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Diets of plains vizcacha, greater rhea and cattle in Argentina

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Abstract

Food habits of plains vizcacha (*Lagostomus maximus*), greater rhea (*Rhea americana*) and cattle (*Bos taurus*) in the Paraná River Delta, Argentina, were studied over 2 years using microhistological analysis of faeces. This was the first study of feeding habits of these herbivores grazing in common in a wetland of Argentina. Poaceae was the main diet component throughout the year for all 3 herbivores, with the exception of spring and summer, when greater rhea consumed a higher proportion of *Prosopis nigra* (Griseb.) pods. Botanical composition of plains vizcacha and cattle diets was generally similar for the same season but different from that of greater rhea. *Panicum milioides* Nees., *Dichondra microcalyx* (Hallier) Fabris. and *P. nigra* were the most consumed species for vizcacha, while *P. nigra, Plantago myosuros* Lam., *Solanum* sp. L., *Spilanthes stolonifera* (H. et A.) Baker and *D. microcalyx* dominated the greater rhea diet. The species most consumed by cattle were *Luziola peruviana* Gmel. and *P. milioides*. Similarities between the diets of plains vizcacha and cattle seem to support the ranchers' view that vizcachas compete with domestic herbivores for forage. However, high overlap in food habits would result in competition only if forage is scarce. Greater rhea and cattle have different foraging patterns and hunting of greater rhea is not justified solely on the basis of forage competition with cattle.

Key Words: diet composition, herbivory, *Lagostomus maximus*, Paraná River Delta, *Rhea americana*

Resumen

Se estudiaron los hábitos alimenticios de la vizcacha (*Lagostomus maximus*), el ñandú (*Rhea americana*) y el ganado vacuno (*Bos taurus*) durante 2 años en el Delta del Río Paraná, Argentina, utilizando análisis microhistológico de heces. El presente es el primer estudio que focaliza en la comparación de los hábitos alimenticios de estos herbívoros en coexistencia en un área de humedal. Las poáceas fueron el componente principal en la dieta de los 3 herbívoros a lo largo del año, excepto en primavera y verano, cuando los ñandúes consumieron una mayor proporción de vainas de *Prosopis nigra* (Griseb.). La composición botánica de la dieta de la vizcacha y el ganado fue en general similar para una misma estación pero diferente de la del ñandú. *Panicum milioides* Nees., *Dichondra microcalyx* (Hallier) Fabris. y *P. nigra* fueron las especies mas consumidas por la vizcacha, mientras que *P. nigra, Plantago myosuros* Lam., *Solanum* sp. L., *Spilanthes stolonifera* (H. et A.) Baker y *D. microcalyx* dominaron en la dieta del ñandú. Las especies mas consumidas por el ganado fueron *Luziola peruviana* Gmel. y *P. milioides*. La similitud entre las dietas de la vizcacha y el ganado parecen apoyar la idea de los ganaderos sobre la competencia por el forraje entre estos herbívoros. Sin embargo, un elevado solapamiento dietario no se traduce en competencia a menos que el forraje resulte escaso. Por otra parte, el ñandú y el ganado presentan diferentes patrones de forrajeo y la cacería que sufren estas aves no esta justificada únicamente sobre la base de la competencia por el forraje.

In farming ecosystems, cattle and other domestic species often co-exist with wildlife. Roughly 80% of Argentina is dedicated to extensive cattle ranching (CONAPA 1991) where cattle interact with a large number of wild species that use the same resources. However, few studies in Argentina have quantified these interactions (e.g., Bonino et al. 1986, Kufner and Pelliza 1987, Martella et al. 1996, Quintana et al. 1998a, 1998b).

Plains vizcacha (*Lagostomus maximus*) and greater rhea (*Rhea americana*) are 2 native species found in these ecosystems. Plains vizcacha are large nocturnal rodents of the Chinchillidae family that dwell in communal burrows ("vizcacheras") of grasslands and semi-arid scrublands from southern Paraguay and Bolivia to central Argentina (Llanos and Crespo 1952, Branch 1993). Greater rhea also live in grasslands and bush country from Brazil and Bolivia to central Argentina. These birds live in polygamous social clusters and are generally associated with farming and cleared fields where native vegetation has been replaced by improved pastures (Martella et al. 1996, Reboreda and Fernández 1997).

The plains vizcacha is often considered to be an agricultural pest, damaging soil and vegetation (Weir 1974) due to its burrow-

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ing and grazing habits and causing losses in yield of crops such as corn, soybean, pastures, and horticultural species (Rendel 1990, Navarro et al. 1997). It is also hunted for its pelt (Rendel 1990, Bruggers and Zaccagnini 1994) and used as a food resource by humans (Mares and Ojeda 1984). Hunting has severely reduced the numbers of plain vizcachas, and it is now extinct in large tracts of the wet Pampa (Redford and Eisenberg 1992). Greater rhea also have been hunted intensively for meat, feathers and skin, and was declared a harmful species due to its negative impact on crops (Bertonatti 1997) and potential competition with cattle for forage (Martella et al. 1996).

There have been few scientific studies on the feeding habits of these wild herbivores despite their widespread continental distribution. Plains vizcacha are selective grazers (Llanos and Crespo 1952) while greater rhea feed on vegetable matter as well as arthropods and small vertebrates (Bruning 1974).

This study focuses, for the first time, on a wetland area of Argentina (the Paraná River Delta Region) and surveys the food habits of plains vizcachas, greater rheas and cattle sharing the same grazing area.

Materials and Methods

The study area was located on the "Don José" Ranch (1,500 ha, 33°27´S, 58°48´W), 6 km north of Ceibas, Department of Gualeguaychú, Entre Ríos province, Argentina. Mean annual rainfall is 978 mm, and temperature averages 17.4 C° (Servicio Metereológico Nacional 1972). The study area is situated in one of the 11 wetland landscape units identified for the Paraná River Delta Region. The landscape pattern corresponds to plains with a savanna physiognomy of grasses, patches of xerophitic *Prosopis nigra* (Griseb.) and *Acacia caven* (Mol.) Mol. forest, and baldspots with a large percentage of bare soil and sparse cover of *Portulaca* sp. L. The area is also crisscrossed by small lentic streams covered with floating and rooted aquatic plants (Malvárez 1997).

Unlike its neighboring areas, the study area is free from the periodical floods of the Paraná River. Large areas are waterlogged by rainfall due to the minimum slope of the land (Malvárez 1997) and the type of soils (Pratolongo 2000). During 1998, coincident with an "El Niño" event, both the waterlogged areas and the duration of the waterlogging were longer than for 1996/97.

Soils are composed of a clayey, sodic horizon close to the surface. These sodic clays hamper water penetration because they swell when wet, creating a layer that is effectively impermeable. Trampling by cattle compounds the problem by compressing and hardening the soil, and eroding thin layers of topsoil (Arias 2000). Extensive cattle ranching (0.7 cows per hectare per year), hunting of wildlife species for food and trade, and exploitation of *P. nigra* trees for lumber are the main human activities in this region.

Vizcachas dig their burrows both in the grasslands and the forest patches and their foraging is restricted to the areas surrounding the burrows (Branch and Sosa 1994, Arias 2000). Greater rhea and cattle, on the other hand, graze over extensive areas, including, in the case of cattle, vegetation from the streams. Cattle were always present on the study area and the overall level of forage utilization was moderate.

Fresh faeces of plains vizcachas and cows were collected seasonally for 2 consecutive years, between November 1996 (spring) and August 1998 (winter). Greater rhea fresh faeces were collected only in spring/summer 1997 and fall/winter 1998, when these birds were present on the study area. Collection dates were in the middle of the respective season. All faeces were collected within the single grazing unit that comprised the study area.

Faeces of plains vizcachas were taken from 8 active burrows located on the edge between grassland and forest patches, while faeces of greater rhea and cattle were collected from droppings found both in grassland and forest patches. We verified the vizcachas´ burrows were active through direct observation of the animals, or signs of recent activity such as fresh faeces, footprints or diggings (Branch et al. 1994b). Fifty pellets were collected at each vizcacha burrow (a total of 400 pellets per season) to form 8 composite samples (1 sample per burrow with 50 pellets each). This is an adequate number of samples to estimate this rodent's diet (Bontti et al. 1997). For greater rhea and cattle, 32 and 24 samples of faeces of 4 g were collected, respectively, and formed into 8 composite samples for both herbivores (each composed of 4 and 3 faeces).

The botanical composition of the diets was determined by means of microhistological analysis using the William's technique (1969). Four slides were prepared from each of the composite samples and 100 randomly chosen microscopic fields were observed at 400x for each slide (Holechek and Vavra 1981, Holechek et al. 1982). Frequencies of each consumed item were converted to percentages of the total sample weight (Holechek and Gross 1982, Martella et al. 1996).

Composite samples of greater rhea underwent a special procedure; whole or fragmented pods and seeds of *P. nigra* and arthropods were separated from the herbaceous components and each of these 3 components was dried and weighed. Herbaceous components were then analyzed following the technique described above.

The percent of each food item was calculated for each season. Diet correlations and dietary similarity among seasons and among herbivore species were analyzed using two-tailed Spearman's rank correlation coefficients (Zar 1996) and Kulczynski´s similarity index (Smith and Shandruk 1979, Henley et al. 2001), respectively. Data were averaged for the 2 years for plains vizcacha and cattle to compare botanical composition of diets among seasons and herbivores.

Results

While vizcachas and cattle fed exclusively on plant leaves, greater rhea also fed on *P. nigra* pods and consumed some arthropods (Tables 1, 2, and 3). Plains vizcacha fed on a wide variety of plants during all seasons (Table 1). A total of 45 plant species were identified in vizcacha diets over the length of the study. Grasses were the staple diet of this rodent, both in amount consumed and in number of species, 42.7% of the diet in winter with 20 species to 65.1% of the diet in spring with 17 species. *Panicum milioides* Nees. was the most consumed grass, contributing 8.8% and 16.4% of the diet in winter and spring, respectively. The item "Other Grasses" was at times similar to *P. milioides* (14.8% vs. 15.1% in summer) or even higher (13.4% vs. 8.8% in winter). Other major items were *Dichondra microcalyx* (Hallier) Fabris. (20.4% and 19.3%, fall and winter) and *P. nigra* (18.7% and 13.2% in fall and winter, respectively).

Legumes were the most common component of the greater rhea diet during spring and summer (25.3% and 38.9%; Table 2) while grasses were more common in fall and winter (35.8% and 45.3%). The high content of legumes was due mainly to the consumption of *P. nigra* pods (21.2% and 37.8%, for spring and summer, respectively). *Plantago myosuros* Lam. (20.5%) and Solanaceae, particularly *Solanum* sp. L. (13.9%) were also important in the spring diet while *Spilanthes*

Table 1. Botanical composition (%) of plains vizcacha diets in different seasons in the Delta of the Paraná River.

Food item	Spring			Summer			Fall			Winter		
	1996	1997	x̄	1997	1998	x̄	1997	1998	x̄	1997	1998	x̄
	(%)											
Perennial grasses												
Aristida sp.	0.0	9.2	4.6	0.0	0.9	0.4	6.2	0.4	3.3	3.8	0.5	2.2
Briza sp.	0.0	3.6	1.8	0.0	0.0	0.0	2.0	0.0	1.0	2.7	0.0	1.3
Bromus sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.2
Cynodon dactylon (L.)	5.5	1.0	3.2	8.3	2.6	5.5	1.2	1.2	1.2	0.3	1.5	0.9
Chloris berroi Arech.	15.2	0.4	7.8	1.2	0.6	0.8	1.0	0.4	0.7	0.7	0.0	0.3
Eleusine tristachya (Lam.) Lam.	5.5	0.4	2.9	1.2	2.6	1.9	0.3	0.6	0.5	0.3	1.5	0.9
Festuca sp.	3.3	0.0	1.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Luziola peruviana Gmel.	0.0	4.5	2.2	6.3	7.8	7.0	10.7	5.4	8.0	5.2	4.0	4.6
Panicum milioides Nees.	16.5	16.4	16.4	11.5	18.6	15.1	12.7	11.6	12.1	9.7	8.0	8.8
Pappophorum sp.	0.0	0.5	0.2	1.2	0.7	1.0	1.8	0.0	0.9	0.5	0.0	0.2
Paspalum spp.	0.0	0.5	0.2	2.2	0.7	1.5	2.8	0.0	1.4	0.3	0.0	0.2
Piptochaetium napostaense Lam.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0
Poa sp.	0.0	0.0	0.0	7.7	0.0	3.8	1.3	0.0	0.7	0.3	0.0	0.2
Setaria sp.	0.0	0.6	0.3	0.5	0.1	0.3	2.5	0.6	1.6	0.0	0.4	0.2
Sporobolus indicus (L.) R. Br.	0.0	0.0	0.0	0.7	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0
Stipa brachychaeta Godr.	0.0	0.0	0.0	7.5	2.1	4.8	0.2	0.2	0.2	0.0	0.7	0.4
Stipa neesiana Trin. et Rupr.	12.7	0.4	6.5	1.0	1.1	1.1	0.2	1.7	1.0	0.0	0.1	0.1
Stipa sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1
Zizaniopsis bonariensis (Balansa et Poitr.) Speg.	0.0	1.9	0.9	1.2	5.6	3.4	3.2	1.5	2.3	3.2	0.4	1.8
Total perennial grasses	58.7	39.4	48.7	50.5	43.4	46.9	46.1	23.7	35.0	27.0	17.7	22.4
Annual grasses												
Hordeum euclaston Steud.	2.0	0.0	1.0	0.5	0.0	0.2	0.0	0.2	0.1	0.0	0.1	0.1
Lolium sp.	0.0	0.0	0.0	0.0	2.7	1.4	0.7	6.8	3.8	0.0	7.5	3.7
Phalaris sp.	0.0	0.5	0.2	0.0	0.4	0.2	0.5	0.4	0.4	1.3	0.5	0.9
Polypogon monspeliensis (L.) Desf.	5.3	7.9	6.6	0.7	0.3	0.5	0.2	0.0	0.1	3.3	0.9	2.1
Total annual grasses	7.3	8.4	7.8	1.2	3.4	2.3	1.4	7.4	4.4	4.6	9.0	6.8
Other Grasses	2.8	13.6	8.2	21.5	8.1	14.8	0.0	9.9	4.9	17.5	9.4	13.4
Grass-like plants (Cyperaceae)												
Carex bonariensis Desf.	0.0	3.6	1.8	0.3	5.5	2.9	0.7	3.4	2.0	1.5	4.6	3.0
Eleocharis sp.	0.0	0.0	0.0	0.3	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0
Other Cyperaceae	3.3	6.5	4.9	0.0	8.7	4.4	6.8	10.1	8.5	9.0	7.1	8.0
Total grass-like plants	3.3	10.1	6.7	0.6	14.2	7.5	7.5	13.5	10.5	10.5	11.7	11.0
Perennial forbs												
Alternanthera philoxeroides (Mart.) Griseb.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.2	0.0	1.6	0.8
Chenopodiaceae	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.4	0.3	0.0	0.5	0.2
Dichondra microcalyx (Hallier) Fabris.	14.3	15.0	14.7	11.2	14.2	12.7	21.0	19.7	20.4	15.7	22.9	19.3
Eichhornia azurea (Sw.) Kunth.	0.0	0.0	0.0	2.7	0.0	1.3	0.0	0.0	0.0	0.0	0.0	0.0
Eryngium sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.2	0.0	0.0	0.0
Gomphrena pulchella Mart.	0.5	1.2	0.9	3.2	2.2	2.7	0.7	0.0	0.3	2.2	2.5	2.3
Holocheilus hieracioides (Don) Cabr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.5	0.2
Modiolastrum sp.	0.0	0.0	0.0	0.0	0.1	0.1	0.2	0.0	0.1	0.2	0.6	0.4
Oxalis sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.1
Pamphalea bupleurifolia Less.	0.0	1.2	0.6	0.7	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0
Phyla canescens (HBK) Greene	2.0	0.7	1.4	4.0	1.5	2.7	2.0	0.4	1.2	0.2	0.0	0.1
Physalis viscosa L.	0.0	0.0	0.0	1.3	0.0	0.7	0.0	0.5	0.2	0.0	0.0	0.0
Solanum sp.	1.7	0.1	0.9	0.7	1.7	1.2	0.3	0.1	0.2	0.2	1.5	0.8
Spergularia levis Camb.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1
Spilanthes stolonifera (H. et A.) Baker	0.0	0.0	0.0	0.7	1.4	1.0	0.0	0.6	0.3	0.3	2.2	1.3
Trifolium sp.	0.0	0.1	0.1	0.3	0.1	0.2	2.7	0.9	1.8	0.2	2.9	1.5
Total perennial forbs	18.5	18.3	18.6	24.8	21.2	22.9	27.2	23.5	25.3	19.2	35.3	27.1
Annual forbs												
Gamochaeta sp.	0.0	2.2	1.1	0.0	0.7	0.4	0.5	0.0	0.2	1.2	2.0	1.6
Medicago sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.4	0.0	0.0	0.0
Plantago myosuros Lam.	3.3	5.0	4.2	0.0	0.6	0.3	0.0	0.1	0.1	0.8	7.0	3.9
Total annual forbs	3.3	7.2	5.3	0.0	1.3	0.7	0.5	1.0	0.7	2.0	9.0	5.5
Shrubs and trees												
Acacia caven (Mol.) Mol.	0.0	0.0	0.0	0.2	0.0	0.1	0.8	0.0	0.4	0.5	0.1	0.3
Prosopis nigra (Griseb.)	6.0	2.7	4.4	1.5	7.7	4.6	16.7	20.7	18.7	18.8	7.6	13.2
Total shrubs and trees	6.0	2.7	4.4	1.7	7.7	4.7	17.5	20.7	19.1	19.3	7.7	13.5

stolonifera (H. et A.) Baker was a major item in summer (14.9%) and *D. microcalyx* was the dominant food item in fall (34.7%). In winter, "Other Dicots" supplied 18.2% of the diet. There were traces of arthropod consumption throughout the year, with the highest values in spring (2.9%) and winter (3.0%).

Grasses were also the dominant group in the cattle diet throughout the year, ranging between 78.3% in fall and 87.3% in summer (Table 3). *Luziola peruviana* Gmel.

Table 2. Botanical composition (%) of greater rhea diets in different seasons in the Delta of the Paraná River.

Food item	Spring 1997	Summer 1997	Fall 1998	Winter 1998
			(%)	
Perennial grasses				
Aristida sp.	0.0	0.0	0.5	0.0
Bromus sp.	0.0	0.9	0.0	0.0
Chloris berroi Arech.	0.0	0.5	0.2	0.2
Luziola peruviana Gmel.	0.2	0.5	8.1	10.7
Panicum milioides Nees.	0.6	0.0	1.9	2.9
Pappophorum sp.	0.0	0.2	0.0	0.0
Setaria sp.	0.0	0.0	0.5	0.0
Zizaniopsis bonariensis (Balansa et Poitr.) Speg.	0.0	0.0	1.2	6.1
Total perennial grasses	0.8	2.1	12.4	19.9
Annual grasses				
Lolium sp.	0.0	0.0	2.1	2.9
Phalaris sp.	0.0	0.0	0.0	0.7
Total annual grasses	0.0	0.0	2.1	3.6
Other Grasses	7.2	6.0	21.5	21.8
Grass-like Plants (Cyperaceae)				
Carex bonariensis Desf.	0.0	0.0	0.7	3.4
Other Cyperaceae	0.0	1.0	0.0	4.6
Total grass-like plants	0.0	1.0	0.7	8.0
Perennial forbs				
Chenopodiaceae	1.0	0.9	0.2	0.0
Dichondra microcalyx (Hallier) Fabris.	4.8	1.6	34.7	6.3
Gomphrena pulchella Mart.	10.8	13.0	0.0	1.0
Holocheilus hieracioides (Don) Cabr.	0.0	0.0	0.5	0.5
Oxalis sp.	1.1	1.0	0.0	0.0
Pamphalea bupleurifolia Less.	0.0	0.6	0.0	0.0
Phyla canescens (HBK) Greene	9.1	13.1	4.2	1.0
Physalis viscosa L.	0.0	1.1	0.0	0.0
Solanum sp.	13.9	1.7	0.2	0.0
Spilanthes stolonifera (H. et A.) Baker	1.9	14.9	1.9	2.2
Trifolium sp.	1.0	0.0	0.0	0.0
Total perennial forbs	43.6	47.9	41.7	11.0
Annual forbs				
Medicago sp.	0.2	0.0	5.8	3.6
Plantago myosuros Lam.	20.5	0.3	6.5	8.2
Total annual forbs	20.7	0.3	12.3	11.8
Shrubs and trees				
Acacia caven (Mol.) Mol.	0.0	0.3	0.0	0.0
Prosopis nigra (Griseb.) leaves	3.0	0.8	0.5	2.7
Prosopis nigra (Griseb.) pods	21.2	37.8	6.6	0.0
Lycium sp.	0.8	0.0	0.2	0.0
Total shrubs and trees	25.0	38.9	7.3	2.7
Other Dicots	0.0	1.0	1.4	18.2
Arthropods	2.9	0.8	1.0	3.0

and *P. milioides* were commonly eaten (the former between 13.8% in winter and 25.0% in summer, and the latter ranging from 9.3% in winter and 20.0% in spring) with *Zizaniopsis bonariensis* (Balansa et Poitr.) Speg. somewhat lower (5.8% in spring and 9.8% both in winter and summer). The item "Other Grasses" averaged about 15% over all seasons. *Luziola peruviana* and *P. milioides* together with "Other Grasses", constituted 60%, 63%, and 58% of the spring, summer and winter diets, respectively.

Within seasons, vizcacha and cattle diets differed in botanical composition between years (Table 4). Summer and winter diets of the vizcacha were significantly correlated between years but the correlation values were low. Similarity index values showed the same trend, except for fall, when similarity was highest (Table 4).

Plains vizcacha and cattle diets were similar among the different seasons, something that matches the rather high values of the similarity index (Table 5). The diet of greater rhea differed among most seasons, being similar only between spring and summer and between fall and winter. Both comparisons also showed the highest similarity values between diets (Table 5).

Botanical composition of the diets of plains vizcacha and cattle was similar within season and the similarity index values oscillated between 50.5 and 57.9 (Table 6). Inversely, plains vizcacha and greater rhea segregated their grazing resources, without significant associations between diets, except in winter, which again had the highest similarity index value (Table 6). Cattle and greater rhea diets differed most with significant negative correlations; also, the observed similarity index´s values showed low values, especially in spring and summer (Table 6).

Discussion

Grasses were the main forage for plains vizcacha and cattle in all seasons. For greater rhea, grasses were the most important diet component when *P. nigra* pods were lacking. The importance of grasses in the plains vizcacha diet has also been reported by other authors (Giulietti and Jackson 1986, Kufner et al. 1992, Jofré 1994, Branch et al. 1994a, Navarro et al. 1997). Although plains vizcacha grazed on a large variety of plant species, only a few food items composed the bulk of its diet in each season. This last fact was observed in other grassland habitats (Giulietti and Jackson 1986), although we found a greater consumption of dicots compared to that study (23 species versus 3 species). Our results are more similar to those from the semiarid scrub of Central Argentina, where 53% of the species in the diet were dicots (Branch et al. 1994a). The number of items consumed by vizcachas in the Delta Region was 45, while Giulietti and Jackson (1986) and Branch et al. (1994a) record 20 and 62 items in grassland and scrub, respectively. The lower number of items found in the grassland might be explained by higher availability of more palatable species, a fact that might allow the rodents to fulfill their nutritional needs with fewer species, in agreement with classic foraging theory (Stephens and Krebs 1986).

In agreement with other studies (Martella et al. 1996, Comparatore and Martínez 1997), greater rhea had a high intake of greens throughout the year. *P. nigra* pods were an important food item during certain parts of the year. These highly nutritious pods appear in spring, reach their peak during summer, their availability decreases in fall, and they cannot be found in winter (Pratolongo 2000), which correlates with their abundance in the rhea diet.

Variations in digestibility of the different food items could be taking place in the

Table 3. Botanical composition (%) of cattle diets in different seasons in the Delta of the Paraná River.

Food item	Spring			Summer			Fall			Winter		
	1996	1997	$\bar{x}$	1997	1998	$\bar{x}$	1997	1998	$\bar{x}$	1997	1998	$\bar{x}$
	(%)											
Perennial grasses												
Aristida sp.	0.0	10.5	5.3	5.0	0.0	2.5	3.5	0.0	1.8	8.0	0.0	4.0
Briza sp.	0.0	5.5	2.7	0.0	0.0	0.0	2.0	0.0	1.0	12.0	0.0	6.0
Cynodon dactylon (L.)	3.5	0.0	1.8	0.5	0.0	0.3	3.0	4.0	3.5	0.0	0.0	0.0
Chloris berroi Arech.	4.0	0.0	2.0	5.5	1.0	3.3	4.0	0.0	2.0	0.0	0.0	0.0
Eleusine tristachya (Lam.) Lam.	0.0	0.0	0.0	4.0	2.5	3.3	0.0	1.5	0.8	0.0	0.0	0.0
Festuca sp.	5.0	0.0	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Luziola peruviana Gmel.	21.5	26.5	24.0	22.0	28.0	25.0	17.5	11.0	14.3	13.0	14.5	13.8
Panicum milioides Nees.	31.0	9.0	20.0	14.0	11.5	12.8	14.0	8.5	11.3	4.0	14.5	9.3
Pappophorum sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.5	1.8	0.0	0.0	0.0
Paspalum sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.3	0.0	0.0	0.0
Poa sp.	0.0	0.0	0.0	1.5	0.0	0.8	0.0	0.0	0.0	3.0	0.0	1.5
Setaria sp.	0.0	0.0	0.0	0.0	2.5	1.3	5.5	0.0	2.8	0.0	0.0	0.0
Stipa brachychaeta Godr.	0.0	0.0	0.0	1.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0
Stipa neesiana Trin. et Rupr.	4.0	0.0	2.0	0.0	3.5	1.8	2.5	9.0	5.8	0.0	0.0	0.0
Zizaniopsis bonariensis . (Balansa et Poitr.) Speg	0.0	11.5	5.8	3.0	16.5	9.8	7.5	8.5	8.0	11.5	8.0	9.8
Total perennial grasses	69.0	63.0	66.1	56.5	65.5	61.4	60.0	46.0	53.4	51.5	37.0	44.4
Annual grasses												
Hordeum euclaston Steud.	1.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lolium sp.	0.0	0.0	0.0	0.0	2.5	1.3	0.0	9.0	4.5	0.0	9.0	4.5
Phalaris sp.	0.0	0.0	0.0	0.0	0.0	0.0	3.0	1.5	2.3	0.0	1.0	0.5
Polypogon monspeliensis (L.) Desf.	3.5	0.0	1.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total annual grasses	4.5	0.0	2.3	0.0	2.5	1.3	3.0	10.5	6.8	0.0	10.0	5.0
Other Grasses	6.5	25.0	15.8	35.5	14.5	25.0	16.0	21.0	18.5	37.5	31.5	34.5
Grass-like Plants (Cyperaceae)												
Carex bonariensis Desf.	0.0	6.0	3.0	0.0	12.5	6.3	0.0	7.5	3.8	1.0	5.5	3.3
Other Cyperaceae	0.5	2.5	1.5	0.0	0.0	0.0	3.0	8.5	5.8	0.0	4.0	2.0
Total grass-like plant	0.5	8.5	4.5	0.0	12.5	6.3	3.0	16.0	9.6	1.0	9.5	5.3
Perennial forbs												
Alternanthera philoxeroides (Mart.) Griseb.	0.5	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Chenopodiaceae	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.5	0.0	1.0	0.5
Dichondra microcalyx (Hallier) Fabris.	7.0	1.5	4.3	1.0	0.0	0.5	4.0	0.0	2.0	2.5	5.0	3.8
Gomphrena sp.	0.0	0.0	0.0	1.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0
Phyla canescens (HBK) Greene	0.5	0.0	0.3	2.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0
Solanum sp.	0.0	0.0	0.0	1.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0
Spergularia levis Camb.	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.5	0.0	0.0	0.0
Spilanthes stolonifera (H. et A.) Baker	0.5	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	1.0
Trifolium sp.	0.0	0.0	0.0	0.5	0.0	0.3	5.5	0.0	2.8	1.0	0.0	0.5
Total perennial forbs	8.5	1.5	5.2	5.5	0.0	2.8	11.5	0.0	5.8	3.5	8.0	5.8
Annual forbs												
Gamochaeta sp.	0.0	0.5	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Plantago myosuros Lam.	0.5	0.0	0.3	2.5	0.0	1.3	0.0	0.0	0.0	0.5	0.0	0.3
Total annual forbs	0.5	0.5	0.6	2.5	0.0	1.3	0.0	0.0	0.0	0.5	0.0	0.3
Shrubs and trees												
Prosopis nigra (Griseb.)	10.5	1.5	6.0	0.0	5.0	2.5	6.5	6.5	6.5	2.5	4.0	3.3
Other Dicots	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.5	0.0	1.8

digestive tract. Plant parts in the rhea faeces were hardly degraded. There were only traces of arthropods in the faeces, in spite of their high abundance in the field throughout the year. As with Martella et al. (1996), these traces were highly digested, unlike the plant material. This seems to indicate that this method for diet quantification is unsuitable to analyze the food habits of the greater rhea, because differences in digestibility produce a bias in establishing the true proportion of each item in its diet (Moreby 1988, Rosenberg and Cooper 1990, Martella et al. 1996).

Although the results obtained by comparing the diet compositions by means of correlations and similarity indices showed on the whole a similar trend, the former were clearer when comparing between years, seasons and species.

Differences observed in botanical composition of the diets of plains vizcacha and cattle between the 2 years could be due to environmental variability. Observed differences in rainfall might account for variability in both vegetation abundance and grazing area because of the waterlogging, resulting in changes in forage availability. Plains vizcacha avoid waterlogged areas. Waterlogging may also provoke changes in the vegetation which may in turn influence changes in the grazing patterns from one year to the next. While some grasses were eaten less in the wettest year (e.g. *Chloris berroi, Stipa neesiana, Polypogon monspeliensis*), intake of Cyperaceae grew (See Tables 1 and 3). Despite the yearly changes in the foraging patterns, however, the staple components of the diet kept their high values between the 2 years of the study (e.g. *Dichondra microcalyx* and *Panicum milioides* for both vizcachas and cattle and *Luziola peruviana* for cattle). Thus, these environmental changes corresponded to changes in the grazing patterns

Table 4. Comparison of the composition of plains vizcacha and cattle diets (Spearman's rank correlation coefficient, r^s and Kulczynski's similarity index, K) between the same season of different years in the Paraná River Delta.

	Plains vizcacha				Cattle			
Comparison[a]	n[b]	r_s	P	K	n	rs	P	K
SP 96 – SP 97	28	0.10	0.61	51.7	21	0.01	0.96	40.5
SU 97 – SU 98	36	0.35	0.04	54.7	21	0.17	0.47	54.5
F 97 - F 98	39	0.30	0.07	68.5	22	0.23	0.30	59.5
W 97 - W 98	39	0.42	<0.01	61.4	18	0.21	0.41	62.5

[a]SP = Spring; SU = Summer; W = Winter; F = Fall.
[b]n = Number of food items.

of both herbivores. Something similar was observed for wild and domestic herbivores in central Entre Ríos (Quintana et al. 1998b). This underscores the need to conduct surveys for at least 2 years, as proposed by Hansen and Lucich (1978).

Variations observed in the greater rhea diet throughout the year may be explained by changes in basic nutritional requirements associated with reproductive activities (Bruning 1974, Robbins 1981, Lombardi 1994, Martella et al. 1995, Reboreda and Fernández 1997). Intake of insects, small vertebrates, and seeds satisfy the need of minerals, vitamins, proteins, or specific nutrients in larger or lesser demand according to the season (Robbins 1981, Martella et al. 1996). This intake was higher during spring and summer, the mating season for this species (Reboreda and Fernández 1997). Consequently, the similar diets observed in these seasons and their difference with the fall/winter intake is logical. Since spring and summer faeces of greater rhea were collected in 1997, while the fall and winter samples were from 1998, one might think that variation of intake of *Prosopis nigra* pods between spring/summer and fall/winter could also be due to environmental changes that took place from one year to the next. Yet, intake of these pods corresponded to the availability of *Prosopis nigra* fruits through the year in this region (Burkart 1976, Pratolongo 2000), supporting our previous argument.

Grazing on common grounds explains the similarity observed in botanical composition of diet observed throughout the year between plains vizcacha and cattle, including a few common dominant species (mainly grasses) and a wide range of less relevant species (<3%). Diet similarities between cattle and medium-sized wild herbivores such as the plains vizcacha have also been reported for mara (*Dolichotis patagonum*) (Kufner and Pelliza 1987) and European hares (*Lepus europaeus*) (Bonino et al. 1986). Increased intake of *P. nigra* leaves by plains vizcacha in fall and summer did not coincide with the results for cattle (except for a slight intake in fall) and this may be due to the wider range of movement of cattle as compared to that of the rodents. Cattle had easy access to areas with more tender, palatable grass, a preferred forage (Hansen and Gold 1977, Vavra et al. 1977, Samuel and Howard 1982). This forage was not as available for vizcachas because their foraging was restricted to the surroundings of their burrows (Branch and Sosa 1994, Arias 2000). Greater rhea diet was more similar to those of the other 2 species in seasons where the intake of *Prosopis* seeds decreased.

According to Kufner et al. (1992), the larger number of items in the diet of plains vizcachas seems to indicate better adapted grazing habits than those of greater rhea and cattle, when faced with the resources available in their habitat. However, the relevance of grasses as a resource shared by this rodent and cattle implies a significant dietary overlap that might be a negative factor for the remaining populations of vizcacha in this area. Plains vizcacha and cattle had similar diets, which supports the ranchers' view that vizcachas compete with domestic herbivores for foraging resources and leads to their being hunted as pests. However, high overlap in the use of resources implies competition only if the resources are scarce (Wiens 1989). Hunting of greater rhea on ranches

Table 5. Comparison of the composition of plains vizcacha, greater rhea and cattle diets (Spearman's rank correlation coefficient, r^s and Kulczynski's similarity index, K) among seasons in the Paraná River Delta.

	Plains vizcacha				Cattle				Greater rhea			
Comparison[a]	n[b]	r_s	P	K	N	r_s	P	K	n	r_s	P	K
SP – SU	38	0.38	0.02	63.1	29	0.48	<0.01	71.2	24	0.58	<0.01	56.6
SP – F	41	0.47	<0.01	56.9	30	0.47	<0.01	67.9	25	0.17	0.42	34.1
SP – W	41	0.51	<0.01	61.6	27	0.48	0.01	63.3	25	-0.17	0.43	30.6
SU – F	43	0.61	<0.01	62.0	28	0.50	<0.01	68.0	30	0.07	0.72	23.3
SU – W	44	0.50	<0.01	64.6	27	0.31	0.11	69.0	28	-0.17	0.36	14.9
F – W	43	0.60	<0.01	76.6	26	0.48	0.01	68.6	25	0.56	<0.01	58.2

[a]SP = Spring; SU = Summer; W = Winter; F = Fall.
[b]n = Number of food items.

Table 6. Comparison of the composition of plains vizcacha (PV), greater rhea (GR) and cattle (CA) diets (Spearman's rank correlation coefficient, r^s and Kulczynski's similarity index, K) in different seasons in the Paraná River Delta.

	PV vs CA				PV vs GR				GR vs CA			
	n[a]	r_s	P	K	N	r_s	P	K	n	r_s	P	K
Spring	30	0.70	<0.01	56.7	35	-0.19	0.29	23.3	30	-0.38	0.04	16.1
Summer	36	0.57	<0.01	53.6	41	0.01	0.98	19.0	32	-0.38	0.04	10.8
Fall	40	0.82	<0.01	57.9	43	0.22	0.16	43.3	32	-0.04	0.83	36.2
Winter	40	0.64	<0.01	50.5	42	0.41	<0.01	49.6	24	0.34	0.11	59.6

[a] n = Number of food items.

and farms has been justified for the same reason: its perceived competition with cattle for the grazing resources. Our results suggest that greater rhea and cattle have different foraging patterns during the year, with little potential for diet competition.

Both native herbivores may have important ecological roles in this wetland area: greater rhea in forest regeneration, not only dispersing *P. nigra* seeds but also speeding up the germination process as the seeds pass through their digestive tract and improving seed germination rates (Pratolongo 2000). Plains vizcachas help recycle nutrients, increase soil water infiltration through their burrowing activities, which could improve these already degraded soils, and add to the creation of a new habitat type that is used by other wildlife species (Arias 2000).

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