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First record of collared peccary (*Pecari tajacu*) in the southern part of the Mexican Altiplano

Primer registro de pecarí de collar (*Pecari tajacu*) en el sur del Altiplano Mexicano

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The collared peccary (*Pecari tajacu*) is found from northern Argentina to the southern United States. In México it is widely distributed in different habitats, mainly in tropical areas. In the southern portion of the Mexican Altiplano its historic distribution is unclear, and it has been considered extirpated due to the overexploitation of its populations and the development of agriculture. We report the first record of collared peccary for the Llanos de Ojuelos, obtained with a trail camera placed in xeroriparian habitat. This finding confirms the reports of inhabitants about the presence of peccary in the region, approximately 20 km north of the record reported here. There are two recent records of the species in the municipalities of Pinos, Zacatecas and Corral de Palmas, San Luis Potosí, about 60 km from ours, and based on that, the three records and verbal information from peasants appear to refer to different herds. The site of the record reported here is a wash with dense cover by trees and shrubs, surrounded by grassland and xeric scrubland with abundant nopales that provide the peccaries with food and water. The presence of the peccary and other mammals, like puma and deer, in Los Llanos de Ojuelos can be used to implement awareness campaigns among the inhabitants to promote the conservation of the natural resources of the region.

Key words: Conservation; Llanos de Ojuelos; puma; xerophilous scrub; xeroriparian habitat.

El pecarí de collar (*Pecari tajacu*) se encuentra desde el norte de Argentina hasta el sur de Estados Unidos. En México se distribuye ampliamente en diferentes hábitats, principalmente en zonas tropicales. En la porción sur del Altiplano Mexicano su distribución histórica es poco clara y se le ha llegado a considerar extirpado por la sobreexplotación de sus poblaciones y el desarrollo de agricultura. Reportamos el primer registro de pecarí de collar para los Llanos de Ojuelos, obtenido mediante una cámara trampa colocada en hábitat xeroribereño. Este hallazgo confirma los informes de campesinos sobre la presencia de pecarí en la región, unos 20 km al norte del registro aquí reportado. Dos registros recientes de la especie en los municipios de Pinos, Zacatecas y Corral de Palmas, San Luis Potosí, distan aproximadamente 60 km del nuestro, por lo que serían de manadas diferentes. El sitio de donde proviene el registro aquí presentado es el cauce de un arroyo con cobertura densa de árboles y arbustos, rodeado de pastizal y matorral xerófilo con abundantes nopales que proveen alimento y agua a los pecaríes. La presencia del pecarí y otros mamíferos grandes, como el puma y el venado, en Los Llanos de Ojuelos puede aprovecharse para realizar campañas de sensibilización entre los habitantes para conservar los recursos naturales de la región.

Palabras clave: Conservación; hábitat xeroribereño; Llanos de Ojuelos; matorral xerófilo; puma.

The collared peccary, *Pecari tajacu*, is found from northern Argentina to the southern United States (Sowls 2013). In México, it is widely distributed, and has its most numerous populations in the tropical areas of the Gulf and Pacific slopes (Hall 1981). The tropical deciduous forest is one of the best habitats for the species, but it is found also in rain forests, pine-oak forests, and temperate forests in southern México and in the Highlands (Leopold 1959). In arid and semiarid ecosystems, it has been reported in xerophytic thorn forest, grassland, and xerophytic scrub vegetation (March and Mandujano 2005; Sowls 2013) where plants of the genus *Opuntia* are abundant (Schmidly 2004), and in riparian habitats (Albert *et al.* 2004).

The presence of the collared peccary in the southern part of the Mexican Altiplano, specifically in the Llanos de Ojuelos region, has historically been unclear and discordant among authors. It has been said that the species is distributed throughout the state of San Luis Potosí and northern Zacatecas, but not in northeastern Jalisco and northern Aguascalientes and Zacatecas (Hall 1981; March and Mandujano 2005; Reyna-Hurtado *et al.* 2019). In contrast, Leopold (1959) included the region omitted by the above-cited authors in the distribution of the species but excluded most of western San Luis Potosí. On the other hand, the International Union for the Conservation of Nature excludes the entire Mexican Altiplano from the

distribution of the species (Góngora *et al.* 2011). The potential distribution of the collared peccary in México, modeled through a GARP algorithm, includes almost the entire Mexican Altiplano (Ceballos *et al.* 2006). Although this must be considered carefully because this map includes also as potential habitat large areas of the Baja California peninsula, where it is firmly established that the species has never occurred naturally. Recent studies (Riojas-López and Mellink 2019; Riojas-López *et al.* 2019) stressed that in the region of Los Llanos de Ojuelos in the Mexican Altiplano, there is little information on most of the biological groups. This gap in the knowledge of biodiversity in general, and of the mammalian fauna in particular, contributes to the ambiguity about the distribution of the collared peccary, and obscures knowledge of the historical presence of the species in the region covered here.

In México, the collared peccary was overhunted in the mid-20th Century, leading to its extirpation from the center of the country (Leopold 1959). In the San Luis Potosí part of the Mexican Altiplano, collared peccary meat was not of great esteem and was consumed less than in the tropical areas of the same state, but they were hunted because of the fine quality and high price of their hides (Dalquest 1953). In the 1980s, hides from collared peccary were still considered of superior quality for the making of gloves (R. García-Maldonado, pers. comm.). In some areas of the southern Mexican Altiplano, including San Bartolo de Berrio, Guanajuato and Pinos, Zacatecas, the species was extirpated, or almost extirpated, during the 20th Century as a result of its hunting, in the first place, and by hunting combined with the expansion of agriculture, in the second (Matson and Baker 1986; Mellink *et al.* 1986).

Since 2016, as part of different research projects, the authors performed a monitoring program to document the presence of mammalian carnivores in xeroriparian systems in the Llanos de Ojuelos region. One of the techniques used to this end was the deployment of trail cameras. With these, we detected a herd of collared peccaries.

The record that we present here confirms the current presence of collared peccary in the Llanos de Ojuelos, for which there were no previous reports, and where there was disagreement between the distribution maps for the species in the country. It has been said that its presence in the southern Mexican Altiplano would be rather rare (Dalquest 1953; Leopold 1959; Hall 1981; Matson and Baker 1986), and the species was even considered as extirpated since the first half of the last century (Leopold 1959; Matson and Baker 1986; Mellink *et al.* 1986).

The region of the Llanos de Ojuelos is located in the southern part of the Mexican Altiplano, at the convergence of the states of Aguascalientes, Guanajuato, Jalisco, San Luis Potosí, and Zacatecas (Figure 1) between 1,800 and 2,500 m. It has a semi-arid climate with an annual rainfall between 400 and 700 mm, 80 % of which falls between June and September. The average annual temperature is 16-18 °C, with the minimum in January (-2 °C) and the maximum in May (32 °C). The dominant types of natural vegetation are semi-arid grassland, dominated by grasses of the genera *Bouteloua*, *Muhlenbergia*, and *Eragrostis,* xerophytic scrub of varied composition (*Vachellia* spp., *Mimosa* spp., *Opuntia streptacantha*, *O. lasiacantha*, *O. hyptiacantha*, and *O. leucotricha*) and dwarf oak forests (*Quercus* spp.; Riojas-López and Mellink 2005; Rzedowski 2006; Harker *et al.* 2008).

The grasslands and shrubs are embedded in a diffuse agricultural matrix (Riojas-López *et al.* 2011) and all of these habitats are used to a greater or lesser extent to graze sheep, cattle, and goats. Regional agriculture is dominated by rain-fed crops (beans, chili, wheat, and barley). The riparian systems of the region are temporary streams with surface water running during rainy season, but thanks to year-round underground currents they support a more or less exuberant tree layer composed of willows (*Salix* sp.), Peruvian pepper trees (*Schinus molle*), mesquite (*Prosopis* sp.) and, to a lesser extent, cottonwoods (*Populus* sp.). This physiognomy clearly differentiates riparian systems from adjacent habitats, composed of open xerophytic scrubs (*Opuntia* spp., *Vachellia* spp., *Mimosa* spp., among the most abundant shrubs) and / or short grasslands (the most abundant species belonging to the genera *Bouteloua*, *Muhlenbergia*, *Eragrostis,* and *Aristida*). In this diffuse matrix with patches of natural vegetation that characterizes the regional landscape, riparian systems could function as corridors between the different habitats that are most suited to larger mammals.

As part of a monitoring program of carnivorous mammals in xeroriparian systems of the Llanos de Ojuelos, since 2016 we installed trail cameras (Bushnell Trophy Cam HD Essential E2 12M) in a cattle ranch in Salitrillo de Chinampas, municipality of Ojuelos de Jalisco, in the state of Jalisco. The monitoring included three cameras separated from each other approximately 400 m, covering the entire length of the stream (1.3 km), placed in sections where vegetation is dense and has superficial water for at least 6 months of the year. These cameras have been working uninterrupted ever since. The vegetation along the stream is made up of an arboreal layer dominated by willows and Peruvian pepper trees, and a dense community of tall shrubs (2 m tall on average), of the genera *Ageratina*, *Montanoa*, *Baccharis* and *Senecio*. In the dry season, the creek bed remains humid due to the shadowing by dense canopy and the presence of a spring, while in the rainy season small pools of 10 to 20 cm deep are formed along it. The adjacent habitat on the west side of the xeroriparian system is a rangeland where a community of grasses (*Bouteloua* spp., *Aristida* spp. and *Eragrostis* spp.) intermingles with huizaches (*Vachellia* spp.). The east side of the creek is covered by a xerophytic shrubland, which includes a dense strip of arborescent nopales (*Opuntia* spp.). The xeroriparian system and adjacent habitats are used for the raising of fighting-bull cattle.

To document the historical and current distribution of the collared peccary in the southern Mexican Altiplano

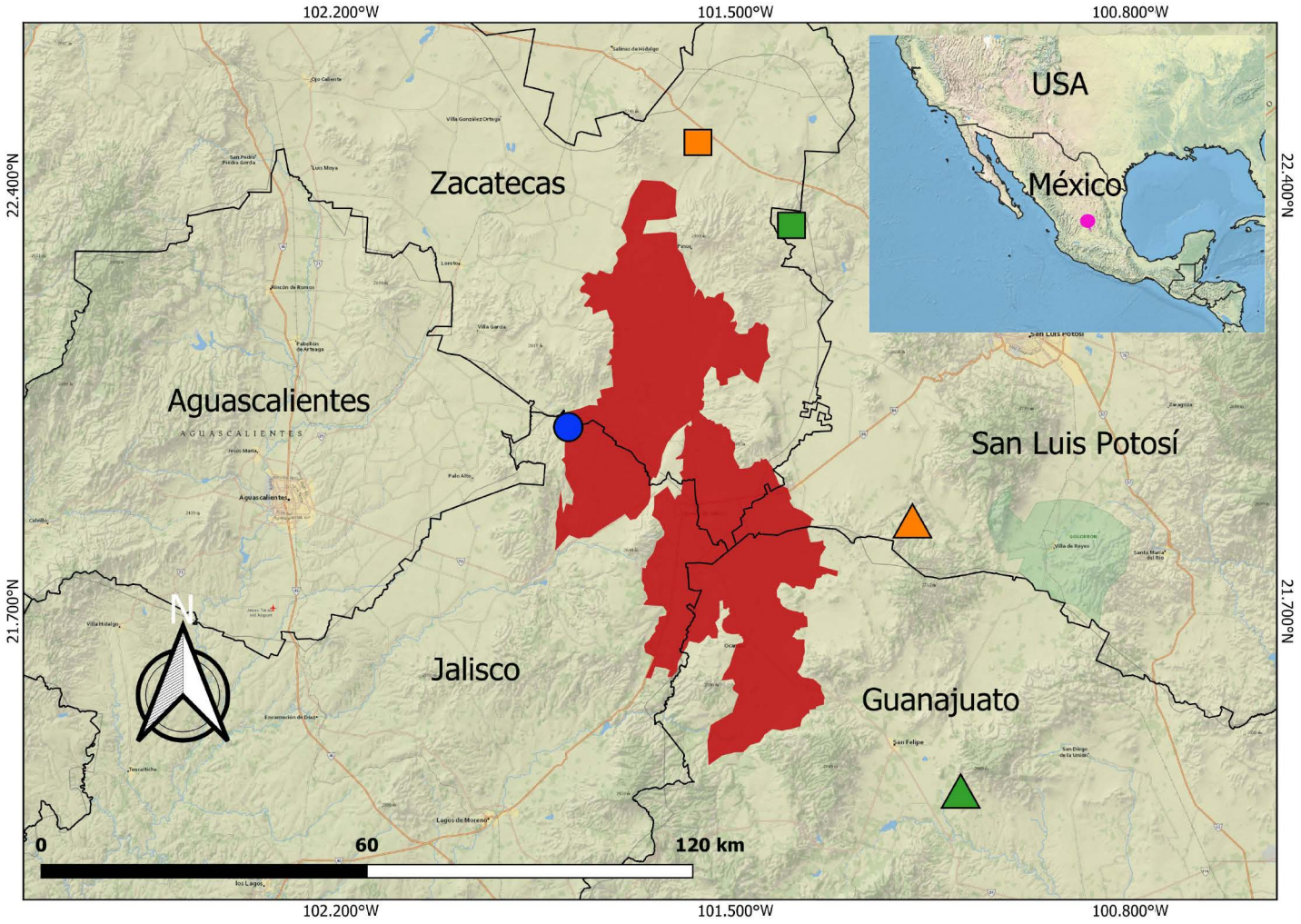

Figure 1. The Llanos de Ojuelos (red polygon) and location of the record of collared peccary (*Pecari tajacu*) in Salitrillo de Chinampas, Ojuelos de Jalisco, Jalisco (blue circle). Recent records from Naturalista (2018a; Pinos, Zacatecas, orange square) and Naturalista (2018b; Corral de Palmas, San Luis Potosí, green square). Historical records from Dalquest (1953; Bledos, San Luis Potosí, orange triangle) and Leopold (1947; San Bartolo de Berrios, green triangle).

and in México, we reviewed the published literature and searched for records in the databases of the Global Biodiversity Information Facility (GBIF 2020) and the Naturalista (2020) digital platform of citizen science. In addition, during our field trips to the region, for four years we have been given verbal reports of collared peccary sightings from the inhabitants.

Our record of collared peccary is the first to confirm the current presence of this species in the Llanos de Ojuelos region. For approximately four years, we had been informed by different peasants of the presence of "peccaries", in the northern part of the sierra that runs between La Montesa and La Laborcilla, Zacatecas. However, we were uncertain that they were collared peccaries, as they could have been feral pigs or European wild boars (*sensu* Secretaría General de Gobierno del estado de Aguascalientes, SEGGOB 2020). On September 12, 2020 at 03:20 a.m. we recorded four adult individuals of collared peccary (Figure 2) through a trail camera, 3.8 km west of Salitrillo de Chinampas, municipality of Ojuelos de Jalisco (21° 55' 00.71" N; 101° 47' 32.37" W; 2,215 m), 20 km south of the above-indicated verbal reports. The camera was installed in the floodplain of a xeroriparian habitat fed by runoff from a 2-m long spring that has water year-round. The vegetation around the trail camera location was of Peruvian pepper trees, willows and shrubs of the genera noted in the description of the study area.

The most recent and nearest peccary records to Los Llanos de Ojuelos are two reported in Naturalista (2018a, 2018b), both 40 km northeast of La Laborcilla. The first of them is from the municipality of Pinos, Zacatecas (Naturalista 2018a) and the second from the municipality of Corral de Palmas, San Luis Potosí (Naturalista 2018b). The two are separated from each other by approximately 17 km, and both are 60 km from our sighting.

Different authors indicate that the collared peccary is found throughout the state of San Luis Potosí and northern Zacatecas, but not in northeastern Jalisco or southeastern Zacatecas, nor from the states of Aguascalientes and Guanajuato (Hall 1981; March and Mandujano 2005; Reyna-Hurtado *et al.* 2019). In contrast, Leopold (1959) included the Llanos de Ojuelos in the distribution of the collared peccary but did not include most of western San Luis Potosí. The two recent and nearest records consigned

in Naturalista (2018a, 2018b) are not included in our study area and are physically separated from it by the Sierra de Pinos in Zacatecas. Of the nearby historical records, one is in Bledos, San Luis Potosí, 90 km east of ours (Dalquest 1953) and dates from 1950. The second, consigned in Hall (1981), is from San Bartolo de Berrios, Guanajuato, 100 km southeast of our current report, supported by a map by Leopold (1947).

Although it has been stated that the collared peccary does not inhabit the desert plains of San Luis Potosí (Dalquest 1953), local populations were later documented in the Sierra de La Mojonera (Luévano *et al.* 1991) and in different nopalera sites in the mid-20th Century (R. García-Maldonado, pers. comm.). It has been speculated that the collared peccary would have inhabited the tunales (communities of arboreal nopales) of the southern Mexican Altiplano, from where it disappeared along with the almost total disappearance of this habitat (Mellink *et al.* 2018).

In arid and semi-arid areas, the presence of collared peccaries is related to the abundance of cacti, especially nopales, and dense plant cover. Cacti are their main source of both food (Dalquest 1953; Leopold 1959; Luévano *et al.* 1991; Schmidly 2004; Sowls 2013) and water (Bissonette 1982; Day 1985; Sowls 2013). In these habitats, peccaries reduce water loss by spending much of their time in the shade of vegetation (Sowls 2013), which is why, in these regions, dense scrub is essential for their survival (Dalquest 1953; Leopold 1959; Schmidly 2004). Likewise, the activity of peccaries is linked to temperature, so that in arid habitats they tend to be more active during the night to avoid excessive day-time heat (Bissonette 1982). The site of the herd herein reported has dense plant cover and thick canopy, and, on the west side of the xeroriparian system, abundant *Opuntia* spp. plants. The nocturnal behavior of the herd matches that which occurs in arid environments or in warm climates.

The main predators of collared peccaries are pumas (*Puma concolor*), and, mainly of young peccaries, coyotes (*Canis latrans*) and bobcats (*Lynx rufus*; Sowls 2013). The first species was recently documented in the same locality where we obtained the record of collared peccary (Riojas-López *et al.* 2019), while the two other species are common in the region. Peccaries could contribute to the maintenance of these carnivores, especially of puma as they are

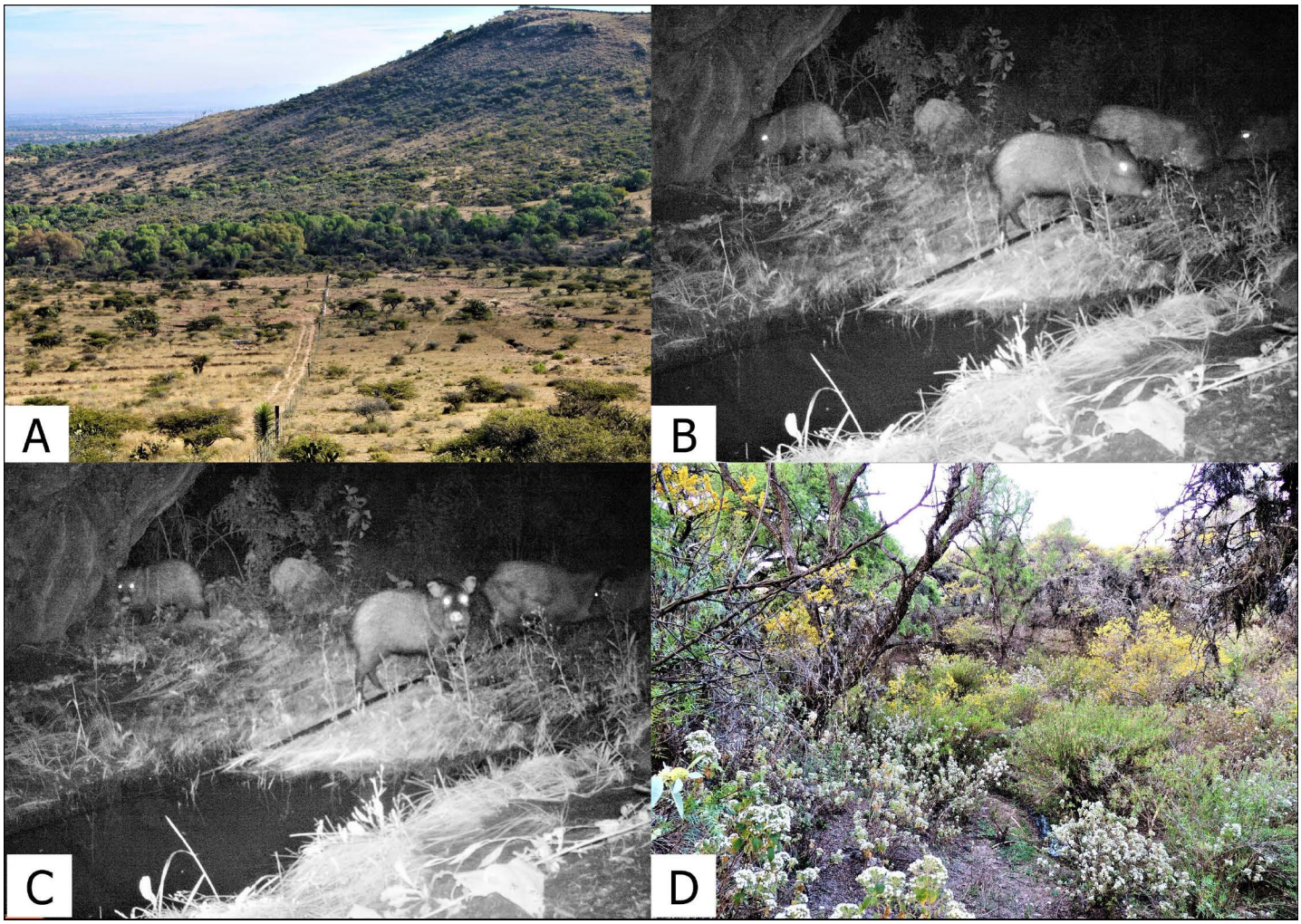

Figure 2. A: Panoramic view of the xeroriparian habitat in which collared peccaries were recorded in the Llanos de Ojuelos, México. B and C: The recorded collared peccaries. D: Vegetation at the trail camera placing. Photographs A and D were taken by the authors.

one of its preferred prey items (Currier 1983). In addition, an increase in the prey species of large mammalian carnivores could prevent them to depredate livestock.

Our record, complemented by the other two reports northeast of Pinos, suggest that the verbal reports on the presence of peccaries in the mountain range near La Laborcilla are most likely also collared peccary. The species usually restrict its movements to a few kilometers, although individuals have been found up to 11 km from the point where they were released (Ellisor and Harwell 1969; Schweinsburg 1971), but these were suggested to be dispersing individuals. Based on this, our own, the verbal reports (20 km north of our record), and the recent records in Naturalista (2018a, 2018b), would correspond to different herds. This indicates that currently the collared peccary is distributed in a wider area of the southern Mexican Altiplano than previously considered, and possibly represents a recent population increase and distribution expansion. A possible explanation for this is a decrease in poaching as an unanticipated result of the increase in police and, especially, military presence in the region in recent years. The group we report here may have been dispersing in search of suitable habitat. The origin of the individuals we recorded cannot be determined. In the region there are no game ranches in which individuals of this species have been introduced; and the Sierra Fría, which has natural populations of peccaries, is more than 70 km away from our study area.

The current record of collared peccary in Llanos de Ojuelos region, and an increase in the presence of white-tailed deer and puma (Riojas-López *et al.* 2019; M. Riojas and E. Mellink, pers. obs.), can be used to promote regional awareness campaigns, regarding the conservation of biodiversity and contribute to the revaluation of the natural habitats of the region by its inhabitants.

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