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Distribution patterns and habitat preferences of medium and large mammals of the order Rodentia in the Carcarañá river basin, Southern Santa Fe province, Argentina

Abstract

This contribution analyzes the distribution patterns and habitat preferences of wildlife in highly anthropized environments. Considering that the pampas grasslands are one of the most modified natural ecosystems in the world and that both the capybara (*Hydrochoerus hydrochaeris* Linnaeus, 1766) and the coypu (*Myocastor coypus* Molina, 1782) have historically been some of the most characteristic mammals of this ecosystem, it is from these two species that the environmental variables that best explain their distribution and affectation will be analyzed.

Keywords: Argentina, ecology, mammals, Santa Fe

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Introduction

Due to their extension, the Pampas constitute the most important grassland ecosystem in Argentina, totaling some 540,000 km^2,[1] occupying the provinces of Buenos Aires (except for the extreme south), Northeastern La Pampa and Southern Córdoba, Santa Fe and Entre Ríos. The dominant vegetation in this region was originally the steppe or pseudo-steppe of grasses among which the genera Stipa, Poa, Piptochaetium and Aristida were predominant.[2] Different edaphic and geomorphologic limitations favored the presence of other plant communities: halophilic grasslands, with salt grass and espartillo; diverse grasslands and wooded communities restricted to ravines. At present, the biomes of the Pampas grasslands are those that have undergone the greatest transformation due to human intervention through the development of agricultural activities, with natural remnants being conserved in areas with serious impediments to agriculture. In terms of conservation status, the Pampas region has been categorized by the World Wildlife Foundation (WWF) as an "endangered" area and is assigned the highest conservation priority because of its high biological diversity, high degree of alteration, and the scarce presence of protected natural areas. As mentioned above, the Pampean grasslands are one of the most modified natural ecosystems in the world and both the capybara (*Hydrochoerus hydrochaeris* Linnaeus, 1766) and the coypu (*Myocastor coypus* Molina, 1782) have historically been some of the most characteristic mammals of this ecosystem.[3] In the south of the province of Santa Fe, the region's fragmentation and land use have transformed its original appearance, with grain and oilseed crops predominating. Wildlife is increasingly threatened by this development, which is pushing fragmentation and habitat loss to the limit. Mammals present different levels of sensitivity to this alteration, depending on their space requirements, their feeding needs and their behavior in the face of landscape changes resulting from anthropization.[4] The objective of the present contribution is to know the distribution patterns and habitat preferences of medium and large species of the order Rodentia (*Hydrochoerus hydrochaeris* and *Myocastor coypus*) present in the Carcarañá river basin, Southern Santa Fe province, Argentina (Figure 1).

Figure 1 *Hydrochoerus hydrochaeris* (left) and *Myocastor coypus* (right). Author: Rimodi, P. G. 2020.

Materials and methods

Study area: The area corresponds to the Carcarañá river basin in the province of Santa Fe, which is bordered to the west by the province of Córdoba and to the east by the Paraná river. It covers a surface area of 4,575 km^2 and is located between 32º26' and 33º20'S and 62º04' and 60º36'W. This area is part of the Belgrano and Iriondo departments, to the north of the Carcarañá river; and Caseros, San Lorenzo and General López to the south of it. Average annual temperatures range between 14 ºC and 20 ºC, with most of the precipitation concentrated in spring and summer. Annual precipitation in the region averages 970 mm and is distributed by isohyets oriented from north to south, with the maximum in the eastern region and the minimum to the west.[5]

Selection of sampling sites: Five sampling zones were established within the basin (distant from each other by 50 km), both on the banks of the Carcarañá river and its tributaries. Each zone for this work took the name of the nearest locality as a reference. Thus, the names were established for each sampling zone as follows: 1- Oliveros Zone (ZO) (32°34'30 "S, 60°54'11 "W), 2-Berreta Zone (ZB) (32°53'48 "S, 61°16'24 "W), 3-Villa Eloísa Zone (ZVE) (33°01'54 "S, 61°42'45 "W), 4-Zona Berabevú (ZBe) (33°21'09 "S, 61°51'09 "W) and 5-Zona Montes de Oca (ZMO) (32°35'22 "S, 61°50'37 "W) (Figure 2). These sectors were defined with the objective of obtaining a good representation of the total extension of the basin, taking into account that all the existing environmental units in the study area are

represented. Based on this, three 3 km long transects were established in each study zone, taking into account that the first one is located on the river/tributary margin, while the remaining ones are parallel to it with a distance of 5 and 10 km respectively (Figure 2). Thus, the methodology used was based on standardized line transects in search of signs of activity.[6]

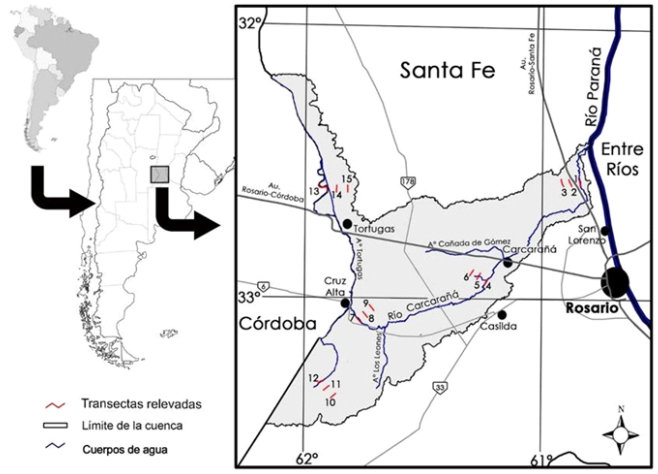

Figure 2 Detail of the Carcarañá river basin in the province of Santa Fe (Argentina). Some reference localities and transect sites are indicated: 1, Oliveros Zone (32° 34' 30 "S, 60° 54' 11 "W); 2, Berreta Zone (32° 53' 48 "S, 61° 16' 24 "W); 3, Villa Eloísa Zone (33° 01' 54 "S, 61° 42' 45 "W); 4, Berabevú Zone (33° 21' 09 "S, 61° 51' 09 "W); 5, Montes de Oca Zone (ZMO) (32° 35' 22 "S, 61° 50' 37 "W).

Data collection: Field work was carried out during two consecutive years (2020 - 2021), seasonally (autumn, winter, spring and summer), with a periodicity of two days per month. The methodology used was the survey of indirect evidence (tracks and feces) and the collection of information from direct evidence (sightings). Transect walks were conducted on foot, during daylight hours and at an average speed of one km/h, and were carried out during one day for each zone. A total of 80 days of field work and a total sampling effort of 360 km were completed in the four environmental units proposed. In 2021, photo-trapping was incorporated as a support method for species confirmation.

Spatial analysis: To establish associations between the presence records and the environmental variables studied (distance to roads and fence edges, land cover, etc.), a geographic information system was generated to integrate information from various sources. Landsat TM 5 satellite images of March 28, 2020 were used to generate maps and the approach scale was 1:100,000. The satellite images were obtained from the Data Distribution Center of the Instituto Nacional de Pesquisas Espaciais (INPE). The Gauss-Krüger coordinate reference system (Belt 5) defined by POSGAR WGS84 was used. The image was geometrically corrected with a first degree polynomial and 40 control points. The RMS (root mean square error) of the geometric correction process was 0.7 pixels. The programs used for spatial analysis were ArcGis 10.0 (ESRI, Redlands, CA, USA), IDRISI Selva GIS (Clark University, Worcester, MA, USA), Quantum GIS 1.7.4 and gvSIG 1.11.0.

Generation of land cover map: For the identification of vegetation units, an unsupervised classification with 15 classes was performed. Subsequently, each of the classes generated was assigned to the different vegetation and environment units based on the spectral characteristics of the image. For the correct assignment, our own field information and high-resolution images available from Google Earth was used. These classes were then regrouped based on the data collected in the field. In this process, the different spectral classes could be reassigned to some of the different environmental units according to the existing bibliography for the south of the province of Santa Fe (croplands, xerophytic forests, halophytic communities and urban environments). For validation, a random draw of 100 points was made and these were corroborated by field information and sources of higher spatial resolution, obtaining an accuracy in the cover map of 90%.

Results

From the presence records, a specific richness (S) was obtained for the Carcarañá river basin in the province of Santa Fe, Argentina for 2 species of medium and large mammals of the order Rodentia (*Hydrochoerus hydrochaeris* and *Myocastor coypus*) which had their individual sequences of tracks quantified and georeferenced for the calculation of specific richness, relative abundance index and association to climatic/environmental variables.

***Hydrochoerus hydrochaeris* (Linnaeus, 1766):** In total, 16 records of presence of *H. hydrochaeris* were obtained, during the years 2020 - 2021, finding traces in all seasons, three (18.75%) in winter, seven (43.75%) in autumn, four (25%) in spring and two (12.5%) in summer. Significant differences were found in the presence of traces of the species between seasons (Chi-square = 3.5, gl = 1, P- Value = 0.0613) since the goodness-of-fit test to a uniform distribution yields P-Value less than 0.10, thus the hypothesis of fit to a discrete uniform distribution can be rejected with a confidence level of 90%. *H. hydrochaeris* was recorded in one of the four environmental units sampled (xerophytic forest). The total sampling effort for xerophytic forest was 48 km, which gives a relative abundance for this species of 0.33 tracks/km. Regarding the seasons of the year, traces were found in all seasons, however, the highest prevalence was obtained in autumn (43.75%). From the point of view of spatial analysis, all records of *H. hydrochaeris* occurred within 50 m (42.42) of a watercourse, with 50% occurring at 36.21 m (RQ= 12.42). Regarding the distance to localities, all the records were more than 1900 m from the nearest locality, with 50% of the records at 3890 m or more (RQ= 881.338). Similarly, the distance to roads was similar, where all the records were found at distances equal to or greater than 1000 m, with an average of 1045.79 m (SD= 20.07). The records were presented at an average height of 54 m (SD= 8.8), while 50% of the records were presented with a slope degree of 0.92% (RQ=0.38). Principal component analysis was applied to the 5 environmental variables. The first component explained 53.769% of the variance of the 5 variables considered. Within this component, the effect of distance to localities, distance to roads and height of terrain versus distance to water and slope were plotted against each other.

***Myocastor coypus* (Molina, 1782):** In total, 32 records of presence of *M. coypus* were obtained, during the sampling years, finding traces in all seasons, six (18.75%) in winter, six (18.75%) in autumn, seven (21.88%) in spring and thirteen (40.63%) in summer. Significant differences were found in the presence of traces of the species between seasons (Chi-square =4.25, gl=1, P-Value =0.0392) since the goodness-of-fit test to a uniform distribution yields P-Value less than 0.05, thus the hypothesis of fit to a discrete uniform distribution can be rejected with a confidence level of 95%. *M. coypus* was recorded in three of the environmental units sampled, xerophytic forest, halophytic communities and urban environments. The data obtained in halophilic communities are presented separately, taking into account the subdivision of this unit into esparto grasslands and

salt meadows. Thus, 11 (34.38%) evidences were found in Xerophytic Forest (5 in summer, 3 in spring, 1 in autumn and 2 in winter), twelve (37.50%) in Salt Meadows (6 in summer, 2 in spring, 1 in autumn and 3 in winter), eight (25%) in Espartillar (2 in spring, 2 in summer and four in autumn) and one (3.13%) in Urban Environments (recorded in autumn). The total sampling effort for xerophytic forest was 48 km, 24 km for halophilic communities of the Espartillar type, 24 km for salt meadows and 24 km for urban environments, giving a relative abundance of *M. coypus* of 0.22 traces/km for xerophytic forest, 0.33 traces/km for halophilic communities of the Espartillar type, 0.5 traces/km for the salt meadows type and 0.04 traces/km for urban environments.

With respect to the seasons of the year, no significant differences were obtained in the comparison between these and the environmental units (Chi-Square =12.63, gl = 9, p<0.1802). From the point of view of spatial analysis, all records of *M. coipus* were within 50 m of a watercourse, with an average distance of 14.20m (SD= 17.09). The distance to localities ranged from 0 to 11575 m, with 50% of the data recorded below 3099.96 m (RQ=4814.34). Regarding the distance to roads, the data ranged between 30 and 8139.79 m. Fifty percent occurred below 1051.21 m (RQ= 3984.81). All the records were presented at an average height of 75.53 m (SD=23.09), while the average slope grade was 0.7684% (SD=0.475). Principal component analysis was applied to the 5 environmental variables. The first two components explain 72.450% of the variance of the 5 variables considered. Within component 1, which is responsible for 43.94% of the variance, is the effect of distance to water and, very close to each other, height and slope. In component two, which is responsible for 28.50% of the variation, distance to localities was associated with a high value and, to a lesser extent, height.

Discussion and conclusion

***Hydrochoerus hydrochaeris*:** Based on the existing information, the species is thought to be extinct in the Northern Pampean ecoregion.[7–9] Its geonemics do not include Southeastern Córdoba, Southern Santa Fe and Northern Buenos Aires province.[7–10] In the present research, the capybara was recorded in one of the four environmental units surveyed (xerophytic forest). The records for this same unit are proposed by Pautasso[9] for the Espinal and Chaco eco-regions (forest wedge and submeridional lowlands). Associated with the Carcarañá River, this unit presented records of the species for all seasons of the year. Although *M. coypus* can be a potential competitor for resources,[7] records of the presence of *H. hidrochaeris* were found associated with the main watercourse (Carcarañá River), while for *M. coypus* they were restricted to surrounding channels. In general, this species is characterized by three essential requirements for its survival: (a) the availability of aquatic environments -water is essential to satisfy different life requirements, such as reproduction, thermoregulation and protection-, (b) the presence of foraging areas in the vicinity and (c) dry areas for resting and sheltering young.[10]

Based on these conditions,[10] established a map of potential habitat suitability for capybaras in Argentina. From this map, it can be seen that a large part of the Santa Fe territory, including the basin under study, presents marked limitations, being the lowest suitability category proposed by the authors. Taking into account that this species is classified as "Near Threatened" (Ojeta et al., 2012) at the national level and "Vulnerable" at the provincial level[9] reinforces the importance of the remnants of forests that still exist on the banks of the Carcarañá River, which would be providing the necessary conditions for the presence of this species in a highly modified area. Other noteworthy data are that the records of *H. hydrochaeris* were found associated with the watercourse, a logical observation due to its semi-aquatic habits[11] and far from urban centers and roads, which could indicate that this species is being affected by urbanization. Another noteworthy fact is that, although it is a normally diurnal and nocturnal rodent[7,12] in the sampling area it has never been seen during the day, apparently, it adopts purely nocturnal habits in areas where it is intensively hunted.[13]

***Myocastor coypus*:** Due to its reproductive rate, high tolerance to different climatic and hydrological conditions and its high dispersal and colonization capacity, this species is one of the most representative of the large wetland systems in our country.[7,14,15] For the province of Santa Fe, Pautasso[9] locates it in the eco-regions of the Paraná River Valley, Espinal, Humid Chaco and Pampean. For the latter, no records have been documented for the Carcarañá river basin. In this work, the coypu was recorded in three of the four environmental units surveyed (xerophytic forest, halophytic communities and urban environments). The highest abundance was recorded in halophilic communities, which are associated with shallow watercourses, a logical observation due to their aquatic habits.[7,8,12]

In turn, within these, the salt meadows associated with lagoons had the highest relative abundance, a fact already observed for the species by Bó et al.[15] This site is not only shallow, but also has calm waters with little current, which is in agreement with what was proposed by Parera[7] and Bó et al.[15] regarding the preference of this species with respect to watercourses. In the xerophytic forests associated with the Carcarañá River, the records were found in canals and marshes bordering the river, a condition similar to that reported by Parera[7] and Pautasso[9] for the Paraná River valley. The records in urban areas, although directly related to a canal where it colonized aquatic vegetation with shallow water, show its tolerance to the presence of man and the alteration of its habitat. This contribution aims to lay the groundwork for future monitoring programs and ecological research on mammal populations, developing actions to increase knowledge about key species, threatened species, species of ecological relevance, ecological interactions, population and ecosystem ecology, in order to incorporate effective strategies in conservation proposals for the native mammal fauna of the region.[16,17]

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None.

Conflicts of interest

The author declares there is no conflict of interest.

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