran importancia en el aprovechamiento forestal a nivel nacional. La presencia de esta especie sugiere un buen estado de salud del bosque, ya que en estas áreas la presencia del felino estaría asociada principalmente a su alimentación con presas como conejos, tejones y aves.

Palabras clave: Bosque pino-encino; cámaras trampa; felino; nuevo registro; Sierra Madre Occidental.

The ocelot (*Leopardus pardalis*) is one of 6 species of wild felines that inhabit México (Aranda 2012). It is also a species playing a central role in natural ecosystems as it regulates the population size of the prey on which it feeds (De Oliveira *et al.* 2010). Due to poaching, illegal trafficking, and fragmentation of its habitat, it is currently listed as Endangered by the Official Mexican Standard (NOM-059; SEMARNAT 2010). It is also included in Appendix I of the list of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES 2024) and as Least Concern in the IUCN Red List of Threatened Species (Paviolo *et al.* 2015).

Its current distribution ranges from the southern United States through México, Central America, and Ecuador to northern Argentina (Murray and Gardner 1997). In México, it thrives in Sonora and Chihuahua to the Pacific coast, in Tamaulipas through the Gulf of México to the Isthmus of Tehuantepec, Oaxaca, and in the Yucatán Peninsula (Aranda 2012).

The ocelot inhabits mainly landscapes with dense vegetation cover, such as humid and dry forests, temperate forests, cloud forests, thorny forests, and xeric scrub (Murray and Gardner 1997; Aranda 2005; Iglesias *et al.* 2009; Bárcenas and Medellín 2010; Aranda *et al.* 2012; Ahumada-Carrillo *et al.* 2013). Specifically for the state of Durango, there is a single record of this species in temperate oak forests (Servín *et al.* 2016) in the La Michilía Biosphere Reserve, municipality of Mezquital, in the southeastern part of the state; however, there are no official records of this species in the dominant pine forests. Therefore, the objective of this note is to report the presence of ocelots in the ejido Chavarría Nuevo, Pueblo Nuevo, an area covered by pine forests of importance in forestry located west of the previous record in Durango.

The study was carried out in the ejido Chavarría Nuevo, municipality of Pueblo Nuevo, Durango. The ejido comprises a total area of 8,430.22 ha; the dominant vegetation type is the pine-oak forest, commonly under forest management, so the present study was derived from a work on the relationship of this primary activity with the diversity of mammals in the region. The municipality is in the west of the state, located in the Sierra Madre Occidental, with the northern portion on the summits of this mountain range, representing extensive highland plains ranging between 2,500 and 2,600 m (INEGI 2010). This ejido comprises 3 types of climate: temperate subhumid, semi-cold subhumid, and semi-cold humid, with summer rains and winter precipitation between 5 % and 10.2 %, according to Köppen's Climate Classification modified by García (1964).

Random sampling was carried out, and 8 Wildgame Innovations Terra Extreme Lightsout 18 MP camera traps were installed at a height not above 40 cm from ground level (Chávez *et al.* 2013) from May 2020 to September 2020 (150 days total). This tool was selected because camera traps are an effective non-intrusive method; its continuous monitoring capacity makes it suitable for recording the presence of rare or elusive wild mammals, which are difficult to detect with other methods (Botello *et al.* 2005). The cameras were set to capture *n* number of photographs every 5 sec and remain active for 24 hr. The location of each camera trap was georeferenced with a Garmin etrex® GPS. During sampling, camera traps were checked monthly and then moved to a different location to cover most of the ejido. Each photograph captured recorded the time and date. The total sampling effort (ME) was calculated by multiplying the number of camera traps used by the number of monitoring days (Monroy-Vilchis *et al.* 2011).

With a sampling effort of 1,200 trap-days, we recorded 239 photographs of large and medium-sized mammals living in the region, as well as birds. Of these records, 4 photographs captured the presence of ocelot (*Leopardus pardalis*) in pine-oak and oak-pine forests. This feline was recorded on the following dates: May 1 and 6, 2020; June 2, 2020, and July 2, 2020, in 2 locations with the following geographic coordinates: 23° 39' 44.26 N, 105° 39' 01.71" W and 23° 39' 24.67" N, 105° 39' 21.62" W (Figure 1).

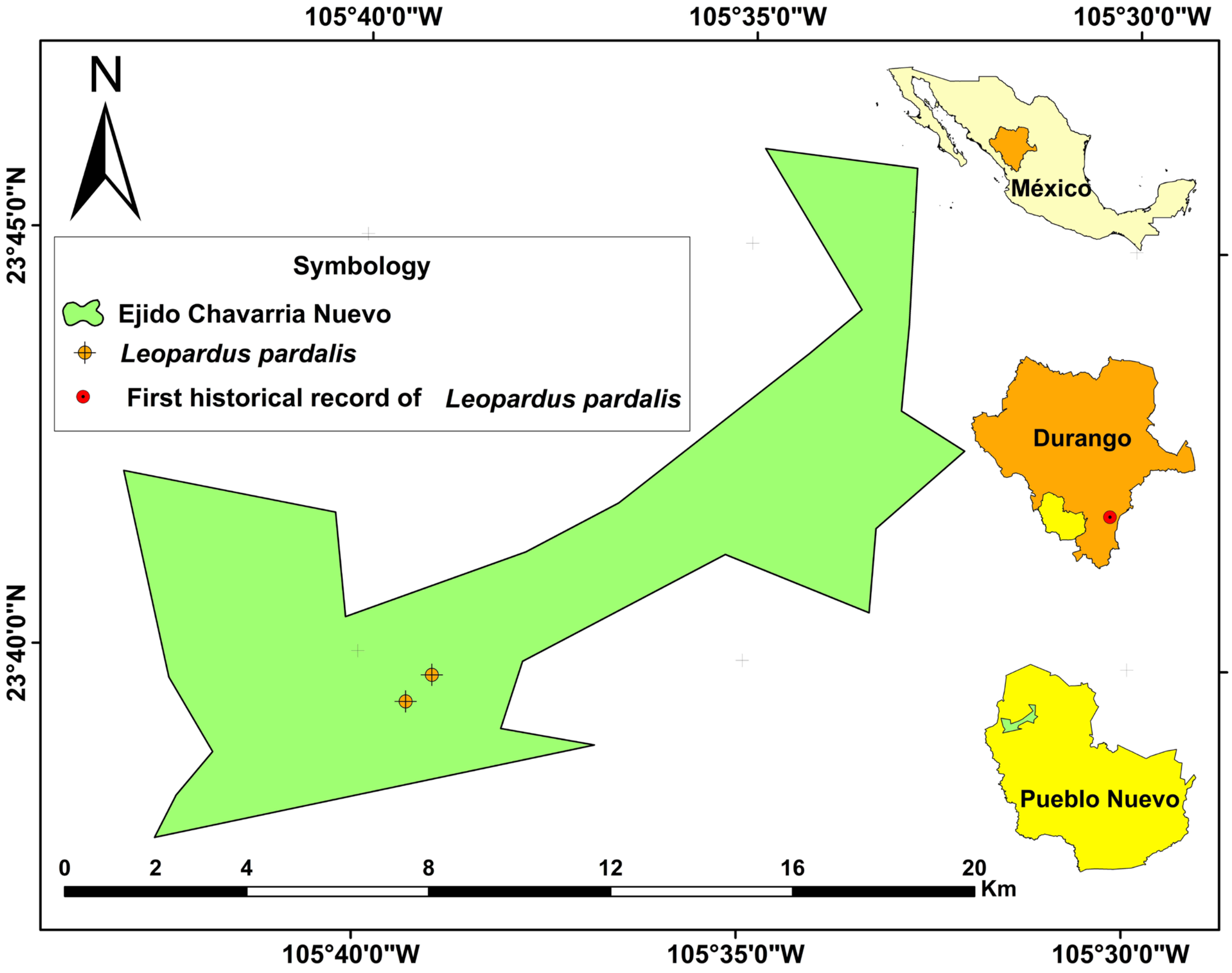

Figure 1. Map of ocelot (*Leopardus pardalis*) photo trapping sites in a pine-oak forest in the ejido Chavarría Nuevo, Durango, México.

The 2 clearest photographs in which the size and pattern of spots on the feline's body can be appreciated suggest that these probably correspond to the same individual (Figure 2). The position of the animal in the remaining photographs did not allow for determining the sex or whether they captured a different individual.

These records are considered the first to document the presence of ocelots in pine-oak forest areas in the ejido Chavarría Nuevo, municipality of Pueblo Nuevo, Durango, located 142 km northwest of the Michilía record. Previously, ocelot was recorded in the area of La Michilía Biosphere Reserve, in an oak forest at 2,750 m in the southeastern part of the state (23° 26' 1.68" N, 104° 16' 40.8" W), between the municipalities of Súchil and El Mezquital (Servín *et al.* 2016). The ejido where this study was carried out has transition areas of steep ravines and dense vegetation, which likely provide favorable conditions for ocelot in terms of shelter and food supply (Sunquist and Sunquist 2002; Jackson *et al.* 2005). Due to the convergence of different environmental and physical conditions in this type of relief, these areas host a high diversity of plant species, including the genera *Pinus* and *Quercus*, and animal species of the orders Didelphimorphia, Cingulata, Lagomorpha, Carnivora, and Artiodactyla, as mentioned by Buendía-Rodríguez *et al.* (2019) and Lira-Torres and Briones-Salas (2012).

Figure 2. First photographic record of ocelot (*Leopardus pardalis*) in the ejido Chavarría Nuevo, Durango, México. Images available on guarimochi494@gmail.com.

The presence of ocelot in this area represents a bioindicator of good health status of the local ecosystem since it is a species that regulates the population size of its prey (Pérez-Irineo and Santos-Moreno 2015). Its presence suggests well-preserved forests that are home to a high diversity of prey, including small and medium-sized mammals, as well as birds (Massara *et al.* 2015). However, this ejido is under timber forest exploitation all year round; that is, there is constant tree cutting that could reduce the habitat of this feline and other species. Therefore, these first records of ocelot (*Leopardus pardalis*) indicate the urgent implementation of measures to conserve it while the forest continues being exploited, applying continuous cover silviculture (Forestry Focus 2024), which helps maintain the habitat of the ocelot and its prey species.

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First morphological and genetic report of the hard tick, *Amblyomma tigrinum* (Acari: Ixodidae) in the Andean cat, *Leopardus jacobita*

Primer registro morfológico y genético de la garrapata dura, *Amblyomma tigrinum* (Acari: Ixodidae) en el gato andino, *Leopardus jacobita*

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The Andean cat (*Leopardus jacobita* Cornalia 1865) is one of the rarest feline species in the world and one of the most threatened in America, where no ixodofauna are known to parasitize these small cats. Here describe the morphological and genetic findings of hard tick specimens in an Andean cat. Four hard tick specimens (2 females and 2 males) were collected from an Andean cat in the locality of Patacamaya, Department of La Paz, Bolivia. DNA was extracted using 1 or 2 of the tick legs, causing minimal damage to the specimens. Morphological and genetic characteristics corresponded to *Amblyomma trigrinum*, with an identity percentage of 99.43 %. This research is the first morphological and genetic report of adult hard ticks of the species *A. tigrinum* parasitizing an Andean cat, extending the distribution of this tick to the Bolivian biogeographic region of high mountains and the Altiplano in the La Paz department, and emphasizes the circulation of this zoonotic parasite in the country.

Key words: Andean region; Feline; Ixodid.

El gato andino (*Leopardus jacobita* Cornalia 1865) es una de las especies felinas más raras del mundo y de las más amenazadas de América, además de no conocerse la ixodofauna que parasita a estos pequeños felinos. Aquí se describen morfológica y genéticamente ejemplares de garrapatas duras en un gato andino. Se recolectaron 4 especímenes de garrapatas duras (2 hembras y 2 machos) de 1 gato andino de la localidad de Patacamaya en el departamento de La Paz, Bolivia. Los ejemplares fueron identificados por sus características morfológicas y genéticas. El ADN se extrajo utilizando 1 o 2 patas de las garrapatas con un daño mínimo a los ejemplares. Las características morfológicas y genéticas correspondieron a *Amblyomma trigrinum*, con un porcentaje de identidad del 99.43 %. Esta investigación constituye el primer reporte morfológico y genético de garrapatas duras en estado adulto de la especie *A. tigrinum* parasitando a un gato andino, ampliando la distribución de esta garrapata a la región biogeográfica boliviana de alta montaña y altiplano en el departamento de La Paz, y enfatiza la circulación de este parásito zoonótico en el país.

Palabras clave: Felino; Ixodido; región andina.

Hard ticks (Acari: Ixodidae), so named due to the hardness of their integument and the presence of a dorsal shield, are obligate blood-sucking ectoparasites with worldwide importance as vectors of diseases (viruses, bacteria, protozoa, and nematodes), which affect wild and domestic animals and humans (Sonenshine and Roe 2014; Guglielmone and Robbins 2018). The Ixodidae family include the primary number of species reported worldwide (n = 752), where *Amblyomma* is the third genus with the highest species richness. One hundred thirty-six taxa have been described within this group (Mastropaolo *et al.* 2014; Guglielmone *et al.* 2020), of which 58 have been reported in South America (Nava *et al.* 2017; Dantas-Torres *et al.* 2019; Martins *et al.* 2019), and in Bolivia, 29 hard ticks are known, of which 22 belong to the genus *Amblyomma* (Mastropaolo *et al.* 2014; Rodríguez *et al.* 2019).

Amblyomma tigrinum (Koch 1844) is a species with a wide range of distribution in South America (Argentina, Bolivia, Brazil, Chile, French Guyana, Paraguay, Perú, Uruguay, and Venezuela), where adult stages frequently parasitize canids, felids (domestic cat, *Panthera onca* and *Puma concolor*), procyonids, bovids, cervids, suids and larval or nymphal stages of canids, felids, cavids, cricetids and murids, as well as many families of birds (Nava *et al.* 2017). It presents a cycle of 3 parasitic stages, with larvae and nymphs developing better in birds and adults in canids; larvae feed for 5 to 6 days, nymphs feed for 6 to 8 days, and females lay viable eggs after feeding on canids (Labruna *et al.* 2002). This life cycle is probably regulated by temperature, without diapause, allowing it to be found in habitats with contrasting climates (Nava *et al.* 2017). Thus, in Bolivia, this species was reported in the Cochabamba, Chuquisaca, and Santa Cruz departments, observing that in adult stages, parasitize domestic dogs (*Canis lupus familiaris*), crab-eating foxes (*Cerdocyon thous* Linnaeus 1766), "borochis" (*Chrysocyon brachyurus* Illiger 1815) and "aguarachays" (*Lycalopex gymnocercus* Fischer 1814), whereas in immature stages parasitize rodents of genus *Galea* (guinea pigs), and probably *G. leucoblephara* (Burmeister 1861) species (Mastropaolo *et al.* 2014).

The Andean cat (*Leopardus jacobita* Cornalia 1865) is one of the rarest feline species in the world and one of the most threatened in America (Andean Cat Alliance 2011). It is classified as "Endangered (EN)" with decreasing populations in its area of distribution, mainly includes the Andes of Argentina, Bolivia, Chile and Perú, and Argentine Patagonia (Reppucci *et al.* 2024), and as "Critically Endangered (CR)" in Bolivia (Villalba *et al.* 2009), where no ixodofauna or other parasite fauna are known to parasitize these small cats. This case report describes the morphological and genetic findings of *A. tigrinum* in an Andean cat from La Paz, Bolivia, constituting the first record of the parasite-host association of an ixodid species in *L. jacobita* in South America.

A male, sub-adult Andean cat (*L. jacobita*) was delivered on March 15, 2016, to the "Vesty Pakos Wildlife Custody Center and Municipal Biopark" from the Patacamaya town in the La Paz department (17° 14' 16.98" S; 67° 54' 51.98" W). The animal was quarantined, and its health status was assessed (Beltrán-Saavedra *et al.* 2020). Four ticks were observed on the upper ear edges, 3 specimens were collected and preserved in 96 % ethanol during a superficial inspection, and 1 specimen was separated for another unpublished study. These 3 specimens were sent to the laboratory of the Bioparque Municipal "Vesty Pakos" in La Paz city, Bolivia, for identification.

Morphological identification was carried out following the dichotomous keys and descriptions based on Nava *et al.* (2017) and making comparisons with specimens deposited in the Bolivian Fauna Collection (CBF) of the Institute of Ecology of the Universidad Mayor de San Andrés. The morphometry was performed using an optical microscope (Olympus, Model CX31RBSFA) and a stereo-microscope (Motic, Model DM143FBGG).

The genetic identification was made from 1 leg of each of the ticks (1 female and 1 male), sent to the Center for Genetic Research (CINGEN) of the Institute for Scientific Technical Research (IITCUP) of the Police University in La Paz city, Bolivia, using the commercial system Wizard® Genomic DNA Purification Kit (Promega), adding 100 mM DTT (Sigma) and 10 mg/ml proteinase K (Sigma). The extracts were quantified using the Qubit 2.0 fluorometer (Invitrogen) according to the manufacturer's specifications. The identification of the specimens was performed by characterizing the cytochrome oxidase I (COI) gene according to the protocol described by Hebert *et al.* (2003) using the commercial GoTaq® Colorless Master Mix kit (Promega), with a final primer concentration of 2 µM at an annealing temperature of 53 °C. The amplified products were subjected to alcoholic purification according to the protocol established at CINGEN, followed by unbalanced PCR with the BigDye® Terminator v.3.1 Cycle Sequencing Kit (Applied Biosystems) according to the manufacturer's recommendations. Next, a second alcoholic purification was performed by adding 10 µl of HI - Di Formamide (Applied Biosystems) to the final product. According to the manufacturer's specifications, this product was sequenced on an ABI3500 Genetic Analyzer (Applied Biosystems). The 2 sequences obtained were analyzed with the program Sequencing Analysis v.6.5. (Applied Biosystems), considering data with an optimal quality value as valid. Once the sequences were verified, they were aligned with the MUSCLE algorithm using the Mega 7.0 program (Kumar *et al.* 2016). These sequences were analyzed in the GenBank database (NIH genetic sequence database; Benson *et al.* 2005) using the MEGABLAST algorithm. The obtained sequences, being identical, were deposited in GenBank under the accession number MW193726. On the other hand, partial and complete sequences of the cytochrome oxidase I (COI) gene were downloaded from this database. The phylogenetic analysis was performed using the sequences analyzed with the maximum likelihood (ML) method (Cavalli-Sforza and Edwards 1967; Felsenstein 1981; Kishino and Hasegawa 2001) and Generalized Reversible Time (GRT; Tavaré 1986) substitution models, considering 1000 bootstraps, using *Amblyomma javanense* (Supino 1897; MK165451.1) as an external group.

The collected and analyzed tick specimens (with morphological and genetic identification) were sent to the Colección Boliviana de Fauna (CBF) for access and deposit according to the cataloging: CBF-Ixo-00036.

The hard ticks analyzed, 1 female and 2 males, were morphologically identified as *Amblyomma tigrinum* (Figures 1 and 2). The female specimen presented overall length 5.75 mm and total width 3.05 mm; the male specimens presented overall length 4 mm and total width 1.95 mm, and an oval body more elongated and with a narrower portion in the males. The scapula appeared rounded with deep cervical grooves in the anterior portion (female = 4.53 mm; male = 2.88-3.18 mm) and less deep in the posterior portion, forming a sigmoid (female = 4.90 mm; male = 3.08-3.38 mm). The marginal groove was complete in males, delimiting the posterior region by scallops with absent carinae.

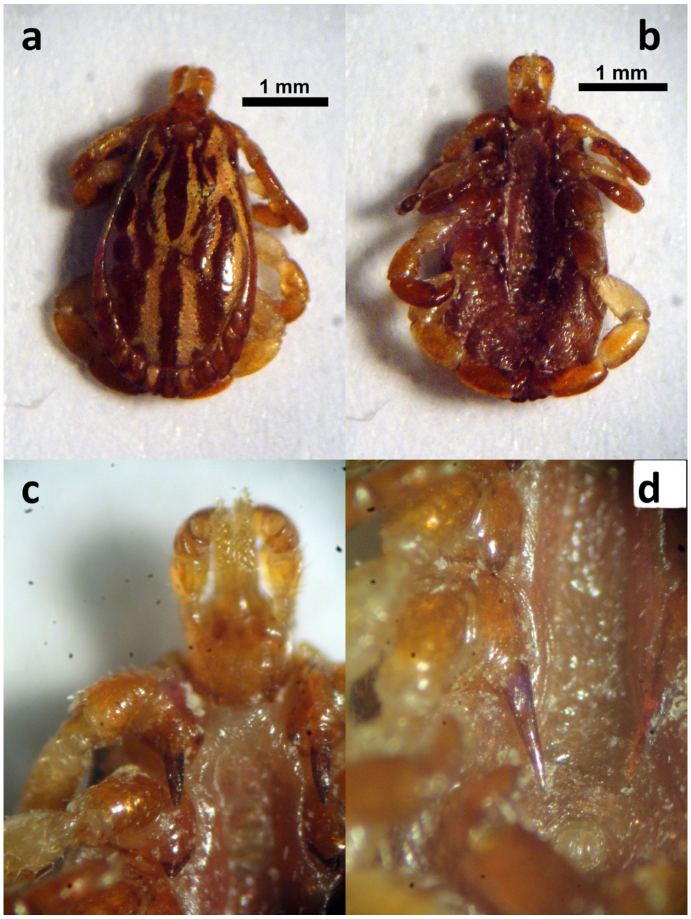

Figure 1. Male *Amblyomma trigrinum* collected from *Leopardus jacobita*: a) dorsal view; b) ventral view; c) ventral view of capitulum and coxa I with an external spine longer than internal spine; d) ventral view of coxa IV with an elongated spine that does not reach the level of the anus.

In females, there was an absence of chitinous tubercles on the posterior margin of the body. The eyes were flattened, and an ornate shield was observed, with pale yellowish spots predominating in the outline and narrow, divergent reddish-brown spots on the posterior cervical part. An extended narrow central area and a glabrous notum were observed in females. The base of the head was dorsally subrectangular (female = 0.60 mm; male = 0.43 mm), without cornua and with oval porous areas in females and with cornua in males. The hypostome was spatulated, and the dental formula 3/3. The genital opening was located at the level of coxa II, in the shape of a "U". In coxa I, 2 differentiated spines were observed; the external spine was long, narrow, and pointed, and the internal spine was small. In coxa II - IV, in females, and II - III, in males, there was a short, blunt, triangular spine. The male also presented a long, narrow, and sharp spine but did not reach the level of the anus on coxa IV, spineless trochanters. A small dorsal spine was presented on the II - IV tibia. Comma-shaped spiral plates were observed.

Sequence analysis with the MEGABLAST algorithm from the GenBank database allowed the identification of tick specimens within the *A. tigrinum* species with an identity of 99.43 % concerning the *A. tigrinum* isolate BRA5A2 (GenBank accession number KU302511.1). The phylogenetic relationships (Figure 3) revealed the grouping of the samples analyzed with individuals of the species *A. tigrinum* considering 31 species of the genus *Amblyomma*, where *A. maculatum* (Koch 1844) and *A. triste* (Koch 1844) were presented as sister groups.

This research constitutes the first report of *A. tigrinum* parasitizing *L. jacobita*, expanding the parasite distribution to the Bolivian biogeographic Andean region in the La Paz department (Mastropaolo *et al.* 2014), although the pathological significance of this tick in Andean cats remains unknown. To our knowledge, no previous studies on macroparasites exist for this host species. Regarding microparasites, Napolitano *et al.* (2019) conducted serological and molecular studies on 17 pathogens in *L. jacobita*, including those transmitted by hard ticks, and obtaining negative results in all cases. On the other hand, Rojas-Barón *et al.* (2022) mention *L. jacobita* as a potential definitive host of *Gurltia paralysans* together with *L. colocolo*. However, there are no records of this. The latter agrees with previous records of this tick in other hosts made in the Argentine Andean-Patagonian Domain (Guglielmone *et al.* 2000). Likewise, it represents the first record in a reference DNA barcode library of ticks identified in Bolivia.

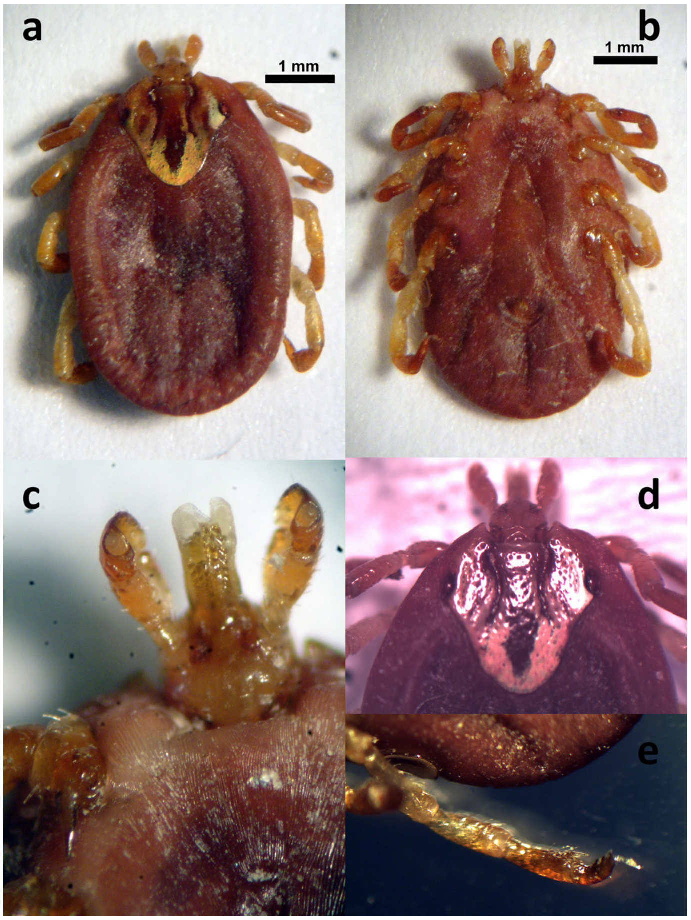

Figure 2. Female *Amblyomma trigrinum* collected from *Leopardus jacobita*: a) dorsal view; b) ventral view; c) ventral view of capitulum and coxa I with an external spine longer than internal spine; d) dorsal view of shield and porous areas at the base of head; e) dorsal spine in right leg IV tibia.

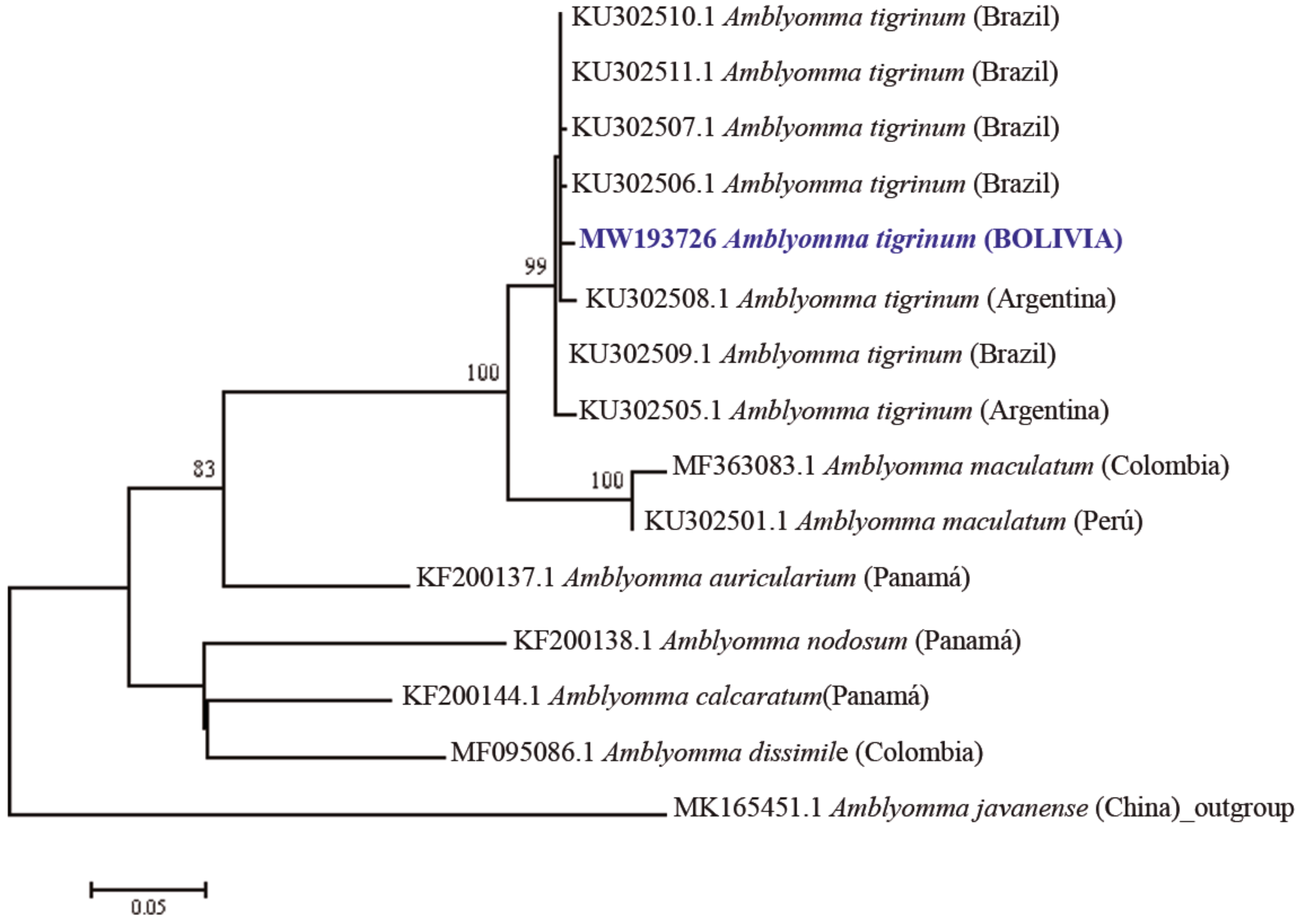

Figure 3. Maximum likelihood tree of COI gene of *Amblyomma* species. In parentheses is the sequence of origin country. The scale bar indicates the number of substitutions per site. Numbers on branches correspond to support values. Specimens reported in this study are shown in bold and blue.

The genetic identification of hard ticks from 1 or 2 legs enables rapid and accurate diagnosis of this parasitism, which is essential for determining potential sanitary risks (Ondrejicka *et al.* 2016). Furthermore, ticks belonging to the *A. maculatum* species complex, including *A. tigrinum* ticks are recognized as vectors of *Rickettsia parkeri*, a zoonotic pathogen (Romer *et al.* 2014). In a previous study conducted in Cochabamba, Bolivia, molecular analyses confirmed the presence of *R. parkeri* in ticks, while serological tests revealed antibodies against this microparasite in dogs (Tomassone *et al.* 2010). In summary, it is crucial to consider the diseases caused by ticks of the *A. maculatum* species complex, which includes *A. tigrinum*, since *A. maculatum*, for example, is the primary causative agent of spotted fever in humans in the New World (Estrada-Peña *et al.* 2005; Nieri-Bastos *et al.* 2018). Thus, it is advisable to expand the morphological and genetic records of this hard tick and its intermediate and definitive hosts in Bolivian territory.

The phylogenetic tree clusters the samples with others from Brazil and Argentina, although with a different haplotype from those previously reported. It also shows that *A. triste* and *A. maculatum* are sister species of *A. tigrinum*.

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Additional dietary records of the arboreal kinkajou (*Potos flavus*)

Registros adicionales de la dieta de la martucha arborícola (*Potos flavus*)

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The kinkajou (*Potos flavus*) is a medium-sized arboreal mammal that primarily feeds on fruits, flowers, nectar, leaves, and occasionally arthropods. While interactions between *P. flavus* and plants are well-documented with the species known to consume fruits and other parts of 119 plant species across 50 families, reports of frugivory involving kinkajous and Araceae plants are scarce. To date, only a single instance of frugivory on *Philodendron crassispathum* has been recorded. During a field trip in March 2022 to Los Tuxtlas, Veracruz, México, we documented the first observed consumption of *Monstera egregia* by kinkajous using a video camera. The kinkajou was observed perched on a leaf stem of the same *M. egregia*, approximately 6 m above the ground. The individual gripped the stem with its feet and prehensile tail while using its hands to manipulate the infructescence. The animal was seen biting into the infructescence and picking individual fruits, which it brought to its mouth. Although Araceae plants have evolved mechanisms to deter herbivory, the consumption of *M. egregia* by kinkajous appears to be a deliberate behavior rather than a random occurrence. Interactions between Araceae species and kinkajous, as well as with other frugivorous mammals, may represent an important ecological relationship deserving of further investigation.

Key words: Diet; frugivory; Los Tuxtlas Biosphere Reserve; plant-animal interaction; Procyonidae.

La martucha (*Potos flavus*) es un mamífero arbóreo de tamaño mediano que se alimenta principalmente de frutos, flores, néctar, hojas y, ocasionalmente, artrópodos. Aunque las interacciones entre *P. flavus* y las plantas están bien documentadas con registros de consumo de frutos y otras partes de 119 especies de plantas pertenecientes a 50 familias, los reportes de frugivoría que involucran martuchas y plantas de la familia Araceae son escasos. Hasta la fecha, solo se ha registrado un caso de frugivoría en *Philodendron crassispathum*. Durante un viaje de campo en marzo de 2022 a Los Tuxtlas, Veracruz, México, documentamos por primera vez el consumo de *Monstera egregia* por martuchas utilizando una cámara de video. Observamos a una martucha posada sobre el pecíolo de una hoja de una planta de *M. egregia*, aproximadamente a 6 m de altura. El individuo se sujetaba al pecíolo con los pies y la cola prensil mientras utilizaba sus manos para manipular la infrutescencia. Se le observó mordiendo la infrutescencia y recogiendo frutos individuales, que luego llevaba a su boca. Aunque las plantas de la familia Araceae han desarrollado mecanismos para disuadir la herbivoría, el consumo de *M. egregia* por martuchas parece ser un comportamiento deliberado más que un evento aleatorio. Las interacciones entre especies de Araceae y martuchas, así como con otros mamíferos frugívoros, podrían representar una relación ecológica importante que merece mayor investigación.

Palabras clave: Dieta; frugivoría; interacción planta-animal; Procyonidae; Reserva de la Biosfera de Los Tuxtlas.

The kinkajou (Procyonidae: *Potos flavus*), also known as "martucha", "micoleón", or "cuchumbí" is a medium-sized arboreal mammal inhabiting most tropical forests of Central and South America, extending from central Brazil and Bolivia, eastern Perú, the Guiana Shield, and Colombia, northward through Central America and into México, in the tropical forests along the slopes of the Pacific and the Gulf of México (Ford and Hoffmann 1988). This species feeds primarily on fruits (90 % of its diet), with a preference for berries and drupes (Julien-Laferrière 1999; Kays 1999), supplemented by flowers (Estrada and Coates-Estrada 1985; Julien-Laferrière 1993; Kays 1999), nectar (Julien-Laferrière 2001), buds (Villa-Ramírez 1944; Kays 1999), and occasionally arthropods (Bisbal 1986; Red ford *et al.* 1989).

While kinkajous primarily consume both mature and immature fruits (Julien-Laferrière 1993; Kays 1999), they typically do not digest the seeds, which pass through their short intestines intact and are dispersed away from the parent tree (Julien-Laferrière 2001; Lambert *et al.* 2014), making them effective seed dispersers in tropical forests (Julien-Laferrière 2001; Galvis *et al.* 2024).

The ecological relationships between kinkajous and plants, particularly regarding their diet, have been extensively documented (*e. g.*, Kays 1999; Julien-Laferrière 2001; Galvis *et al.* 2024). It is known that *P. flavus* feeds on fruits, flowers, or nectar from at least 119 plant species across 50 families (Appendix 1). It also consumes insects and small vertebrates (Appendix 2). However, due to their nocturnal behavior (Ford and Hoffmann 1988) and tendency to avoid passive monitoring (Schipper 2007), the full range of plant species consumed may be underestimated.

The genus *Monstera* Adans. includes nearly 70 recognized hemi-epiphytes plant species distributed across the Neotropics (Govaerts *et al.* 2021; Govaerts 2024) especially diverse in Central America (Croat *et al.* 2024). It is conspicuously recognized for their leaf lamina exhibiting fenestrations (*i.e.,* perforations) in many species (but not restricted to this genus; Madison 1977). Like other members of the Araceae family, *Monstera* species employ a defense mechanism using insoluble calcium oxalate crystals found mainly in bundles in different floral parts, mostly in the spathe and in the inflorescence (Jdeed *et al.* 2024), deterring herbivores (Madison 1977, 1979; Coté and Gibernau 2012). Frugivory on *Monstera* by birds has been documented (Madison 1977; Cedeño-Fonseca et al. 2020), and Geoffroy's Tamarin monkeys (*Saguinus geoffroyi*) have been observed feeding on *Monstera adansonii* in Panamá (Cedeño-Fonseca *et al.* 2020). However, consumption of *Monstera* species by other mammals remains largely undocumented.

In this study, we report the first documented consumption of ripe fruits from *Monstera egregia* Schott by *P. flavus*. The plant is an endemic species for México (Acebey and Krömer 2008), formerly included in *Monstera lechleriana* (Madison 1977), and is characterized by the leaves aggregated at the apex of the stem. The infructescence of this species ranges from 20 to 28 cm in length and 4.5 to 5.5 cm in diameter. The berries are typically 16-20 mm long and 7-9 mm wide. They are usually one-seeded, oblong in shape, and measure 10-13 mm in length, 4-6 mm in width, and 3.4 mm in thickness (Madison 1977). This event occurred during a survey of the bat fauna in the Los Tuxtlas region (March 9, 2022), located in Southeastern México. The site (18° 32′ 3.55″ N, 95° 8′ 18.54″ W; 1,034 m) is located on the San Martín Tuxtla volcano within the Los Tuxtlas Biosphere Reserve, Veracruz,

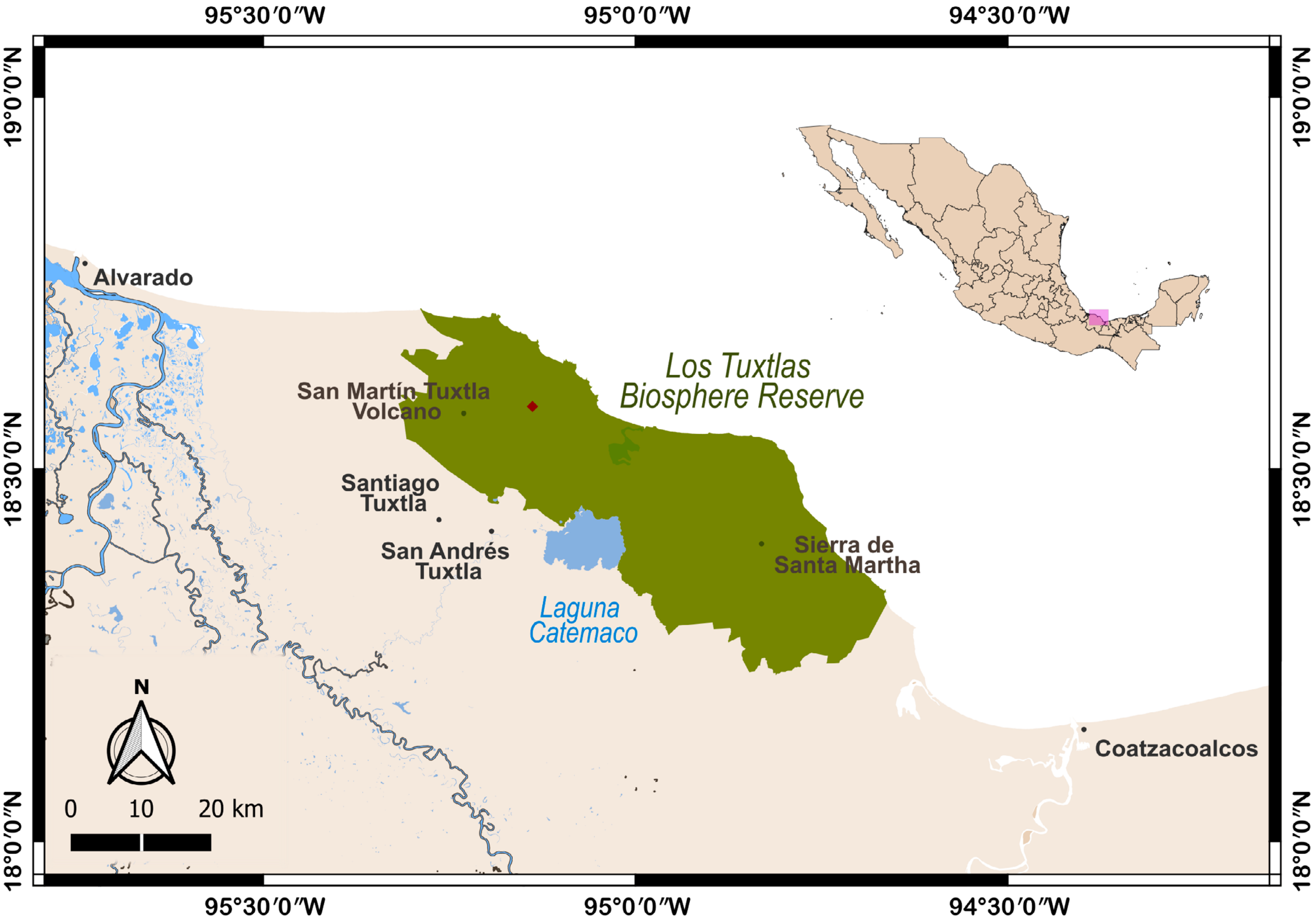

Figure 1. Location (marked with a red diamond) of the visual record documenting the interaction between *Potos flavus* and *Monstera egregia* on the San Martín Tuxtla volcano, located within the Los Tuxtlas Biosphere Reserve in Veracruz, Mexico.

México (Figure 1). The area has a temperate and humid climate, with tropical montane cloud forest vegetation surrounded by a matrix of pastureland (Guevara et al. 2004).

The kinkajou, whose sex and age could not be determined, was observed twice near a mist net during a bat survey. The first sighting occurred over trees located between a paddock's wire fence and a rural road. No feeding activity was noted at that time. Although the kinkajou noticed our presence, it did not attempt to escape. Minutes later, around 21:05 hr, the kinkajou was seen again a few meters away from the initial location, but on the opposite side of the rural road. This time, it was observed feeding on the ripe fruits of an adult *M. egregia* growing on an unidentified tree, approximately 6 m above the ground (Figure 2). Photographs and video were taken with a Nikon Coolpix B500 camera (Nikon, Inc., Japan).

The kinkajou was positioned on a leaf stem of the same *M. egregia*, gripping it with its feet and prehensile tail. It

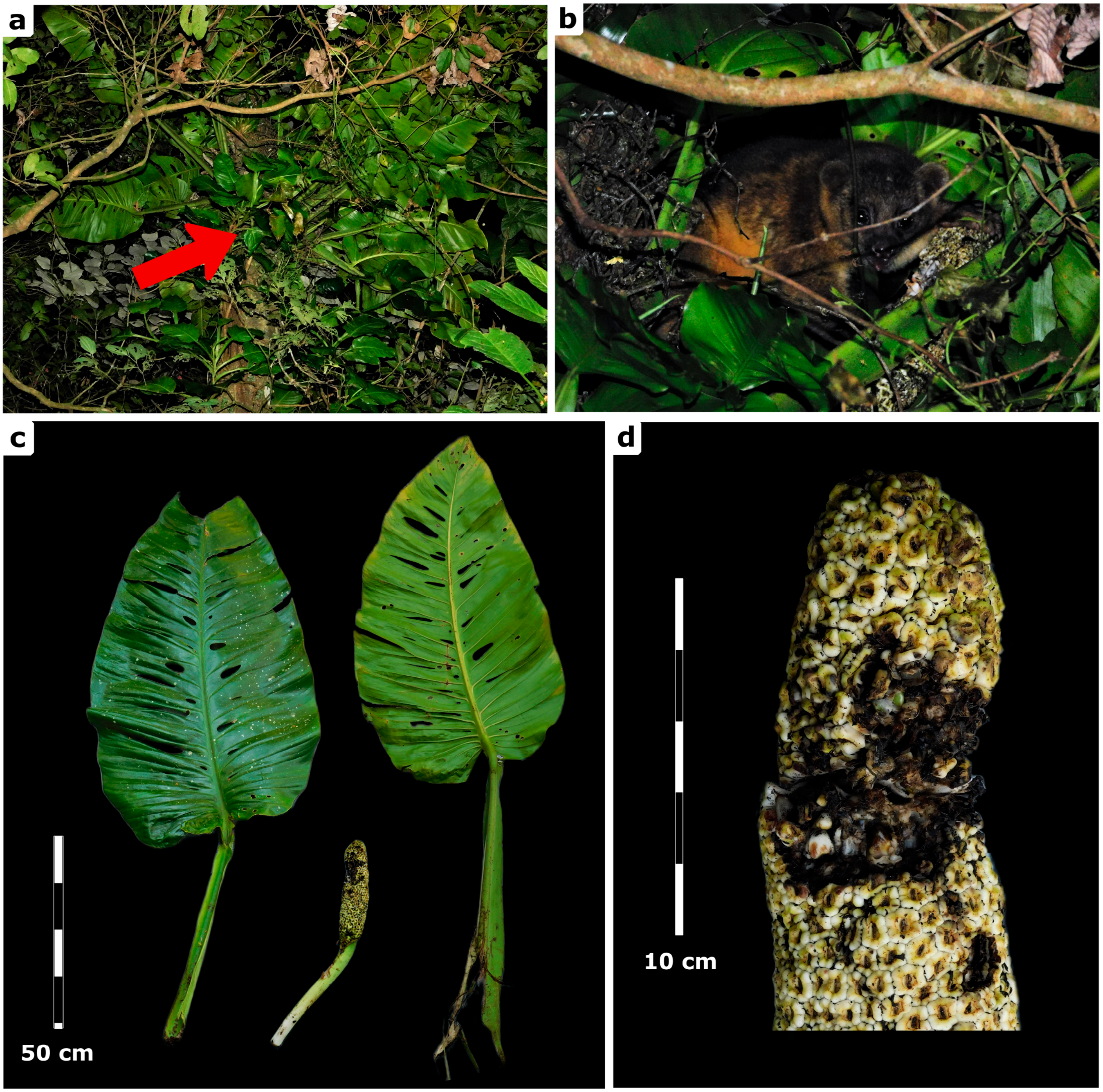

Figure 2. Interaction *Potos flavus*–*Monstera egregia*. (a) Adult individual of *M. egregia* whose fruits were consumed by *P. flavus*. (b) Kinkajou of unknown sex and age consuming the infructescence of *M. egregia*. (c) Leaves and infructescence of *M. egregia* collected for taxonomic identification. (d) Infructescence of *M. egregia* showing signs of bites made by kinkajou.

frequently used its hands to hold the infructescence while biting into it and to pick individual fruits and bring them to its mouth (see Appendix 3). Although the kinkajou occasionally used its hands to access individual berries, most of the fruit consumption was done directly with its mouth, without the use of its hands. The kinkajou spent about 10 min feeding on the fruits of *M. egregia*, consuming roughly 30 % of the infructescence (Figure 2). During this feeding event, few berries were accidentally dropped to the ground, but most were completely consumed by the kinkajou.

After the kinkajou left the site, we explored the area and noticed 2 others ripe infructescences near the one it had consumed, in another individual aroid, although these were located farther from the center of the host tree and show no evidence of frugivory. The next morning, we collected the infructescence and a leaf from the plant to determine its taxonomic identity in the laboratory. Unfortunately, the voucher material was lost before it could be deposited in an academic herbarium. During the collection process, we observed several individuals of *M. egregia* in the surrounding area, some of which had ripe infructescences.

To our knowledge, this is the first documented case of an ecological interaction between *P. flavus* and *M. egregia*, as well as the fourth recorded instance of an Araceae species being consumed by this arboreal and frugivorous mammal. The first report of Araceae fruit consumption by kinkajous was by Bisbal (1986), who noted the consumption of an Araceae infructescence by *P. flavus* in Venezuela, though the specific species was not identified. Later, in Panamá, Kays (1999) reported a kinkajou feeding on the inflorescence of a *Philodendron* species. More recently, Cedeño-Fonseca *et al*. (2020) documented a new interaction between *Philodendron* and *P. flavus*, specifically with *Philodendron crassispathum*, whose infructescence was consumed.

Previous records of *P. flavus* consuming Araceae plants suggest that this behavior is not random and that the infructescences of Araceae plants could be a potential food resource for arboreal frugivorous mammals. This premise is also supported by the record of *Saguinus geoffroyi* consuming the infructescence of *Monstera adansonii*. But how do frugivorous mammals avoid the raphides found in these plants? Cedeño-Fonseca *et al.* (2020) suggest that in ripe fruits of *Monstera* species, the styles, which are rich in raphides, detach in large segments or all at once, exposing the pulp surrounding the seed. At this stage, the fruits can be eaten without the ingestion of raphides. The observations of *P. flavus* and *S. geoffroyi* support this idea, as in both cases, the fruits were consumed when mature. However, when checked for consumed seeds, some raphides were still present in the tegument of the berries.

In addition to the maturity of the infructescence, our observation indicates that, among the 3 infructescences available in the surrounding area, the one consumed was also the most accessible. It is known that for *P. flavus*, the location and ease of access to fruit sources often determine fruit selection (Julien-Laferrière 1999), even more so than the degree of fruit maturity (Julien-Laferrière 1993; Kays 1999). In the case of *Monstera*, we know that only ripe fruits are likely to be consumed by frugivorous mammals (Cedeño-Fonseca *et al.* 2020). However, in our observation, the ease of access to the plant may have played an important factor, as the other 2 infructescences, which appeared to be mature, showed no signs of frugivory, likely due to their inaccessibility to the kinkajou.

Potos flavus is generally considered a high-canopy frugivore, typically consuming fruits located at around 10-30 m above the ground (Janson and Emmons 1990). In Los Tuxtlas area this species is uncommon at lower heights (Estrada and Coates-Estrada 1985). However, our observation took place at a low height (approximately 6 m). This could be explained by the fact that the tree, where the Kinkajou was observed, was part of a secondary forest, with a low density of tall trees but a high density of *M. egregia* plants (ca. 150 reproductive individuals/ha in 2024). This abundance of fruit resources may have led the kinkajou to forage at a lower altitude. A subsequent observation, on May 2024 by most of the same team, recorded a kinkajou feeding on *Ficus insipida* (Moraceae) in this same location, suggesting this is the feeding area of at least one individual.

Apart from the observations on fruit consumption noted above, no specific data on *Monstera* seed dispersal has been documented. In fact, within the Araceae family, seed dispersal and seed predation remain under-researched (see Vieira and Izar 1999; Cockle 2001; Kobayashi *et al.* 2017 and with references to *Arisaema*, *Anthurium*, *Monstera, Rhodospatha*, and *Philodendron* spp.). Most reports on seed dispersal are anecdotal, involving bats, arboreal mammals, and especially birds as the primary dispersers within the family (Madison 1979; Gentry and Dobson 1987; Charles-Dominique and Cockle 2001; Linder and Morawetz 2006; Galindo-González *et al.* 2008; Suzuki and Maeda 2014; Low 2024). Notably, there is even a report of bears dispersing aroid seeds (Tanaka 2004). Mice and wasps have also been recorded as seed predators in Araceae (Gibernau *et al.* 2002; Suzuki and Maeda 2014).

It is widely reported that seeds consumed by kinkajous are not negatively affected by digestion (Charles-Dominique *et al.* 1981; Julien-Laferrière 1993, 1999, 2001; Kays 1999). In some cases, digestion may even enhance germination (Julien-Laferrière 2001). During our observation, the kinkajou ate the entire berries, so it is possible that the seeds of *Monstera* passed through the Kinkajou's digestive tract and were later excreted. Reported transit times for food through a kinkajou's digestive system range from 45 min to 3 hr, with an average of 35 min (Julien-Laferrière 1993). Considering that our observation lasted around 10 min, and the home range estimated for the species in Los Tuxtlas is 8 ha (Estrada and Coates-Estrada 1985), it is possible that the kinkajou traveled a sufficient distance before excreting the seeds of *M. egregia*. Some partially eaten seeds were found in mildly ingested berries, suggesting that not all consumed seeds survive digestion.

In conclusion, while ecological interactions between *P. flavus* and Araceae plants are rarely documented, they appear to be more than incidental events. Though our findings are based on a single observation, the study conditions (*e. g.*, high *Monstera* density and secondary forest characteristics) suggest that this interaction may be relatively common in Los Tuxtlas, Veracruz, México. This highlights the need for further research focused on the frugivory of kinkajous in disturbed habitats, particularly important given that *P. flavus* is considered a threatened species in México (Diario Oficial de la Federación 2019).

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Appendix list

Appendices are available at: https://zenodo.org/records/15090507

Appendix 1. Taxonomic list of plant species with which kinkajou (*Potos flavus*) have ecological interactions in terms of diet in its distribution area.

Appendix 2. Other no-plant items consumed by kinkajou (*Potos flavus*).

Appendix 3. Video of the kinkajou (*Potos flavus*) manipulating and consuming the infructescence of *Monstera egregia,* recorded at Los Tuxtlas Biosphere Reserve, Veracruz, México. https://zenodo.org/records/14597888