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Is the native deer *Mazama gouazoubira* threatened by competition for food with the exotic hare *Lepus europaeus* in the degraded Chaco in Córdoba, Argentina?

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ABSTRACT

Using microhistological analysis of faeces, we studied the diets of the wild Chacoan Brown brocket deer (*Mazama gouazoubira*) and the exotic European hare (*Lepus europaeus*) by comparing plant species frequency in faeces with plant species availability. Research was conducted in the dry southern portion of South American Chaco, in forests subjected to livestock ranching in the north of Córdoba province, Argentina. The diet of the Brown brocket deer was more closely related to forage availability ($C = 0.82195$) than the diet of the European hare ($C = 0.38565$). Dicots comprised 90% of the Brown brocket deer diet and were preferred throughout the year, while gramineous species were consumed in low amount. In the diet of the European hare, gramineous species were frequent (65 to 87%) and preferred in every season but in winter, when dicots were consumed in higher proportions (92%). Differences in feeding habits and in habitat use would allow both herbivores to coexist; however, probable competition for food with the European hare during the dry period, in addition to habitat loss, threatens survival of the Brown brocket deer.

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1. Introduction

The portion of the semiarid Chaco region located in north of the province of Córdoba, Argentina, has been subjected to deforestation, overgrazing, and agricultural practices in the last 50 years, leading to fragmentation and degradation of the native forest (Bonino and Araujo, 2005; Cabido and Zak, 1999) and fauna (Kufner and Giraudo, 2001). Two middle-sized herbivorous mammals coexist in this forest: the native Brown brocket deer, *Mazama gouazoubira* (G. Fisher, 1814) and the exotic European hare, *Lepus europaeus* (Pallas, 1778). The ecology of these species is poorly known in the region.

The Brown brocket deer is a small cervid (15–20 kg) of wide distribution to the east of the Andes in South America, from Colombia and Venezuela to Uruguay and Argentina (Emmons, 1990). In Argentina, the Brown brocket deer occupies the northern half of the country. This highly territorial species inhabits forests, savannas and shrublands, and its populations have decreased due to hunting pressure and habitat degradation (Dellafiore and Maceira, 1998). In the Llanos of La Rioja province, within the Argentine Chaco region, Cartes Yegros (1999) related the presence of Brown brocket deer to a good tree

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canopy cover and diversity of sparse shrubs, which agrees with a diet based on tree and shrub species that Brown brocket deer browses in the dry season. In its southernmost distribution area (Córdoba), the species occupies declining forest habitats, which makes its populations vulnerable (Kufner and Giraudo, 2001; Kufner et al., 2005).

The European hare was repeatedly introduced to Argentina since 1888, reaching such population numbers that in 1907 the species was declared a pest in the country. The species has become a lucrative commodity for the meat packing industry and is exported to the European Union (González Ruíz, 2004). In Argentina the ecology of this leporid has been especially addressed in Patagonia, where its competition for food with wild and domestic herbivores has been evaluated (Amaya et al., 1979, 1980; Somlo et al., 1994; Bonino et al., 1997; Puig et al., 2007). In Córdoba the European hare is distributed all throughout the province, in the Pampas plains and sierras with low and open vegetation cover.

In arid and semiarid areas, primary productivity and consequently food availability, varies with the amount and distribution of precipitations (Oesterheld et al., 1999). At the same time, the type of human activities influences the dominant vegetation and diet of herbivores in a region (Kufner and Monge, 1998; Pelliza et al., 1997). Herbivores, in turn, respond to such alterations with particular strategies (Ellis et al., 1976). Thus, in the Monte, the mara (*Dolichotis patagonum*) exhibits some shifts in its diet through avoidance of competition when it co-occurs with cattle (Kufner and Sbriller, 1987). Wild exotic animals, like the European rabbit (*Oryctolagus cuniculus*) and the European hare, come into conflict with agricultural activities and the fauna present in large areas (Amaya et al., 1980; Campos, 1997; Puig et al., 2007).

Assuming that exotic animals can compete with and even displace the native fauna (Dellafiore and Maceira, 1998), what factors would contribute to the sympatry of these herbivores? Is the presence of the European hare likely to interfere with the Brown brocket deer through competition for food? Is survival of the native species at risk? We postulate that the native herbivore might overcome such difficulties through adaptations to the Chaco environment. We evaluated diet composition, relationship between diet and food availability, and trophic relationships of two middle-sized mammals, the native Brown brocket deer and the exotic European hare, occurring in sympatry in the northern Chaco portion of Córdoba province, Argentina, with the aim of examining factors facilitating their coexistence and/or negatively affecting survival of the native species.

2. Materials and methods

2.1. Study area

The study was conducted in fields near Deán Funes, (Department of Ischilín, Córdoba). The area is phytogeographically included in the Western Chaco forest, which extends across the plains to the west of the Sierras del Norte. The area is exploited for livestock, timber and fuelwood production (Cabido and Zak, 1999; Luti et al., 1979). The forest has an open xerophytic physiognomy, the tree canopy reaching 7–8 m in height in relict areas, where algarrobos (*Prosopis chilensis* and *P. nigra*), mistol (*Ziziphus mistol*), quebracho blanco (*Aspidosperma quebracho-blanco*), and tala (*Celtis tala*), as well as shrub species (*Bulnesia retamo*, *Larrea divaricata*, and *Acacia* spp.) occur. The fauna is typical of the Chaco and is influenced by the Amazonia, Pampas, Patagonia, and Andes regions. Among the mammal species, the following middle-sized native herbivores occur: *Lagostomus maximus*, *Pediolagus salinicola*, *M. gouazoubira*, *Microcavia australis*, and *Ctenomvs* spp., as well as the exotic *Lepus europaeus* (Bucher, 1980; Kufner and Giraudo, 2001).

2.2. Methodology

Based on physiognomic studies and cartography of the region (Luti et al., 1979; Zak and Cabido, 2002), sites representative of the dry Chaco used mainly for extensive livestock ranching were selected. The forest exhibits good portions of natural vegetation and others altered by thinning, rolling, logging, etc. Sampling was conducted at the sites in better conditions, taking into account seasonality (dry winter and wet summer periods).

Botanical composition of diets was studied by microhistological analysis of plant epidermal fragments present in faeces (Holechek, 1982; Sparks and Malechek, 1968; Williams, 1969). Fresh faeces were collected from 15 fixed $50 \times 2\text{-m}^2$ plots that were randomly established (a total of $1500\,\text{m}^2$). The faeces, easily identifiable by size and mode of deposition (small and in dung piles of Brown brocket deer), were collected in autumn, winter and spring of 1995, and in summer of 1996.

To prepare faecal samples for analysis, the material was cleared by the addition of sodium hypochlorite, washed in boiling water for 20 minutes, and stained with 1% safranin. For random identification, a homogeneous distribution of fragments and a given fragment density were needed so that at least one fragment was identified anywhere in the slide at $100\times$ magnification. Six slides with 30 microscopic fields each, totalling 180 fields per sample, were required for the presence of at least 80% of the species. Microscopic identification of species was performed by comparison with a reference collection, which consisted in microhistological slides (160) of ground plant material and surface view of epidermis (Baumgartner and Martin, 1939; Latour and Pelliza de Sbriller, 1981).

Interspecific trophic relationships were analyzed based on seasonal diet composition; diet similarity was evaluated with the Morisita–Horn index and as a measure of niche breadth, species diversity was estimated with the Shannon index and compared with the "*t*" test (Moreno, 2001). Dietary overlap was estimated with the coefficient $C = 2\Sigma xiyi/\Sigma xi^2+\Sigma yi^2$ (*xi* and *yi* = proportions of plants in each diet), which ranges between 0 and 1 for higher or lower overlap (Rodríguez et al., 1988).

Relationship or correspondence between seasonal forage availability (yi) and diet (xi) was also obtained with coefficient C. For this purpose, plant species were grouped as follows: woody trees, woody shrubs, herbaceous dicots, and gramineous species. Proportions of bare soil and litter were not considered in these overlap estimations. Food availability during dry winter and wet summer periods was estimated considering vegetation cover as an approximate measure of availability that is compatible with faecal samples at a spatial–temporal scale (Norbury and Sanson, 1992). Measurements of cover which followed the method of Canfield (Hays et al., 1981) were performed seasonally along six 30-m lines located in the sample collection sites. The transect length was calculated based on an accumulated species curve, where the number of species accumulated in distance units is plotted against the transect distance. In all cases species number stabilized well before 30 m, consistent with the homogeneous level of disturbance of the same forest type; 180 m of sampled vegetation gave an adequate measure of species richness and cover for the area of activity of the populations analyzed. A χ^2-test on the distribution of plant covers in the field in winter and summer was performed for differences in the seasonal availability of plants present in the diets.

Plant selection by Brown brocket deer and European hare was analyzed using Bonferroni's simultaneous confidence intervals (Byers and Steinhorst, 1984; Neu et al., 1974) calculated with the Bailey's correction (Cherry, 1996). The confidence interval for the observed proportion of an item in the diet was obtained as follows:

$$Pi - Z_{(1-\alpha/2k)}((Pi(1-Pi/n))^{1/2}[Pi[Pi + Z_{(1-\alpha/2k)}((Pi(1-Pi/n))^{1/2},$$

where Z is the highest value of the standardized normal curve, corresponding to an accumulated probability of the area $1-\alpha/2k$, and K is the number of categories tested (species observed at least once in the diet). Significance level is $= 0.05$ and n is the number of samples considered (total number of observation fields of each species in the diet). Food preferences were analyzed for summer and winter, and food availability was estimated for both seasons.

3. Results

3.1. Botanical composition of diets

The diet of the Brown brocket deer comprised a total of 36 species (Table 1). In general, the deer consumed mainly dicots; especially woody arboreal and shrub species (more than 80%), both in the dry and wet seasons. The European hare's diet was composed of 31 species (Table 1); gramineous species were an important component in the wet summer period and in autumn (mean of 75%), but not in winter. Of a total of 49 plant species identified in the diets, 16 dicots and one gramineous species were common to both mammals' diets.

3.2. Trophic relationships

The diets of the Brown brocket deer and the European hare showed low overlap ($C = 0.18$). Their dietary composition was different in all the seasons (Morisita–Horn: Spring = 0.141; Summer = 0.016; Autumn = 0.129; Winter = 0.198). Diets breadth (Shannon: Brown brocket deer $H = 2.09$; European hare $H = 2.63$) did not differ significantly ($t = -0.61$; df = 242.78). Considering seasons, European hare diet was more diverse in spring ($t = 4.98$, $P < 0.001$; df = 169.86).

3.3. Relationship between forage availability and diets

Although the study region is an exploited forest area, dicots had a significant presence, with good composition of woody species in the plant cover. During dry winter, trees and shrubs had a relatively higher proportion. In the summer period of greatest vegetative activity, distribution was more even among strata, with an increase in herbaceous cover with respect to gramineous species, and particularly herbs (Table 2).

The distribution in the field of plant cover present in the diets, however, did not differ significantly in winter and summer ($\chi^2 = 16.1495$, df = 17, P-value = 0.5133). Yet, the relationship between forage availability and diet composition and items selection, was analyzed seasonally for small changes that could affect the availability of key species consumed.

The relationship between forage availability and dietary composition was different for both herbivores. Feeding of the Brown brocket deer revealed greater consistency with food offer ($C = 0.82$) than that of the European hare ($C = 0.38$).

3.4. Selection of plant species

The diet of the Brown brocket deer revealed clear preference for woody species (Table 3). *Condalia microphylla*, *Porliera microphylla*, *Schinus* sp., *Lycium* sp., and *Maytenus spinosa* were preferred in winter and summer. *Acacia aroma* and *Prosopis torquata* were selected only in winter, and were present in the diet in low proportions. One herbaceous species (*Solanum* sp.) was selected in summer, although its low proportion in the diet hardly demonstrates preference by the Brown brocket deer.

The diet of the European hare showed a seasonal variation in species preference (Table 4). In summer the hare chose the gramineous species *Eulesine* sp., *Sporolobus pyramidatus*, *Trichloris pluriflora*, with an important contribution of

Table 1
Species composition and seasonal contribution of growth forms (%) in the diets of the Brown brocket deer and the European hare

Species	Spring		Summer		Autumn		Winter	
	B.b. deer	E. hare	B.b. deer	E. hare	B.b. deer	E. hare	B.b. deer	E. hare
Acacia aroma		1.81		0.93	3.32	1.33	3.99	
Acacia atramentaria **Benth.**	1.69	2.55	1.46	0.66	21.39	3.07	2.45	22.71
Acacia furcafispina Burk.	0.40				0.15			
Aspidospema quebracho blanco Schlecht.	0.62							
Capparis atamisquea 0. Ktze.			0.12					
Celtis pallida Torrey	2.03		5.57		3.44		6.41	
Condalia microphylla Cav.	13.39	1.25	17.7		5.81		23.28	0.68
Condalia montana	0.12				0.3		0.17	
Iodina rhombifolia		0.21						
Porliera microphylla	4.63	1.46	2.70	0.14	8.41	0.59	8.65	6.44
Prosopis alba Griseb.			0.12					
Prosopis flexuosa		2.17		0.36	9.09	0.14	0.17	
Prosopis nigra (Griseb.) Hieron.	0.15		1.98		1.64			
Schinus eugleri	11.65		13.99	0.55	7.48		9.45	0.34
Schinus sp.	10.00		1.98	0.14	1.8		8.06	
Total trees	44.68	9.45	45.62	2.78	62.83	5.13	62.63	30.17
Aloysia gratisima (Gill. et Hook) Tronc.		1.26	1.24	0.14	4.76	5.32	1.41	7.12
Cassia sp.					1.21	0.14		
Lycium cestroides Schlecht			1.36		0.15			
Lycium ciliatum	1.38	0.21	3.59		5.35		6.45	
Lycium elongatum	1.83		1.73		5.95		11.86	
Lycium sp.	0.14				2.38			
Maytenus spinosa (Griseb.) Lourt. et O'Don	36.29	3.96	34.4		9.29	0.32	11.6	3.39
Pithecoctenium cynanchoides D.C.					0.15		0.60	
Prosopis torquata (Lag.) D.C.	3.47	1.46	1.09		1.94	2.95	4.13	13.56
Total shrubs	43.11	6.89	43.41	0.14	31.18	8.73	36.05	24.07
Commelina erecta	0.62		1.09				0.19	
Dicliptera tweadiane Nees	2.08							
Ephedra triandra Tul. Emend. J. Hunz		5.10	0.12	0.26		1.27		11.53
Evolvulus sericeus Swartz			0.25	2.78	0.15	4.13		1.69
Galactia glaucophylla Harms.	2.53				0.01		0.17	
Heliotropium amplexicaule	0.15		0.42					
Heliotropium sp.	5.39		0.42				0.37	
Solanum croniotrichum Morton.	0.31		5.57	0.14	2.08	0.89		1.69
Solanum eleagnifolium Cav.		11.47		2.76		4.87		14.24
Sphaeraleca cordobensis Krapov.	0.40	0.95	2.71	3.70	1.05	1.86	0.35	1.69
Talinum polygaloides Gill. et Arnot.	0.12							
Tillandsia bryoides	0.40	1.25	0.37	0.27	2.53	0.30	0.19	7.12
Total herbaceous	12.00	18.77	10.95	9.91	5.82	13.32	1.27	37.96
Aristida adscensionis L.		8.52		15.44		13.67		0.34
Bromus brevis		4.70						
Cenchrus ciliaris		2.63		2.58		1.39		
Chloris canterai		3.87		1.37		4.58		1.02
Eragrostis cilianensis		5.18		4.69		10.42		0.34
Eulesine sp.		3.81		5.70		3.87		
Gowinia paraguayensis		1.26		6.79		7.82		
Hordeum sp.		14.34						
Pappophorum caespitosum	0.15	10.25	0.15	20.73		14.03		5.76
Pappophorum sp.					0.15			
Setaria pampeana Parodi ex Nicora		1.07		2.72		1.65		
Sporobolus pyramidatus		6.51		14.16		13.30		0.34
Trichloris pluriflora Fournier		2.71		12.95		2.07		
Total gramineous	0.15	64.85	0.15	87.13	0.15	72.8		7.80

Shared species are highlighted in bold.

Pappophorum caepitosum and *Aristida adscensionis* in the diet composition. Few herbaceous species were selected (e.g. *Sphaeralcea cordobensis*). In winter the preferred species were the herbaceous *Ephedra triandra*, *Solanum eleagnifolium*, *Tyllandsia bryoides*, the woody shrub *P. torquata*, and the woody arboreal *P. mycrophylla*. Consumption of gramineous species—scarcely available in the field in winter—would be opportunistic (e.g., consumption of *P. caepitosum*). Other species were not ingested, even though their availability was important.

Table 2
Seasonal food availability

Species	Winter	Summer
Acacia atramentaria Benth.	1.18	2.61
Acacia caven (Mol.) Mol.	4.05	4.81
Acacia furcatispina Burk.	5.07	2.44
Aspidospema quebracho blanco Schlecht.	7.33	5.78
Capparis atamisquea 0. Ktze.	1.79	
Celtis pallida Torrey	4.16	2.23
Cercidium australe Johnst	0.86	4.59
Condalia microphylla Cav.	1.74	0.65
Geoffroea decorticans (Gill.) Burk.	1.67	
Mimosygantus carinatus (Griseb.) Burts.		2.30
Porlieria microphylla		0.10
Prosopis alba Griseb.	0.48	1.76
Prosopis nigra (Griseb.) Hieron.	13.44	6.41
Schinus fasciculatus (Griseb.) Johnst.	0.06	
Total trees	41.857	33.71
Aloysia gratissima (Gill. et Hook) Tronc.	3.85	6.80
Cestrum parquii		0.08
Flourencia campestris Griseb.	18.27	16.04
Lantana grisebachii Stuck		0.75
Larrea divaricata Cav.	7.41	2.68
Lycium sp.	0.21	0.14
Maytenus spinosa (Griseb.) Lourt et O'Don	2.66	0.94
Piptochaetium sp.	4.07	
Pithecoctenium cynanchoides D.C.	0.24	0.84
Prosopis torquata (Lag.) D.C.		0.32
Total shrubs	36.73	28.59
Abutilon pauciflorum St Hil	0.10	0
Aster squamatus (Spreng.) Hieronimus	0.09	0
Baccharis pingraea D.C. var. *angustifolia*	0.24	0
Baccharis pingraea D.C. var. *pingraea*	0.09	0
Baccharis ulicina H. et A.	0.09	0.23
Clematis montevidensis Spreng.	0.86	1.46
Cordobia argentea (Griseb.) Niedenen		0.32
Dolichandra cynanchoides Cham.	0.07	
Ephedra triandra Tul.	0.22	0.27
Euphorbia pentadactyla Grises.		0.09
Evolvulus arizonicus A. Gray		0.04
Evolvulus sericeus Swartz		0.07
Galactia glaucophylla Harms.		2.10
Gnaphalium cheiranthifolium Lamarck	0.10	
Gomphrena pulchella Martius		0.11
Grindelia pulchella Dunal	0.81	
Heliotropium sp.		0.09
Indigofera parodiana Burkart		0.05
Janunsia guaranitica (St. Hil.) A. Juss.	0.08	0.19
Justicia squarrosa Griseb.	2.65	8.72
Justicia xylosteoides Griseb.		0.04
Melochia anomala Grises		0.19
Menodora integrifolia var. *trifida* (Cham. et Schlacht) Kuntzee		0.08
Nierenibergia aristata Sweet		0.42
Opuntia sp.	0.57	0.41
Portulaca lanceolata Engelman		0.18
Pseudobutilon sp.		0.04
Rhynchosia senna H. et H.		0.044
Rivina humilis		0.20
Sida pontatilloide St. Hil	0.03	0.200
Silena sp.		0.030
Solanum eleagnifolium Cav.		0.640
Solanum sp.	0.11	
Spergularia sp.	0.06	
Sphaeralcea cordobensis Krapov.	0.30	0.05
Talinum paniculatum (Jacq.) Gaerth		0.66
Talinum polygaloides Gill. et Arnot.		0.18
Tragia geranifolia Baill.	0.17	0.10
Tragia volubilis L.	0.05	

Table 2 (*continued*)

Species	Winter	Summer
Trixis antimenorrhoea var. *cladoptera* (Baker) Cabrera	0	0.84
Total Herbaceous	6.72	18.05
Agrostis sp.		4.48
Aristida adscensionis L.		0.27
Bouteloua sp.	0.04	
Cenchrus myosuroides		0.70
Eragrostis lugens Nees		0.39
Eragrostis sp.		0.06
Erianthus sp.		0.01
Fabacea sp.	0.06	
Gowinia latifolia		1.89
Schizachirium sp.	0.19	
Setaria lachnea (Ness) Kuath	1.07	1.81
Setaria pampeana Parodi ex Nicora	3.13	3.54
Stipa papposa Nees	1.23	0.32
Stipa sp.	0.27	
Trichloris crinita (Lag.) Parodi		5.09
Trichloris pluriflora Fournier		1.09
Trichloris sp.	8.72	
Total gramineous	14.70	19.65

Percentages of plant cover.

Table 3
Observed and expected percentages of use of plant species in the diet of the Brown brocket deer in summer and winter

Species composition	Summer			Winter		
	CI[a] of 95% for *Pi*	Expected use	Use	CI[a] of 95% for *Pi*	Expected use	Use
Trees						
A. quebracho blanco Schlect.		0.1678	A		0.171	A
A. aroma		0		(0.003 ⩽ 0.028 ⩽ 0.081)	0.000	S
A. furcatispina Burk.		0.071	A	(0.000 ⩽ 0.000 ⩽ 0.000)	0.118	A
A. atramentaria Benth.	(0.001 ⩽ 0.022 ⩽ 0.073)	0.076	A	(0.000 ⩽ 0.017 ⩽ 0.064)	0.028	P
C. pallida Torrey	(0.025 ⩽ 0.072 ⩽ 0.143)	0.065	P	(0.010 ⩽ 0.044 ⩽ 0.106)	0.097	P
C. microphylla Cav.	(0.118 ⩽ 0.200 ⩽ 0.296)	0.019	S	(0.092 ⩽ 0.167 ⩽ 0.258)	0.041	S
P. microphylla	(0.007 ⩽ 0.039 ⩽ 0.098)	0.003	S	(0.019 ⩽ 0.061 ⩽ 0.129)	0.000	S
Schinus sp.	(0.079 ⩽ 0.150 ⩽ 0.239)	0.000	S	(0.055 ⩽ 0.117 ⩽ 0.199)	0.001	S
Prosopis sp.	(0.003 ⩽ 0.028 ⩽ 0.081)	0.237	A	(0.000 ⩽ 0.000 ⩽ 0.000)	0.325	A
Shrubs						
P. torquata (Lag.) D.C.	(0.000 ⩽ 0.017 ⩽ 0.064)	0.009	P	(0.003 ⩽ 0.028 ⩽ 0.081)	0.000	S
Lycium sp.	(0.025 ⩽ 0.072 ⩽ 0.143)	0.004	S	(0.055 ⩽ 0.117 ⩽ 0.199)	0.005	S
M. spinosa (Griseb.) Lourt. et O'Don	(0.168 ⩽ 0.261 ⩽ 0.363)	0.027	S	(0.291 ⩽ 0.400 ⩽ 0.508)	0.062	S
Other woody shrubs	(0.000 ⩽ 0.017 ⩽ 0.064)	0.222	A	(0.000 ⩽ 0.011 ⩽ 0.054)	0.096	A
Herbaceous						
Solanum sp.	(0.029 ⩽ 0.078 ⩽ 0.151)	0.019	S	(0.000 ⩽ 0.000 ⩽ 0.000)	0.003	A
Other herbaceous species	(0.010 ⩽ 0.044 ⩽ 0.106)	0.073	P	(0.000 ⩽ 0.011 ⩽ 0.054)	0.054	P

Pi is the proportion of an item observed in the diet. If the expected proportion of a species is outside the interval limits for the observed proportion in the diet, its use is significantly different from that expected by chance ($\alpha = 0.05$) (A = avoided, P = consumed in proportion of its availability, S = selected).

[a] CI simultaneous Bonferoni's intervals calculated with the Bailey's correction (Cherry, 1996).

4. Discussion and conclusions

In natural Chaco forests, which is the distribution range of Brown brocket deer in Argentina (Dellafiore and Maceira, 2001), the species' diet is composed of a medium number of plant species: 36 species were found in this work, and 38 species were found in La Rioja (Cartes Yegros, 1999), whereas in arid northern Patagonia Puig et al. (2007) cited 29 species, and in humid areas like the Yungas, more than 70 items and "frugivory pulses" were mentioned to compose the diet (Richard et al., 1995). However, in general the Brown brocket deer feeds on dicotyledonous species, woody species (shrubs and trees), and non-gramineous herbs. Selection of dicots throughout the year and a stronger correlation of the diet with

Table 4
Observed and expected percentages of use of plant species in the diet of the European hare in summer and winter

Species composition	Summer			Winter		
	CI[a] of 95% for *Pi*	Expected use	Use	CI[a] of 95% for *Pi*	Expected use	Use
Trees						
A. atramentaria Benth.	(0.002 ⩽ 0.006 ⩽ 0.044)	0.130	A	(0.141 ⩽ 0.228 ⩽ 0.327)	0.159	P
P. microphylla	(0.002 ⩽ 0.006 ⩽ 0.044)	0.005	P	(0.019 ⩽ 0.061 ⩽ 0.129)	0	S
Other woody trees	(0.001 ⩽ 0.022 ⩽ 0.073)	0.033	P	(0.000 ⩽ 0.011 ⩽ 0.054)	0.044	P
Shrubs						
P, torquata (Lag.) D.C.		0.016	A	(0.067 ⩽ 0.133 ⩽ 0.219)	0	S
Other woody shrubs	(0.002 ⩽ 0.006 ⩽ 0.044)	0.393	A	(0.047 ⩽ 0.106 ⩽ 0.186)	0.443	A
Herbaceous						
E. triandra Tul. Emend. J. Hunz.	(0.002 ⩽ 0.006 ⩽ 0.044)	0.014	P	(0.055 ⩽ 0.117 ⩽ 0.199)	0.010	S
S. eleagnifolium Cav.	(0.003 ⩽ 0.028 ⩽ 0.081)	0.032	P	(0.088 ⩽ 0.161 ⩽ 0.252)	0.015	S
T. bryoides	(0.002 ⩽ 0.006 ⩽ 0.044)	0	P	(0.025 ⩽ 0.072 ⩽ 0.143)	0	S
Other herbs	(0.019 ⩽ 0.061 ⩽ 0.129)	0.006	S	(0.005 ⩽ 0.033 ⩽ 0.090)	0.041	P
Gramíneous						
A. adscensionis L.	(0.083 ⩽ 0.156 ⩽ 0.245)	0.013	S	(0.002 ⩽ 0.006 ⩽ 0.044)	0	P
Eulesine sp.	(0.016 ⩽ 0.056 ⩽ 0.121)	0	S			
P. caespitosum	(0.118 ⩽ 0.200 ⩽ 0.296)	0	S	(0.016 ⩽ 0.056 ⩽ 0.121)	0	S
S. pyramidatus	(0.071 ⩽ 0.139 ⩽ 0.226)	0	S	(0.002 ⩽ 0.006 ⩽ 0.044)	0	P
T. pluriflora Fournier	(0.067 ⩽ 0.133 ⩽ 0.219)	0.054	S			
Other gramineous*	(0.1 ⩽ 0.178 ⩽ 0.271)	0.304	A	(0.000 ⩽ 0.011 ⩽ 0.054)	0.289	A

Pi is the proportion of an item observed in the diet. If the expected proportion of a species is outside the interval limits for the observed proportion in the diet, its use is significantly different from that expected by chance ($\alpha = 0.05$) (A = avoided, P = consumed in proportion of its availability, S = selected).
*The expected value corresponds mostly to *Setaria pampeana*.
[a] CI simultaneous Bonferoni's intervals calculated with the Bailey's correction (Cherry, 1996).

food availability—which imply a greater trophic breadth (Feisinger et al., 1981)—show the species adaptation to and a close (territorial) relationship with forest habitat.

In the Chaco environment the European hare had a basically gramineous diet—more diverse in spring—that included dicots in the driest period. This pattern is similar to the one found in Patagonia, where the species consumes mostly gramineous/graminoids and shifts to woody dicots and herbs when the offer of other forage species decreases (Pelliza et al., 1997; Puig et al., 2007). In the Monte desert, the European hare would select arboreal and herbaceous dicots, although it also consumes graminoids (Campos, 1997).

Under more arid conditions, wild herbivores would alternate between a selective and an opportunistic behaviour, depending on food availability. This behaviour was reported for *Ozotoceros bezoarticus* and *L. maximus* in San Luis (Giuglietti and Jackson, 1986; Jackson and Giuglietti, 1988) and for *L. maximus* and *Ctenomys mendocinus* in Mendoza (Kufner and Monge, 1998; Madoery, 1993), related to avoidance of human-induced impacts (clear-cutting, overgrazing, fire, invasion of exotic species) (Dellafiore and Maceira, 1998; Kufner and Chambouleyron, 1991; Kufner and Sbriller, 1987; Kufner et al., 1992; Rosati and Bucher, 1995). However, the Brown brocket deer does not show this behaviour in the Chaco in Córdoba.

The European hare used 17 food items of the 49 plant species consumed by the Brown brocket deer in Córdoba. Since data on daily consumption of food were not found for Brown brocket deer, and assuming the species is comparable to *Capreolus capreolus*, a similar-sized cervid (15–20 kg) territorial in forests of Spain, its daily consumption might be 4–5% of the body weight, that is to say 800–900 g. If the European hare (3.5 kg) consumes 6.5% of its body weight (225 g) (Amaya et al., 1979), then about four hares would consume an equivalent amount of food as one Brown brocket deer. These figures are significant considering the restricted presence of the Brown brocket deer observed in the study area. Exploitation for livestock adds pressure and relegates the wild ungulates to a marginal position in the use of primary productivity (Carpintero Laguna, 1994).

Dietary generalism of the European hare, its opportunistic behaviour, and its wide habitat use, must have certainly collaborated to the species expansion. The heterogeneity and variety of the cultivated landscapes in Europe increase the habitat capacity for the European hare. Also, small patches of forest are chosen (particularly by females) while large masses of forest are rejected (Pepin, 1985). So, clearing and fragmentation of the Chaco forest for agriculture not only is dramatically reducing the habitat availability for the Brown brocket deer, but also provides the hare with a potential advantage.

In summary, feeding of both herbivores differed in dietary composition and preferences; which together with different habitat use, would facilitate the coexistence of the two species. The diversity of the Brown brocket deer diet has been a positive attribute for survival; European hare has demonstrated highly probable competition for food with other wild and domestic herbivores in Argentina. The fact that both species use the same food resource during the dry season, together with severe habitat loss, arouse concern for the conservation of the native species, especially if we take into account that field data were recorded a decade ago and that degradation of Chaco forest in Córdoba by agricultural expansion (Cabido and Zak, 1999; Kufner and Giraudo, 2001) still continues.

Dellafiore and Maceira (2001) mentioned that the Brown brocket deer shows ecological plasticity that would allow it to survive in moderately altered environments, secondary habitats, and forest edges, which are the generalized conditions at present in Córdoba. This probably supported the declaration of the species status as of ''minor concern'' or not threatened (Resolución 1030/04, 2005). However, the interference of an exotic herbivore that has successfully adapted to wild conditions, such as the European hare, together with the continuous forest habitat loss and uncontrolled hunting pressures that Brown brocket deer is subjected to, puts the latter species' survival at risk.

The Chaco forest and its biodiversity are of primary conservation concern. Although it is considered a ''harmful species'', the European hare has commercial value (González Ruíz, 2004). From different points of view, both animal species are valuable resources. The viability that the European hare and the Brown brocket deer coexist depends on the conservation of forest habitat, including secondary forests, so as to ensure survival of the Brown brocket deer and of many other, more sensitive Chacoan species (Kufner and Giraudo, 2001).

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