

Medium-sized mammals in an urban park of Xalapa, Veracruz, México and local knowledge about wildlife

Mamíferos medianos en un parque urbano de Xalapa, Veracruz, México y conocimiento local sobre la fauna silvestre

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Wildlife inventories are key elements for the study of biological diversity and useful tools to increase public awareness on environmental topics. This study provides insights into the medium mammals that roam the Jardín de las Esculturas, a 2 ha park located in the capital of the state of Veracruz, México, in which no previous work on mammals has been conducted. Data was obtained as part of an environmental education-focused project, through camera-trapping stations and informal interviews with park employees. We report as the first time an inventory of medium-sized mammals for this site. A total of 5 orders were registered, 7 families and 10 species, 8 of which are local fauna. None of these species are under any risk category, although the loss of greenspaces and socio-environmental conflicts could eventually lead to their extirpation and local extinction, along with their ecological roles. Employees noted that the human influence of nearby settlements has had several adverse effects on local wildlife. We highlight the importance of this area as a part of the larger archipelago of forests fragments and greenspaces of Xalapa, while also mentioning the relevance of designing environmental education programs to increase public knowledge of local wildlife, their biology and conservation.

Key words: Camera-trapping; greenspaces; species checklist; urban ecology; urban wildlife.

Los inventarios de vida silvestre son herramientas para la investigación biológica que pueden fomentar la conciencia pública sobre temas ambientales. Este estudio proporciona información sobre los mamíferos medianos que deambulan por el Jardín de las Esculturas, un parque de 2 ha ubicado en la ciudad de Xalapa, Veracruz, México, en el que no se han llevado a cabo trabajos previos sobre mamíferos. Los datos se obtuvieron como parte de un proyecto de educación ambiental, a través de fototrampeo y entrevistas informales con los empleados del parque. Reportamos por primera vez un inventario de mamíferos medianos para este sitio. Se registraron un total de 5 órdenes, 7 familias y 10 especies, 8 de las cuales son fauna nativa. A pesar de no encontrarse en ninguna categoría de riesgo, la pérdida de áreas verdes y los conflictos socioambientales podrían eventualmente llevarlas a la extirpación, junto con sus funciones ecológicas. Los empleados reportaron diversos conflictos entre asentamientos humanos vecinos y las especies silvestres registradas. Nosotros destacamos la importancia de esta zona como parte del archipiélago de fragmentos de bosques de Xalapa, al tiempo que mencionamos la relevancia de diseñar programas de educación ambiental que tengan como fin el fomentar la conexión con las especies locales, la difusión de su biología y conservación.

Palabras clave: Áreas verdes; ecología urbana; fauna urbana; fototrampeo; inventario de especies.

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Besides their ecological significance, wildlife inventories are useful tools to increase public awareness on environmental topics and establish links between the scientific community and the general public ([Aranda 2000](#); [Contreras-Hernández 2008](#)). Providing such information to urban communities is important in regions of accelerated urban development, especially those with high biodiversity ([González-García et al. 2014](#); [MacGregor-Fors et al. 2016](#)). Such is the case of Xalapa de Enríquez, Veracruz, México, a state capital, whose original vegetation was a mosaic composed mainly of cloud

forests, as well as tropical dry forests, oak forests, coniferous forests and riparian vegetation ([Castillo-Campos 1991](#); [Lemoine-Rodríguez et al. 2019](#)).

Xalapa de Enríquez is a city relatively abundant in vegetation ([Von Thaden et al. 2021](#)). However, disturbed patches of native vegetation are common, with 90 % of the municipality's surface being occupied by urban settlements, coffee plantations, cattle ranching, urban and periurban parks as well as isolated fragments of second-growth forests ([Castillo-Campos 1991](#); [Williams-Linera](#)

1992; Williams-Linera *et al.* 2002; Lemoine-Rodríguez *et al.* 2019). The urbanization of this city and its associated reduction of habitat quality has had negative effects on the local fauna, reducing its diversity and increasing their exposure to human-made threats, such as road impacts (MacGregor-Fors *et al.* 2016; Von Thaden *et al.* 2021). In the case of mammals, historically their diversity in Xalapa de Enríquez has decreased by 54 % (from 57 mammal species reported since the end of the XIX century to 26 species) as reported by González-Romero and López-González (1993).

Urban parks are defined by Capitanachi and Amante (1995) as greenspaces surrounded by an urban matrix, with native and exotic vegetation. The role of these spaces as wildlife refuges has been consistently reported in recent years, as well as the negative ecological effects of urban growth (MacGregor-Fors 2010; Pineda-López *et al.* 2010; Bernardo and Melo 2013; MacGregor-Fors *et al.* 2016). One of Xalapa's largest urban greenspaces is the Tejar-Garnica, a 133 ha State Natural Protected Area, which includes on its zonification an urban park called the Parque Natura, and whose vegetation connects with that of adjacent properties and cultural spaces such as the Jardín de las Esculturas (referred to hereafter as JEX).

The dominant vegetation of the Tejar Garnica is represented by second-growth heavily-disturbed cloud forest with an influence of subtropical semi-deciduous forests (MacGregor-Fors *et al.* 2016). In contrast the JEX is a homogeneous greenspace, comprised of a mixture of native reintroduced trees such as sweetgums (*Liquidambar styraciflua*) and sycamores (*Platanus mexicana*), and a vast array of exotic species such as loquats (*Eriobotrya japonica*) and African tulips (*Spathodea campanulata*). Historically, this area had been dominated by agricultural zones, which heavily modified the original vegetation, mainly for the production of shade-grown coffee and secondly for sugar cane plantations and cattle ranching (Castillo-Campos 1991; Williams-Linera 1992; SDR and SEDEMA 2001). This area is considered as part of a broader Natural Protected Area, the Archipiélago de Bosques y Selvas de la Región Capital del Estado de Veracruz. This zone is a biological corridor of connected patches and vegetation islands (SEDEMA *et al.* 2017; Hensler and Merçon 2020).

Due to their background, several stages of ecological succession can be appreciated in both the JEX and the Tejar-Garnica, making them important shelters for urban wildlife (SDR and SEDEMA 2001). Despite this, few studies on medium-sized mammals have been conducted in the area. The most relevant was the management program for the Tejar-Garnica which identified 10 species (SDR and SEDEMA 2001); Mella-Méndez *et al.* (2019a) reports 12 species in 5 urban parks of Xalapa, reporting 7 for the Parque Natura (Mella-Méndez *et al.* 2019b). On a broader study of the suburban areas of Xalapa and Coatepec, González-Romero and López-González (1993) registered 27 species of mammals for the region, their abundance and notes on human-wildlife interactions as well as compiling a list of

57 species of mammal fauna historically reported for the region since the end of the 19th century.

The community of medium-sized mammals is comprised of species with a wide array of behavioral specializations and feeding guilds being best described as species weighting > 100 g, who are able to leave observable indirect evidence (Aranda 2000; García-Burgos *et al.* 2014; Ramírez-Bautista and Lavariega 2021). For México, this classification includes all the species in the orders Artiodactyla, Carnivora, Cingulata, Lagomorpha, Perissodactyla, Pilosa and Primates; and species in the families Agoutidae, Caluromyidae, Cuniculidae, Didelphidae (Order Didelphimorphia), Erethizontidae and Sciuridae (order Rodentia; Aranda 2000; Ramírez-Bautista and Lavariega 2021). Given the role of urban parks and greenspaces as shelters for wildlife, the objective of the present study was to compile for the first time an updated inventory of the medium-sized mammals inhabiting or moving through this space, to contribute to further develop environmental education activities that involve a conservation background.

This study was carried out in the Jardín de las Esculturas, a 2 ha cultural precinct/urban park located in the south-eastern zone of Xalapa, which opened to the public in 1998 and is managed by a state dependency, the Instituto Veracruzano de la Cultura (IVEC). It adjoins a high-traffic road on its northwest side (Rafael Murillo Vidal avenue), a small urban settlement on its northeast (Campo Nuevo), and it has connectivity on its southeast and west side with the Tejar-Garnica natural protected area (Figure 1).

This research started on June 2020 as part of a multidisciplinary environmental-education oriented project titled "Flora y Fauna del Jardín", intending to share information about the biodiversity of the JEX and the city of Xalapa de Enríquez, Veracruz with a broader audience through art and science. While conducting a botanical survey, we noticed indirect evidence of mammals, such as feces and tracks. At the same time, testimonies of employees confirmed the presence of at least 4 different mammal species.

From June 2020 to March 2021, we installed 4 camera-trapping stations in patches of second-growth cloud forest, 2 baited with a mixture of sardines and chicken viscera (Orjuela and Jiménez 2004). Two camera traps (Bushnell Trophy Cam) were interchanged in these stations and set to trees at 30-40 cm above ground level, which were separated by 500 m on average on sites identified as possible corridors for mammals. Cameras were programmed to run for 24 hr on hybrid mode, with a delay of 4 sec between photographs and video. Additionally, we conducted 5 unstructured informal talks with 5 employees of the JEX (adults from 28 to 60 years old) to gather additional information on their experiences with local fauna and we presented the results to them to inquire about their knowledge of the listed species.

To identify the photographed species and catalogue their local status, we consulted the guides of Aranda (2000)

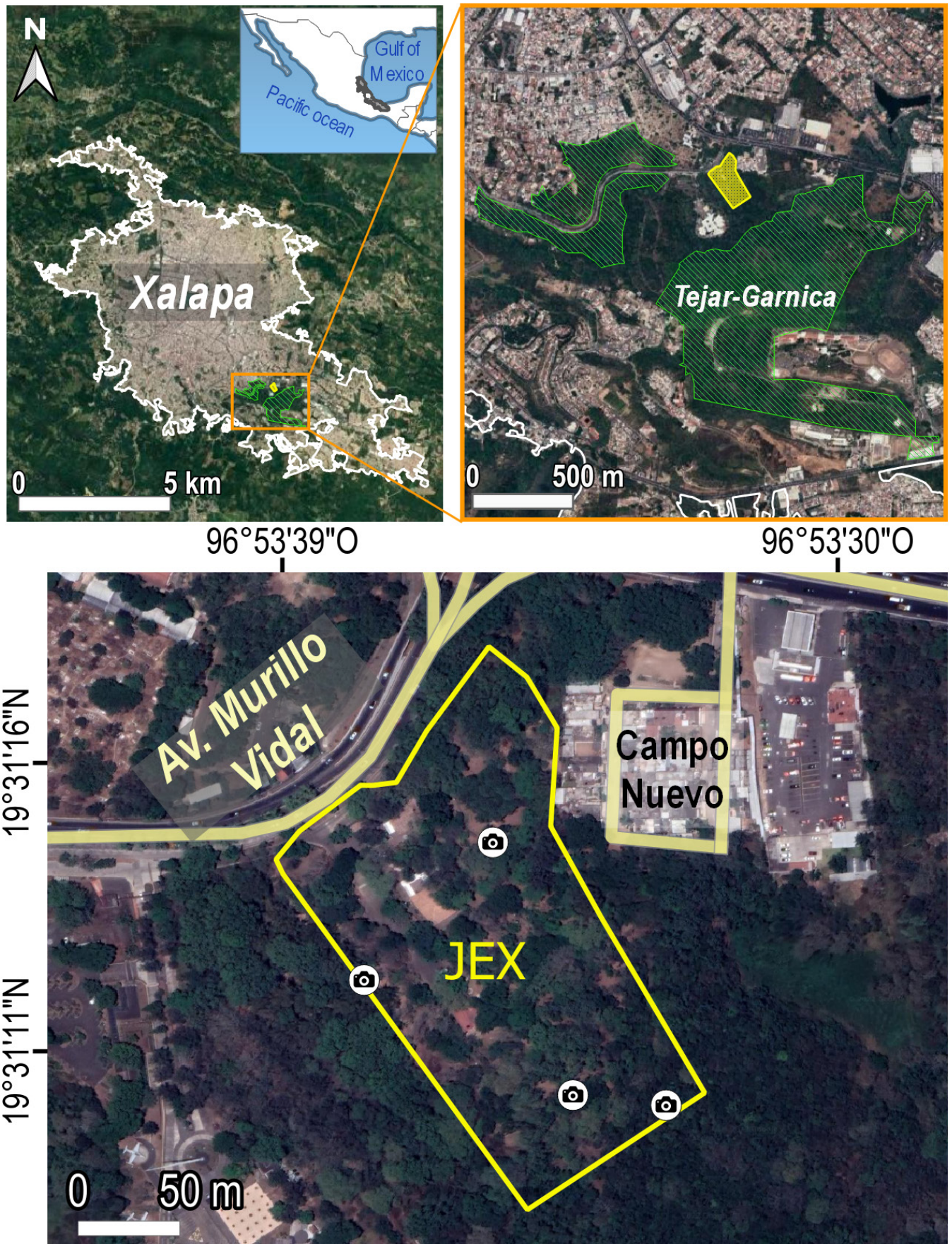


Figure 1. Geographical location of the Jardín de las Esculturas (JEX) in the metropolitan area of the city of Xalapa de Enríquez, in central Veracruz, México. Circles indicate the position of camera-trap stations.

and Reid (2006). Taxonomic nomenclature for the species list follows the proposal of Ramírez-Pulido *et al.* (2014). About their conservation status, we consulted the Mexican Official Norm NOM-059-ECOL-2010 (SEMARNAT 2010) and the red list of the International Union for the Conservation of Nature (IUCN 2019).

During the survey, we recorded 10 medium-sized mammal species, corresponding to 5 orders and 7 families (Table 1; Figure 2). None of the identified species are under any category of protection under Mexican Law nor globally. Two records are of domestic mammals, *Felis catus* and *Canis familiaris*, which roam the JEX at noon and nighttime (at least 3 different dogs were identified in the photographs). Little human activity was registered, mostly accounting to photographs of night guards, due to the space being closed to the public due to the COVID-19 pandemic.

Employees of the JEX recognized 5 out of the 8 native species reported in this study as part of the local fauna: *Dasyurus novemcinctus*, *Didelphis* spp., *Sciurus aureogaster*, *Sylvilagus floridanus* and *Urocyon cinereoargenteus*. The other native species photographed (*Bassariscus astutus*, *Philander opossum* and *Procyon lotor*) surprised them, believing that such species were not distributed in this place. During the 5 informal interviews (2 females ages 32 and 67, and 3

males ages 28-55 were surveyed), personal interests, background knowledge of local wildlife and each informant's working schedule were relevant to the information provided. On the topic of human-wildlife interaction, 2-night guards mentioned that opossums (*Didelphis* spp.) are often seen during their work shifts, foraging from trees of guava (*Psidium guajava*), avocado (*Persea schiedeana*) and loquat (*Eriobotrya japonica*) when fruits are available. Armadillos (*D. novemcinctus*) and grey foxes (*U. cinereoargenteus*) are also frequent but harder to spot; cottontail rabbits (*Sylvilagus floridanus*), opossums (*Didelphis* spp.) and squirrels (*Sciurus aureogaster*) were the animals reportedly seen by all 5 of the employees during daytime and early morning after night shifts. The 8 native species registered (including those which caused surprise), were not perceived as negative by those interviewed. It was mentioned that individuals of *D. novemcinctus* were previously captured for consumption by a former employee. Activities such as logging, cattle ranching and hunting for armadillos and rabbits used to be common in the adjacent areas of the Tejar-Garnica during the past century. It was also mentioned that a pair of grey foxes (*U. cinereoargenteus*) were commonly seen in the JEX during the early 2000's, but they were poisoned by the inhabitants of the adjacent human settlement, as collateral damage on an attempt to poison feral dogs and cats.

Table 1. Species list of medium-sized mammals recorded with camera traps in 4 sites of the Jardín de las Esculturas de Xalapa, Veracruz, México. Conservation status according to the IUCN Red List (2019). IUCN categories: (LC) Least Concern.

Species list	Activity patterns	Ecological roles	Records	Conservation status IUCN	Local status
Carnivora					
Canidae					
<i>Canis familiaris</i>	Crepuscular		4		Exotic
Felidae					
<i>Felis catus</i>			2		Exotic
Procyonidae					
<i>Bassariscus astutus</i>		Seed dispersal	11	LC	Native
<i>Procyon lotor</i>		Seed dispersal	1	LC	Native
<i>Urocyon cinereoargenteus</i>		Predation; Seed dispersal	4	LC	Native
Cingulata					
Dasyopodidae					
<i>Dasyurus novemcinctus</i>	Nocturnal	Seed dispersal	1	LC	Native
Didelphimorphia					
Didelphidae					
<i>Didelphis</i> spp.	Nocturnal	Seed dispersal	75	LC	Native
<i>Philander opossum</i>	Nocturnal	Seed dispersal	13	LC	Native
Lagomorpha					
Leporidae					
<i>Sylvilagus floridanus</i>		Prey	9	LC	Native
Rodentia					
Sciuridae					
<i>Sciurus aureogaster</i>		Seed dispersal	7	LC	Native

The records of ringtails (*B. astutus*), gray four-eyed opossums (*P. opossum*) and raccoons (*P. lotor*; Figure 2a, 2d, 2e) caused surprise during the interviews, with both ringtails and four-eyed opossums being unknown species to the 5 interviewed employees. The presence of free-ranging dogs had remained mostly unnoticed during the day (Figure 2i), while the presence of cats was reported as common (Figure 2j). In the case of cats, they probably come from an adjacent urban settlement, while dogs most likely live in conditions of abandonment in nearby greenspaces. Both cats and dogs are invasive carnivorous mammals which represent a threat to local fauna of urban and peri-urban greenspaces, affecting the richness, activity and abundance of medium-sized mammals as reported by [Mella-Méndez et al. \(2019b\)](#) in 5 urban parks and greenspaces of Xalapa de Enríquez. Such threats can be pointed out by the action of domestic species as predators, competitors and carriers of parasites and diseases ([Creel and Christianson 2008](#); [Mella-Méndez et al. 2019a, 2019b](#)).

No previous work on mammals had been conducted at the JEX. Nevertheless, for the adjacent natural protected area, the Tejar-Garnica, 7 out of these 8 native species had been reported ([SDR and SEDEMA 2001](#)), with the exception of the gray fox (*Urocyon cinereoargenteus*) while for the Parque Natura, the results of this inventory are consistent with the findings reported by [Mella-Méndez et al. \(2019b\)](#). All of the recorded species were registered by [González-Romero and López-González \(1993\)](#) as part of the mastofauna of the Xalapa-Coatepec region.

Some of the native species registered in this study (such as opossums, raccoons, and grey foxes) are classified by [McKinney \(2002\)](#) as urban adapters. This group includes some medium-sized omnivores and carnivores, who take advantage of human-subsidized food and other resources in suburban spaces, forest fragments and surrounding greenspaces. Concerning their functional significance, these species play ecological roles such as seed dispersal in second degree forests and acting as prey and predators (Table 1; [Chapman et al. 1980](#); [Fritzell and Haroldson 1982](#); [Castro-Arellano et al. 2000](#); [Cortés-Marcial et al. 2014](#); [Medrano Nájera et al. 2014](#); [Villalobos Escalante et al. 2014](#); [Koprowski et al. 2016](#)).

The JEX is a space more widely known for its botanical diversity and cultural appeal, while fauna (in particular mammals) has largely been sidelined, due in part to visitor's difficulties to observe them. The use of camera traps allowed us to record evasive species of mainly nocturnal behavior. Due to the relatively small size of this park and its abundant open spaces, it might be inferred that most of these species do not inhabit directly in the area, but in neighboring grounds, as it occurs in coffee plantations, depending on each species requirements and home ranges ([Gallina et al. 1996](#)).

This research shows that even small greenspaces surrounded by urban areas can host or act as corridors for local wildlife. However, further studies are needed to gather

additional insight into movement dynamics and behavioral patterns of native mammals inside the park and adjacent areas, as well as the human influence on their abundance and biomass. Depending on their roles and interactions, medium and large-sized mammals have the potential to be monitored as indicators of ecosystem health and connectivity ([Dirzo et al. 2009](#)). The JEX is a recreational space, whose public activities are conducted mostly during the day (on a schedule of Tuesday to Sunday from 10 to 18:00 hr); given the mostly nocturnal and crepuscular activity patterns of the species registered, a significant change on their behavior would not be expected as a result of the post-COVID-19 reopening of the precinct ([Reilly et al. 2017](#); [Mella-Méndez et al. 2019a, 2019b](#)).

While none of the species registered are listed under any category of risk at a national or international level, the local survival of their populations is not guaranteed. Amongst the conservation challenges they face are the proximity to a high traffic road (which divides 2 large sectors of the Tejar-Garnica), the presence of free-ranging exotic species, the proximity to urban settlements and urban growth, which could eventually limit the terrestrial connection between these areas.

Informal interviews provided some insights into the relationship between the neighboring human community and local wildlife, which has mostly been neutral in recent years. Negative situations, such as logging, cattle ranching and poaching reportedly used to occur in the adjacent area of the Tejar-Garnica, with the JEX being undisturbed possibly due to its relatively small size and the presence of employees at all times. Regarding the consumption of mammals, only *S. floridanus* and *D. novemcinctus* were mentioned as prey, while previous reports for the region also mention *P. lotor* and *S. aureogaster* ([González-Romero and López-González 1993](#)), which were also recorded on the present study.

Previous studies have mentioned that poaching, cattle ranching, species extraction and logging are still common in the area and that such activities can accelerate local extinctions ([SDR and SEDEMA 2001](#); [Hensler and Merçon 2020](#)). For these reasons, it is crucial to enforce and improve municipal and state-level management frameworks that involve different social actors to promote a healthy coexistence between human communities and wildlife ([Collins et al. 2021](#)). In Xalapa de Enríquez and the central region of Veracruz, advances have been made in participatory management schemes, such as the conservation actions of the Network of Custodians of the Natural Protected Area Archipiélago de Bosques y Selvas de Xalapa ([Ayora Vázquez 2020](#); [Hensler and Merçon 2020](#)).

Finally, it is essential to improve conservation awareness amongst the general public, active programs of environmental education can be helpful not only to transmit knowledge and inform about socio environmental problems, but also to enhance public perceptions towards wildlife and the environment ([Aranda 2000](#)). As part of the mul-

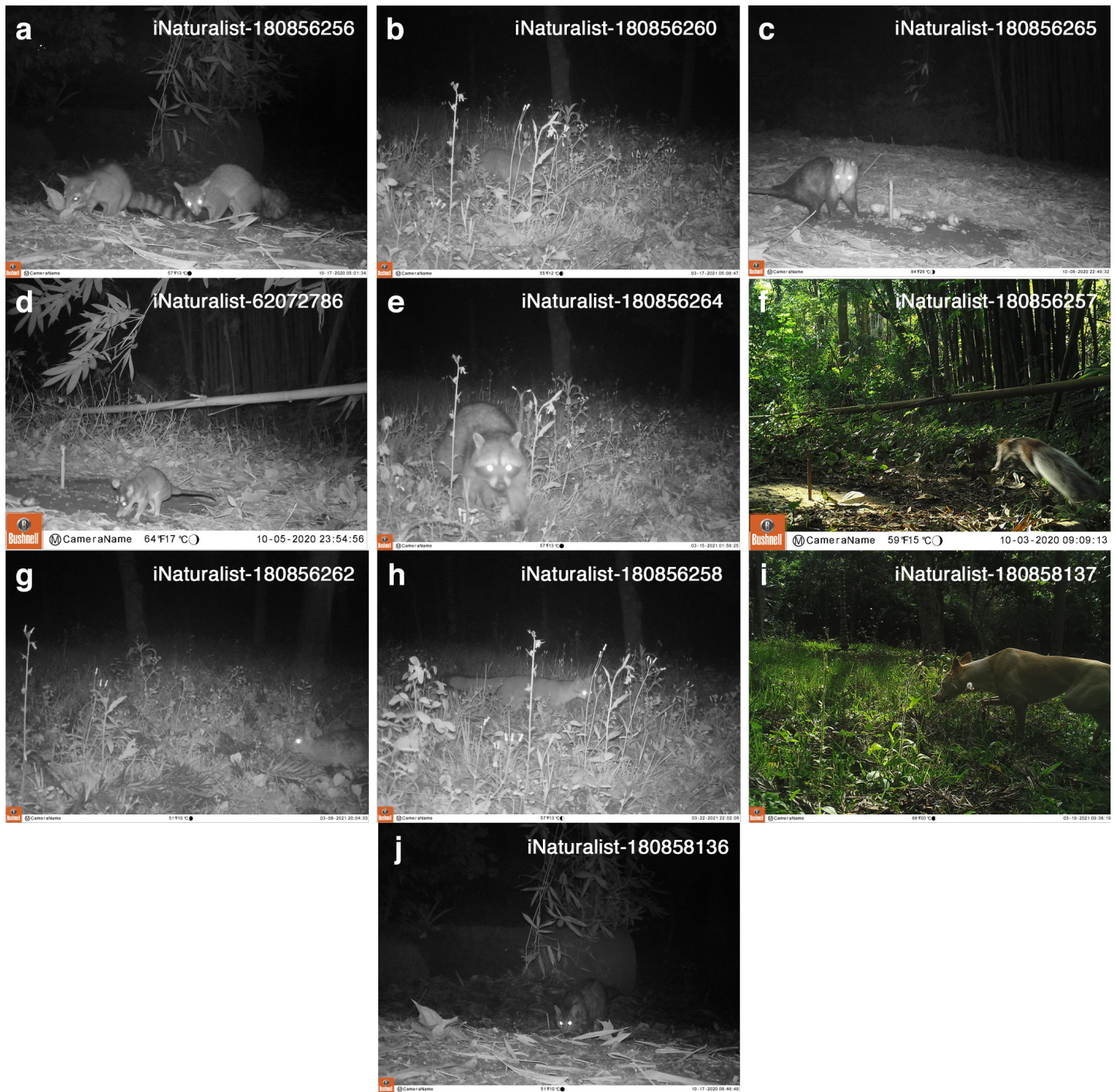


Figure 2. Evidence of medium-sized mammals of the Jardín de las Esculturas de Xalapa, Veracruz, México. Exotic species are i) and j). a) *Bassariscus astutus*, b) *Dasyurus novemcinctus*, c) *Didelphis* spp., d) *Philander opossum*, e) *Procyon lotor*, f) *Sciurus aureogaster*, g) *Sylvilagus floridanus*, h) *Urocyon cinereoargenteus*, i) *Canis familiaris*, j) *Felis catus*.

tidisciplinary collaboration with the JEX, and regarding the wild mammal species, 1 children-oriented workshop was conducted and 2 scientific communication materials were produced by the IVEC: a printed guide to the mammals of the cultural precinct, illustrated by Mexican artists (http://www.ivec.gob.mx/jex/recursos/GUIA_DE_MAMIFEROS.pdf) and a short documentary film featuring the audiovisual materials generated through camera trapping (<https://www.youtube.com/watch?v=M4nuyG2PhfU>). Addition-

ally, a citizen science project is being promoted on the iNaturalist platform (<https://www.naturalista.mx/projects/biodiversidad-del-jardin-de-las-esculturas>) and for its 23rd anniversary, the JEX presented Caco, Miztli and Jex, a trio of character mascots inspired by the *B. astutus*, to accompany child-oriented activities and workshops, and as a flagship species to promote the protection of the precinct's greenspace and its wild inhabitants. We hope this study motivates local authorities and the civil society to get involved in active conservation actions.

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