NEOTROPICAL BIOLOGY AND CONSERVATION

Neotropical Biology and Conservation
15(3): 399–407 (2020)
doi: 10.3897/neotropical.15.e54979

SHORT COMMUNICATION

Wildlife associated with burrows of *Dolichotis patagonum* in central west Argentina

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Academic editor: A. M. Leal-Zanchet | Received 1 June 2020 | Accepted 11 September 2020 | Published 25 September 2020

Citation: Gatica A, Ochoa AC, Denkiewicz NM, Mangione AM (2020) Wildlife associated with burrows of *Dolichotis patagonum* in central west Argentina. Neotropical Biology and Conservation 15(3): 399–407. https://doi.org/10.3897/neotropical.15.e54979

Abstract

Community structure is strongly influenced by positive interactions between species. Detecting and describing these interactions is essential in the study of communities. *Dolichotis patagonum* Zimmermann, 1780 (CN: mara) is a cavid rodent that builds burrows for breeding. In this study, camera traps were used to identify which species use the burrows built by maras in Sierra de las Quijadas National Park, San Luis, Argentina. All burrows were used by other species. A total of 68.7% of all medium- and small-sized taxa recorded in this study used the burrows. This is a clear indicator of the role of *D. patagonum* as an ecosystem engineer in this environment.

Keywords

camera traps, ecosystem engineer, mara, Sierra de las Quijadas National Park

Introduction

Recognising positive interactions between community members can improve our understanding of community structure processes and dynamics (Bertness and Callaway 1994). Positive interactions are amazingly abundant and diverse (Bruno et al. 2003). For example, some herbivores facilitate the presence of other herbivores by improving conditions for their feeding and/or nutrient assimilation, as is the case of *Lepus europaeus* that has been known to facilitate grazing by *Branta bernicla* in a temperate salt marsh (Van der Wal et al. 2000).

Ecosystem engineers are organisms that regulate resources availability for other species in a direct or indirect way. For example, termites, ants and earthworms are considered soil engineers because of their effects on soil properties and their influence on the availability of resources for other organisms, including microorganisms and plants (Jouquet et al. 2006). Some authors also consider animals that dig holes and modify the soil's matrix as ecosystem engineers as these animals generate an offer of refuge for other vertebrates (Jones et al. 1994; Machicote et al. 2004). Burrowing mammals are often in direct conflict with human activities like agriculture and cattle activities, as these burrowing mammal populations have declined dramatically (Davidson et al. 2012). This fact reinforces the importance and the necessity to generate basic ecological information that contributes to the understanding of interactions that occur between different species that share burrows. This information includes determining which species use the burrows and how they use them (Kondo 2018).

The mara (*Dolichotis patagonum* Zimmermann, 1780) is a cavid rodent, endemic to Argentina and weighs on average eight kilograms. Maras excavate dens to raise their juveniles, but the adults never use them as refuge. Dens are only used by maras during the reproductive season, when juveniles are small, either by multiple pairs of maras or just by a couple (Taber 1987; Gatica et al. 2019). In previous works, the mara has been proposed to be an ecosystem engineer. In Valdés Peninsula, in Argentinian Patagonia, seven species were determined to use maras' dens: *Athene cunicularia* (Molina, 1782), *Lepus europaeus* (Pallas, 1778), *Chaetophractus villosus* (Desmarest, 1804), *Conepatus chinga* (Molina, 1782), *Eudromia elegans* (I. Geoffroy, 1832), *Lycalopex gymnocercus* (Fisher, 1814) and *Bothrops ammodytoides* (Leybold, 1873) (Roldán and Sauthier 2016).

This study describes the interactions between different taxa and maras' dens in central west Argentina. The objectives of this work were: *i*) to describe the assembly of mammals present in the surroundings of maras' dens; *ii*) to define which taxa entered maras' dens and the proportion of effective entrances of each of these taxa into the dens and *iii*) finally, in order to assess whether burrows were equally available when they were occupied by maras and when they were not, we evaluated whether the presence of maras' juveniles affected the presence of the taxa that entered maras' dens.

Methods

The study took place in Sierra de las Quijadas National Park (32°47'S, 67°10'W), located 116 km north of San Luis City, Argentina. During October 2015, a surface of 230 hectares was swept, through parallel transects 5 m apart from one another, searching for maras' burrows (Gatica et al. 2019). In this area, 20 burrows were detected and monitored during a year through regular visits every ten days registering traces (October 2015 to October 2016). In each visit, when traces and/or signs of activity were registered (i.e. fresh faeces or excavating signs), the den was considered active. Camera traps were placed in the dens considered active through traces. In total, 17 different dens were monitored with camera traps (Bushnell m. 119736c or MOULTRIE m. MFH-DGW-5.0). This was done throughout the year and during variable periods of time (cameras were re-located in each visit according to the activity of the animals). Eleven of the dens were used by *D. patagonum* for reproductive purposes. In these dens, the camera remained after the juveniles left the dens or when they were no longer detected. Cameras were set in camera mode to take three photos per shot, followed by a minute of pause. This cycle was programmed to re-initiate when new detection of movement occurred.

Three analyses were carried out. 1) A general description of all species detected around maras' burrows, considering each day as an independent event of detection (camera days = CD). We summed the CD in which a given species was present for all camera traps, including the 17 monitored dens. Taxa detected were separated into two categories: species that enter the den (at least once) and species that pass by. 2) In order to assess whether burrows were equally available, with or without maras occupying them, we analysed whether the presence of juveniles of *D. patagonum* affected the presence of other taxa that enter the burrows. We compared daily frequency of each of these taxa between days with juveniles (J) and without juveniles (NoJ) by means of the Wilcoxon test (*W*), this analysis being made with CD records of the taxa that entered the dens. We used the data of the 11 dens where juveniles were detected at some point of the study. We considered the days with juveniles (J) to be those when juveniles were photographed at the dens and NoJ, the days after the juveniles left the den or were no longer detected. 3) To describe how frequently the species entered the den, we used all photographs. We categorised each photograph into two possible categories: a) effective entrances or exits and b) passing by, which was assigned to photographs where the species was detected nearby, but did not enter the burrow.

Results

During the year of monitoring, 34850 photographs of animals were obtained, in a total of 2857 camera-days (CD). The majority of photographs correspond to mara and 27% (9477) belong to other taxa, including other mammals, birds and reptiles (Fig. 1). The taxa most frequently detected (out of the total CD) were: *Eudromia elegans* (697

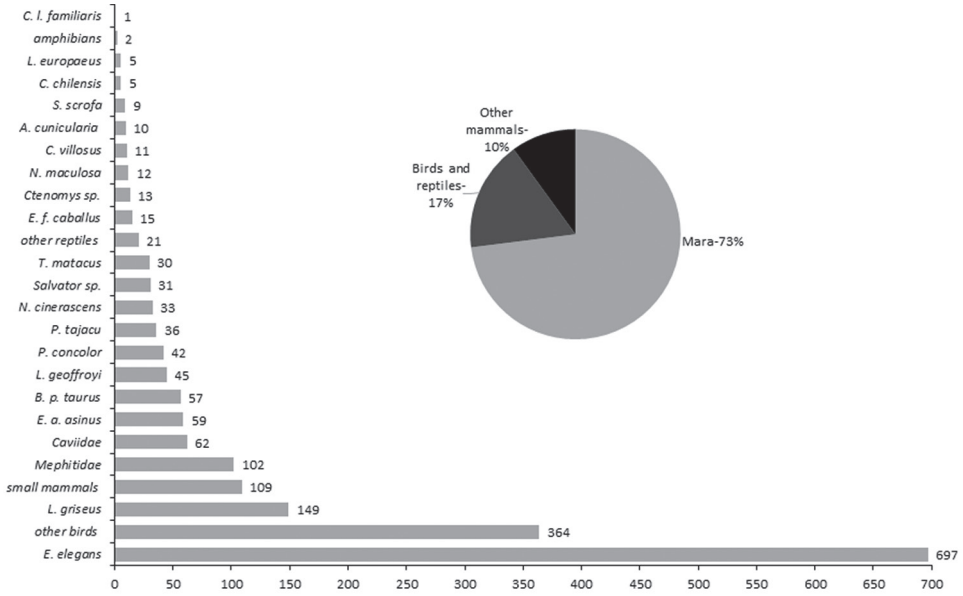

Figure 1. Animals detected in camera traps in Sierra de las Quijadas National Park, San Luis, Argentina. The pie chart represents the percentage of photographs of mara, birds/reptiles and other mammals. The bar chart represents the number of camera days (CD) in which each taxa was registered (without considering mara).

CD), other birds (birds except the Tinamidae family (364 CD)), *Lycalopex griseus* (Gray, 1837) (149 CD) and small mammals (*Cricetidae* and *Thylamys* sp. 109 CD).

Amongst the species detected in the surroundings of maras' dens, 11 taxa were not registered using the dens (passing by): other birds, *Caviidae*, *Bos primigenius taurus* (Linnaeus, 1758), *Equus africanus asinus* (Linnaeus, 1758), *Pecari tajacu* (Linnaeus, 1758), *Equus ferus caballus* (Linnaeus, 1758), *Sus scrofa* (Linnaeus, 1758), *Lepus europaeus*, *Canis lupus familiaris* (Linnaeus, 1758), other reptiles (reptiles except genus *Salvator*) and amphibians. We also registered three species reported as predators of *D. patagonum*: *Lycalopex griseus*, *Leopardus geoffroyi* (d'Orbigny & Gervais, 1844) and *Puma concolor* (Linnaeus, 1771).

Another 11 taxa entered the dens (the total number of records, including all species, was 1053 CD): *Eudromia elegans*, small mammals, *Salvator* sp., *Nothoprocta cinerascens* (Burmeister, 1860), *Athene cunicularia*, *Nothura maculosa* (Temminck, 1815), *Ctenomys* sp., *Chelonoidis chilensis* (Gray, 1870), *Conepatus chinga*, *Chaetophractus villosus* and *Tolypeutes matacus* (Desmarest, 1804) (Figs 2 A–K).

We observed that *E. elegans, C. chilensis, Salvator sp., T. matacus* and *C. villosus* showed no difference in their daily frequency presence between J or NoJ days. Small mammals, *N. cinerascens*, *C. chinga* and *N. maculosa* showed a negative association with the presence of juveniles of mara in the dens. *A. cunicularia* was only detected

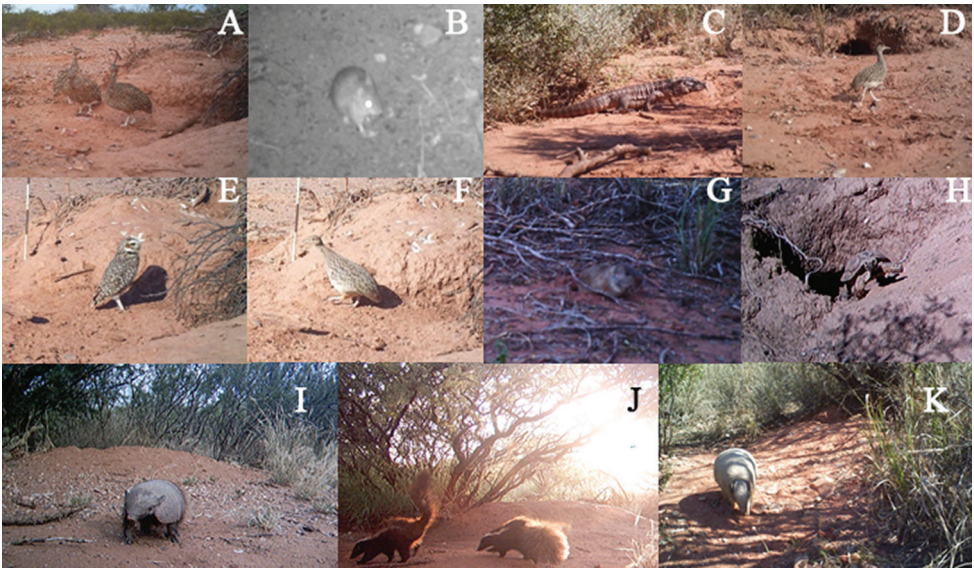

Figure 2. Taxa that use maras' burrows in Sierra de las Quijadas National Park, San Luis, Argentina. **A** *Eudromia elegans*, **B** small mammals, **C** *Salvator* sp., **D** *Nothoprocta cinerascens*, **E** *Athene cunicularia*, **F** *Nothura maculosa*, **G** *Ctenomys* sp., **H** *Chelonoidis chilensis*, **I** *Chaetophractus villosus*, **J** *Conepatus chinga* and **K** *Tolypeutes matacus*.

once in an inactive den and the same happened with *Ctenomys* sp., detected in two dens while they were inactive (Table 1).

With reference to the proportion of effective entrances of each species, we registered a high percentage of entrances (considered to be over 15%) of *C. chilensis*, *Salvator* sp. and *C. villosus*. *Ctenomys sp*. had few entrances registered in photographs, but we remark that this species modified the entrance of two dens completely, covering the original entrance and generating many alternative smaller entrances (Fig. 3).

Discussion

In this study, 25 taxa were registered, three are predators of *D. patagonum*, six are large-sized animals and 16 are animals smaller than mara. Of this last group of species, 68.7% showed effective entrances to maras' dens. Our data suggest that maras' dens are a useful resource for a great proportion of small- and medium-sized vertebrates present in the monitored ecosystem. This finding coincides with the proposition of Roldán and Sauthier (2016) who considered *D. patagonum* as an ecosystem engineer.

Mara has been reported to be an item of the diet of *Puma concolor*, *Lycalopex griseus* and *Leopardus geoffroyi* (Nuñez and Mangione 2008; Donadio et al. 2010; Palacios et al. 2012). The presence of these species near the dens was therefore associated with their search for prey. Even if we had registers of *L. griseus* partially enter-

Table 1. Species that use Maras' burrows in Sierra de las Quijadas National Park, San Luis, Argentina. In relation to: the number of burrows in which they were present, percentage of days of each species in the presence of mara juveniles (J) and without juveniles (NoJ) and significant differences in the presence of the species between days J and NoJ (Wilcoxson, $p < 0.05$).

Species that use Maras's burrows	Number of burrows where the species occurs (of a total of 11)	J	NoJ	Wilcoxon test
A. cunicularia	1	0%	0.31%	–
Ctenomyidae	2	0%	2.24%	–
N. cinerascens	6	0%	2.67%	p = 0.0022*, W = 21, N = 6
N. maculosa	6	0%	0.85%	p = 0.0022*, W = 21, N = 6
C. villosus	3	0.46%	1.49%	p > 0.05, W = 8, N = 3
Small mammals	9	0.53%	5.14%	p = 0.0022*, W = 21, N = 9
T. matacus	9	1.02%	1.20%	p > 0.05, W = 66.5, N = 9
C. chilensis	3	1.66%	0.67%	p > 0.05, W = 11, N = 3
C. chinga	10	2.22%	3.34%	p = 0.0155*, W = 74, N = 10
Salvator sp.	9	2.51%	1.26%	p > 0.05, W = 88, N = 9
E. elegans	11	28.77%	22.93%	p > 0.05, W = 126, N = 11

The (-) indicates that the analysis could not be performed. The (*) indicates a significant difference.

ing the den, we chose to consider it to be a reflection of predation activity and not evidence of use of the den *per se*. Comparing with Roldán and Sauthier (2016), we found coincident information related to the entrance of *Athene cunicularia*, *Chaetophractus villosus*, *Conepatus chinga* and *Eudromia elegans*. Regarding *L. europeus*, we observed the species nearby the dens, but it was never registered entering or exiting, contrary to what was observed by Roldán and Sauthier (2016) in Patagonia.

Species with the highest percentage of entrances were: *Salvator* sp., *C. chilensis* and *C. villosus*. These species probably use the dens as a refuge. Dens have been reported to be important micro-climate generators, providing thermic refuges for reptiles (Gálvez Bravo et al. 2009; Pike and Mitchell 2013). The other species that enter the burrows have low percentage of entrances (< 15%), which could indicate that they are probably using the dens as feeding areas, rather than refuge. Read et al. (2008) reported that dens and holes constructed by vertebrates are adequate feeding areas for small vertebrates, because they provide appropriate habitats for invertebrates.

Four of the taxa had a negative association with the presence of juveniles of mara: *N. cinerascens*, *N. maculosa*, small mammals and *C. chinga*. These species were more frequently detected when dens were not occupied by mara juveniles. As we mentioned earlier, these species have low percentage of entrances; however, if they are effectively using dens as a feeding site, the removal activity generated by the presence of juveniles could decrease the availability of invertebrates, which could be the reason why they do not visit the dens so frequently when the juveniles of maras are present. *Ctenomys* sp. was detected in two inactive dens, causing noticeable modifications in them. Maras' dens probably provide a better substrate for the species to transform and adapt burrows rather than constructing their own. As Luna and Antinuchia (2006) explain, for some *Ctenomys* species, the substrate´s

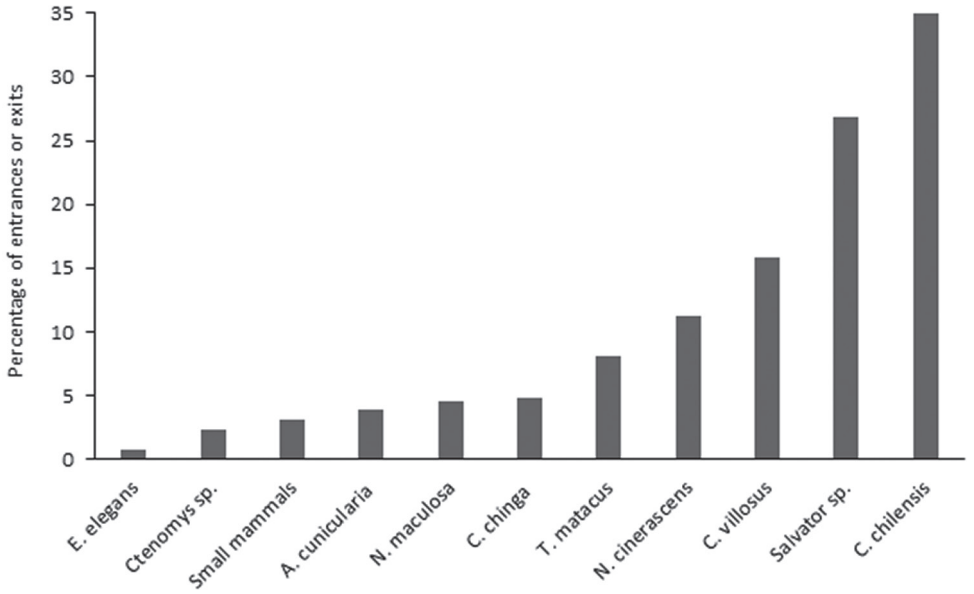

Figure 3. Percentage of photographs where species are entering or exiting maras' burrows in Sierra de las Quijadas National Park, San Luis, Argentina. The percentage was calculated in relation to the total number of photos of each species or group.

hardness generates a high metabolic cost that could be limiting and strongly influence their site selection.

During the year of the study, all the dens monitored were used by other species at some point and 11 out the 24 taxa registered used maras' dens. Our data contribute to the understanding of the role of maras' dens as a resource for other animals of the ecosystem. This knowledge becomes more relevant in a scenario where the mara is categorised as vulnerable (Alonso Roldán et al. 2019), mostly because of anthropogenic pressure. Our results show that the loss of *D. patagonum* would affect many other species, by diminishing their possibilities of refuge and feeding areas and compromising the positive interactions that allow the functioning of native ecosystems in a whole.

Acknowledgements

We thank the Park Rangers of Parque Nacional Sierra de las Quijadas (Sierra de las Quijadas National Park, in San Luis, Argentina), specially Park Ranger D. Figueroa, for his support in logistics, territory guidance and fieldwork during the realisation of this work. Thanks to L. Gabriela Ochoa for her kind assessment and improvement of the manuscript´s English. We also thank the many volunteers, who collaborated in the data collection. This work was partly financed by PROICO 02-2818, Secretaria de Ciencia y Tecnología, Universidad Nacional de San Luis, IMIBIO CONICET San Luis and the Rufford Foundation. The authors have declared that no competing interests exist.

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