

Herbivory by tuco-tucos (*Ctenomys mendocinus*) on shrubs in the upper limit of the Monte desert (Argentina)

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ABSTRACT

Ctenomys (tuco-tuco) is a small fossorial herbivorous rodent of the Monte desert, and is probably the most abundant and widely distributed rodent in these arid lands. The aim of this study is to describe the impact of *C. mendocinus* herbivory on shrubs in two plant communities (Reserve of Divisadero Largo and Villavicencio) in the upper limit of the Monte desert, and to assess the association between environmental variables and level of damage caused by tuco-tucos. Herbivory by tuco-tucos affected 39% of the total shrubs in Villavicencio, and 9.37% of the total plants sampled in Divisadero Largo. In Villavicencio, the most highly damaged species were *Larrea divaricata* (65%), *Lycium aff. chilensis* (41%), *Junellia seriphioides* (38%) and *Menodora decemfida* (33%). In Divisadero Largo, damage was lower: *J. seriphioides* (14%), *Lycium chilensis* (9%), and *M. decemfida* (6%). With respect to the association between level of damage caused by tuco-tucos and environmental variables, in Divisadero Largo the level of damage was negatively associated with both maximum and mean soil depth, while in Villavicencio it was negatively associated with plant cover, and positively associated with maximum and mean soil depth. There was no association between level of damage caused by tuco-tucos and mean stone diameter.

KEY WORDS

Monte desert,
mammals,
animal-plant interaction,
herbivory.

RÉSUMÉ

Les tuco-tucos (genre *Ctenomys*) sont de petits caviomorphes fouisseurs et herbivores, probablement les plus abondants rongeurs vivant dans les terres arides du désert de Monte (Argentine : 32° S ; 69°W). Le but de ce travail est de décrire l'impact de l'herbivorie de *C. mendocinus* sur les plantes buissonnantes de deux communautés végétales des zones supérieures du désert de Monte, afin d'estimer la relation entre les variables environnementales et les niveaux des perturbations causées à la végétation par les tuco-tucos. Au site d'étude de Villavicencio, l'herbivorie a concerné 39 % des plantes buissonnantes, mais seulement 9 % des plantes échantillonnées au site de Divisadero Largo. A Villavicencio, les espèces végétales les plus abimées par les rongeurs ont été *Larrea divaricata* (65 %), *Lycium aff. chilensis* (41 %), *Junellia seriphioides* (38 %), et *Menodora decemfida* (33 %). Au site de Divisadero Largo, les dommages ont été moindres, et ont concerné les espèces *J. seriphioides* (14 %), *Lycium chilensis* (9 %), et *M. decemfida* (6 %). La relation entre l'étendue du dommage causé par les rongeurs et les variables environnementales est négativement corrélée avec les variables d'épaisseur (maximale, moyenne) du sol à Divisadero Largo, tandis qu'au site de Villavicencio, les dommages sont corrélés de façon négative avec le couvert végétal, et de façon positive avec l'épaisseur (maximale, moyenne) du sol. Aucune corrélation n'apparaît entre le niveau de consommation des plantes et le diamètre moyen des cailloux dans le sol.

MOTS CLÉS

Monte desert,
mammifères,
interaction plantes animaux,
herbivorie.

INTRODUCTION

Bucher (1987) has suggested that herbivory plays an important role in modelling plant community composition, structure and function in South American drylands. However, he was thinking of herbivory by present (Camelidae, Cervidae and Tapiridae) and extinct large mammals (Gomphoteridae, Toxodontidae, Megateridae), and by insects (e.g. leaf cutting ants and migratory locusts), rather than by small and medium-sized mammals such as rodents. Nevertheless, the present mammal fauna of South American drylands is characterized by medium-sized herbivorous and small omnivorous rodents (Mares 1980; Kelt *et al.* 1996; Ojeda *et al.* 2000; Campos *et al.* 2001a), and by only a few large herbivores with relict distribution (Bucher 1987). A few studies assessing the effect of herbivorous mammals in arid and semiarid regions of South America have been made on the fossorial rodent *Spalacopus cyanus* (Contreras & Gutiérrez 1991; Contreras *et al.* 1993), the native rodent *Octodon degus*, and

the European rabbit *Oryctolagus cuniculus* as browsers of shrub seedlings (Fuentes *et al.* 1983), on vegetation disturbances by *Lagostomus maximus* in semiarid scrubs (Kufner & Chambouleyron 1993; Branch *et al.* 1996; Campos 1997), and on the importance of native mammals as seed dispersal agents (Campos & Ojeda 1997).

Ctenomys (tuco-tuco) is a small fossorial herbivorous rodent, and is probably the most abundant and widely distributed rodent in the arid lands of South America. The Monte, one of the largest dry areas of Argentina, consists mainly of an extensive shrubland dominated by *Larrea* spp. interspersed with open forests of *Prosopis* spp. (Morello 1985). At least three species of *Ctenomys* occur in the Central Monte: *C. eremophilus*, *C. validus*, and *C. mendocinus* (Ojeda *et al.* 2000).

The importance of another species of *Ctenomys* (*C. eremophilus*) and of *Microcavia australis* as herbivores in the Monte desert was recently assessed in a creosote bush community dominated

by *Larrea cuneifolia* (Borrueal *et al.* 1998). This study showed that both species had affected 35% of the total plants sampled. However, little is known about the effect of herbivory by *Ctenomys* on different plant communities of the Monte desert, or about how herbivory relates to habitat use and abiotic factors. Just as the composition of plant communities is clearly associated with environmental factors such as soil, altitude and rainfall, we suspect that functional relationships within communities, as herbivory, could also be related to these factors. Within this framework, the aim of this study is to describe the impact of tuco-tucos' herbivory on shrubs in two plant communities in the upper limit of the Monte desert, and to assess the association between environmental variables and level of damage caused by tuco-tucos.

MATERIAL AND METHODS

The study was conducted between May and June of 1998, on two sites in the piedmont of Mendoza, Argentina: the Reserve of Divisadero Largo, 5 km from Mendoza city (32° 55'S and 69° 05'W; 1200 m a.s.l.), and Villavicencio, 35 km from Mendoza city (32° 33'S and 68° 57'W; 1140 m a.s.l.).

The piedmont of Mendoza exhibits two vegetation belts, both included in the Monte biome. One belt is dominated by *Larrea cuneifolia* (700 to 1100 m), and the other one by *L. divaricata* (1200 to 1500 m; Roig 1976). Both study sites are located in the latter belt.

In the Reserve of Divisadero Largo mean annual rainfall is 180 mm, and the climate is dry (Martínez Carretero 1985). The major plant communities include *Dolichlasium lagascae*, *Cercidium praecox*, *Zuccagnia punctata*, *Larrea divaricata*, *Artemisia mendocana*, *Eupatorium buniifolium*, and *Argemone subfusiformis* (Martínez Carretero 1985).

Villavicencio presents low hillocks and depressions furrowed by wadis. Soils are made up of lithosols in a matrix of strongly compacted clay and silt. Shrub communities of *Larrea divaricata* and *L. cuneifolia* prevail, alternating with dense riparian vegetation (Roig 1976; Rosi *et al.* 1996). The climate is arid to semiarid, with scarce annual precipitations, ranging from 100 to 300 mm, concentrated in summer (Puig *et al.* 1999).

The effect of tuco-tucos on vegetation was quantified on 100 quadrats (2 m²) taken along 10 transects (30 m long) randomly run in both study areas. The extent of herbivory by tuco-tucos was quantified by counting the damaged plants. Tuco-tucos browse with their incisors cutting diagonally across the stem of shrubs, as

jackrabbits do in the Chihuahuan desert (Ernest 1994; Borrueal *et al.* 1998).

Plant density was quantified on the same 100 quadrats, as number of individual shrubs/2 m². To express plant density as shrubs/10 m², data were analyzed by forming 20 groups of 5 samples each. Then, results of plant density were expressed as mean number of shrubs/10 m² ± 1 SD.

Damage to each plant was scored by percentages of cut or stripped stems, as follows: undamaged (0%), damaged (1-50, 51-90, 91-100%). Level of damage caused by tuco-tucos at the study sites was expressed as percentage of damaged shrubs on 2- m² quadrats. Percentages of damaged shrubs at each study site were grouped: 0-20, 21-40, 41-60, 61-80, 81-100%, and they were compared by chi-square analysis (Zar 1999). Recorded environmental variables were maximum, minimum and mean soil depth, plant cover, and mean stone diameter. Ten samples of soil depth were taken from each quadrat. The association between environmental variables and level of damage caused by tuco-tucos was analyzed by Spearman rank order correlation (Zar 1999).

RESULTS

Shrub density was found to be 58.40/10 m² (SD = 15.4; n = 20) in Villavicencio, and 27.75/10 m² (SD = 8.46) in Divisadero Largo. In Villavicencio, for *Junellia seriphioides*, the most abundant shrub, density was estimated as 46.30/10 m² (SD = 14.89; n = 20). Other species were present in lower densities like *Larrea divaricata* (4.05 ± 2.86 shrubs/10 m²), *Senecio uspalatensis* (3.10 ± 5.93 shrubs/10 m²), and *Lycium aff. chilensis* (2.20 ± 2.71 shrubs/10 m²). Maximum soil depth was 29.23 cm (SD = 8.09; n = 100), minimum soil depth 6.64 cm (SD = 5.9; n = 100), and mean soil depth 17.7 cm (SD = 7.48; n = 100). In Divisadero Largo, the most abundant shrub was *J. seriphioides* (13.60 ± 9.39 shrubs/10 m²). Other species in lower densities were *Menodora decemfida* (5.70 ± 7.00 shrubs/10 m²), *Lycium chilensis* (4.05 ± 3.59 shrubs/10 m²), and *Verbena aspera* (1.90 ± 2.34 shrubs/10 m²). Maximum soil depth was 20.48 cm (SD = 8.01; n = 41), minimum soil depth 4.09 cm (SD = 2.9; n = 41), and mean soil depth 10.36 cm (SD = 3.7; n = 41). In the areas with *Ctenomys*, we found a significant reduction in

plant cover in Divisadero Largo, and the same tendency (but not significant) was found in Villavicencio (Table 1).

Herbivory by tuco-tucos affected 39% of the total shrubs in Villavicencio, and 9.4% of the total plants sampled in Divisadero Largo (Table 2). In Villavicencio, among the most abundant

plants, the most highly damaged species were *Larrea divaricata* (65%), *Lycium aff. chilensis* (41%), *J. seriphioides* (38%), and *M. decemfida* (33%). On the other hand, in Divisadero Largo, damage was lower among the most abundant plants: *J. seriphioides* (14%), *Lycium chilensis* (9%), and *M. decemfida* (6%; Table 3).

TABLE 1. Plant cover with and without presence of *Ctenomys* in Villavicencio and Divisadero Largo (Mendoza, Argentina).

	Plant cover Villavicencio				Plant cover Divisadero Largo			
	25 th percentil	Median	75 th percentil	n	25 th percentil	Median	75 th percentil	n
Without <i>Ctenomys</i>	50	80	90	19	40	75	95	75
With <i>Ctenomys</i>	40	65	83	81	30	40	70	25
Mann Whitney U test.	p = 0.11 ns				p = 0.05 *			

TABLE 2. Number of undamaged and damaged shrubs in Villavicencio and Divisadero Largo (Mendoza, Argentina). Percentages are between parentheses.

	Undamaged	Damaged		
		<50	50-90	91-100
Villavicencio	712 (60.9)	285 (24.4)	73 (6.3)	98 (8.4)
Divisadero Largo	503 (90.6)	48 (8.7)	3 (0.5)	1 (0.2)
TOTAL	1215 (70.6)	333 (19.3)	76 (4.4)	99 (5.8)

Chi-Square =167.217, D.F. = 3, Prob. = 4.486E-07.

TABLE 3. Damage to shrubs (percentage of cut or stripped stems) in Villavicencio and Divisadero Largo (Mendoza, Argentina). Total species includes all species regardless of frequency of occurrence.

	Undamaged	Damaged			n
		<50	50-90	91-100	
Villavicencio					
<i>Junellia seriphioides</i>	61.6	24.4	5.7	8.3	926
<i>Larrea divaricata</i>	34.6	38.3	17.3	9.9	81
<i>Senecio uspallatensis</i>	85.5	11.3	3.2	—	62
<i>Lycium aff. chilensis</i>	59.1	25.0	2.3	13.6	44
<i>Menodora decemfida</i>	66.7	23.8	9.5	—	21
Total species	61.0	24.4	6.3	8.4	1168
Divisadero Largo					
<i>Junellia seriphioides</i>	86.4	12.9	0.4	0.4	272
<i>Menodora decemfida</i>	93.9	4.4	1.8	0.0	114
<i>Lycium chilensis</i>	91.4	8.6	0.0	0.0	81
<i>Verbena aspera</i>	97.4	2.6	0.0	0.0	38
<i>Larrea cuneifolia</i>	100.0	0.0	0.0	0.0	15
<i>Gochnatia glutinosa</i>	100.0	0.0	0.0	0.0	11
Total species	90.6	8.7	0.5	0.2	55

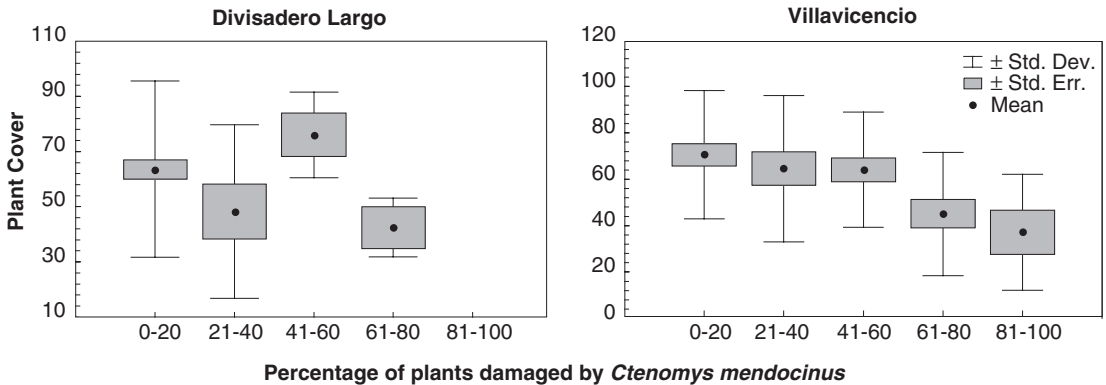


FIG. 1. – Relation between plant cover and percentage of plants damaged by *Ctenomys mendocinus* in a) Divisadero Largo, and b) Villavicencio (Mendoza, Argentina).

Considering the level of damage, all categories included, caused by tuco-tucos at each study site, damage was much more significant in Villavicencio than it was in Divisadero Largo ($\chi^2 = 167.217$; D.F. = 3; $p < 0.00001$).

With respect to the association between level of damage caused by tuco-tucos and environmental variables, in Divisadero Largo the level of damage was negatively associated with maximum soil depth ($r_s = -0.33$; $n = 41$; $p = 0.03$) and mean soil depth ($r_s = -0.36$; $n = 41$; $p = 0.02$). On this site, no association was found between level of damage and plant cover ($r_s = -0.18$; $n = 100$; $p = 0.06$; Fig. 1a). In Villavicencio, the level of damage was negatively associated with plant cover ($r_s = -0.4$; $n = 100$; $p < 0.0001$; Fig. 1b), and positively associated with maximum soil depth ($r_s = 0.47$; $n = 100$; $p < 0.00001$) and mean soil depth ($r_s = 0.53$; $n = 100$; $p < 0.00001$). There was no association between level of damage caused by tuco-tucos and mean stone diameter (Divisadero Largo: $r_s = 0.02$; $n = 100$; $p = 0.86$; Villavicencio: $r_s = -0.03$; $n = 100$; $p = 0.75$).

DISCUSSION

Tuco-tucos damaged an important number of plants in the upper limit of the Monte desert. Tuco-tucos browsed a great number of shrubs in

Villavicencio (39%), but only 9% of these plants in Divisadero Largo. In Villavicencio, the effect of *Ctenomys* was more important than in other creosotebush communities studied (23%) in the Reserve of Ñacuñán (Borrueal *et al.* 1998). All these data suggest that *Ctenomys*, despite its different impact on different shrub communities, is the most important native herbivore that feeds on shrubs in the Monte desert, and especially on *Larrea* plants.

The impact on vegetation and on soil of another species of the same genus, *C. talarum*, was studied in a coastal grassland of Argentina by Malizia *et al.* (2000). They reported that *C. talarum* reduces the abundance of prevalent grass and forb species, promotes the replacement of grasses with forbs, and modifies soil nutrient concentration. In the Monte desert, *C. mendocinus* is a trophic generalist that consumes perennial monocotyledons and dicotyledons, although it shows a marked preference for grasses (Madoery 1993; Puig *et al.* 1999). Seasonal changes were observed in the proportion of consumed plants according to green vegetation availability. *Ctenomys* compensates for the low nutritional quality of mature grasses in winter with an increased use of shrubs and succulents (Puig *et al.* 1999). Coinciding with these data, Madoery (1993) and Campos *et al.* (2001b) found that *Larrea* is present in the diet of tuco-tucos primarily during the dry season.

Both the above data and the results of this study suggest that this plant species becomes an important food and water resource for tuco-tucos during the dry season, in spite of the high number of antiherbivore substances that it accumulates (Rhoades 1977).

The present study, along with others, contributes to highlight the importance of herbivory by hystriognath rodents in the arid and semiarid lands of Argentina (Kufner & Chambouleyron 1993; Branch *et al.* 1996; Borrueal *et al.* 1996; Campos & Ojeda 1997; among others), especially herbivory by *Ctenomys* in the Monte desert. The relationship between *Ctenomys* and Monte desert plant communities is probably the most important animal-plant interaction, given the magnitude of the impact of this herbivore on vegetation (Borrueal *et al.* 1998; Tognelli *et al.* 1999; Campos *et al.* 2001b).

CONCLUSIONS

Notwithstanding, the present study goes further since it considers the heterogeneity of herbivory resulting from the various environmental variables. Therefore, within the same biome, animal-plant interactions between different species may exhibit entirely different levels. In our case, soil depth and plant cover appear as the major variables determining the type and intensity of *Ctenomys*-plant community interactions.

Herbivory by *Ctenomys* spp. in the drylands of Argentina is probably as important as is granivory in the deserts of the Northern Hemisphere. Thus, further studies are needed to understand the relationships between *Ctenomys* and the structure and function of dry neotropical ecosystems.

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