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Diet of the brown hare (*Lepus europaeus*) and food availability in northern Patagonia (Mendoza, Argentina)

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Abstract

The brown hare, a Leporid widespread in the world, is now dispersed across Argentina after its introduction at the end of the 19th century. Studies on hare feeding ecology are important to evaluate a potential competition with domestic and native wild herbivores. This study analyses the brown hare diet in relation to food availability, and dietary overlaps with several herbivores in northern Patagonia. Food availability was estimated by point-quadrat transects, and hare diet by microhistological analysis of faeces, carried out in five habitats in five seasonal samplings. Significant differences were detected by Kruskall-Wallis ANOVA with multiple comparisons by Tukey test. Feeding selection was detected by χ^2 test, and dietary preferences by the confidence interval of Bailey. Grasses and chamaephytes were the most available plant categories, with *Stipa*, *Panicum* and *Acantholippia* as main species. Grasses and phanerophytes were the main dietary categories, including *Poa*, *Panicum*, *Bromus*, *Adesmia* and *Prosopidastrum*. The phanerophytes *Prosopidastrum* and *Ephedra* were more eaten in winter, when the main food item (*Poa*) presented lower availability. A higher dietary proportion of the chamaephyte *Acantholippia* occurred in rocky habitats, where the coarse dominant grasses were always avoided. Hares shared most food items with several wild and domestic herbivores in northern Patagonia. The lack of preference for forbs differentiates brown hares from other herbivores. However, hares exhibited important dietary similarities with plain and mountain vizcachas, goats and horses, and an interspecific competition for food is highly probable.

Key words: Lagomorphs, arid environments, feeding ecology

Introduction

The brown hare or European hare (*Lepus europaeus* Pallas, 1837) is a medium-sized herbivore belonging to the Lagomorpha order. A range from 2.5 to 7.0 kg was documented for the body weight of this species (Macdonald and Barret 1995), averaging 3.3 kg in the region of study (Bonino 1999). This hare is considered one of the most widespread mammal species in the world, that dispersed in Argentina at a rate of 18.6 km/year after having been introduced in South America from Germany and France (Grigera and Rapoport 1983). The hare arrived in central Argentina in 1888 and

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1897 (Godoy 1963), in southern Argentina in 1930 (Carman 1976), and in southern Chile in 1896. The presence of hares was detected also in southern Peru as of 2002 (Cossios 2004). The current distribution of hares in Argentina overlaps with the geographical ranges of two indigenous herbivores of intermediate sizes, the mara (*Dolichotis patagonum*, Caviidae family, 8.0 kg in body weight, Taber 1987) and the plain vizcacha (*Lagostomus maximus*, Chinchillidae family, 5.2 kg in body weight, Llanos and Crespo 1952), both belonging to the Rodentia order.

Despite differences in behaviour and ecological pretensions (Taber and Macdonald 1992), it still remains unknown whether a decline in the population levels of the mara is due to the introduction of the brown hare because possible interspecific competition for food (Bonino et al. 1997; Grigera and Rapoport 1983). Studies about the feeding ecology of hares are important to evaluate potential management problems derived from competition of hares with wild herbivores as well as domestic ungulates, particularly considering the food overlaps of brown hares with sheep and goats detected in central Patagonia (Bonino et al. 1986, 1999).

The objectives of this study are to analyse the diet composition of brown hares, dietary changes in relation to food availability, and dietary overlaps with several herbivores in a northern Patagonia environment.

Material and methods

Study area and habitat characteristics

The study was conducted in La Payunia Reserve (Mendoza, Argentina, 36°10′S and 68°50′W, 2,500 km^2, 1300–2000 m in altitude). This area is located within the northernmost unit of the Patagonian Biogeographical Province (Cabrera and Willink 1980). The climate is of continental desert type (Consejo Federal de Inversiones 1977). Mean seasonal temperature ranges from 6 °C in winter to 20 °C in summer, and annual precipitation averages 255 mm. The relief presents gentle slopes and large plains, interrupted by basaltic steps and groups of hills originated from volcanic activity (González Diaz 1972). The xerophyllous vegetation, with a moderate mean cover (58%), belongs to the Patagonian shrub steppe. Almost all shrubs are represented by evergreen species.

La Payunia was divided into habitats characterized by recurrent patterns of relief, soil and vegetation, based on 1:50,000 aerial photography, geological cartography (González Diaz 1972) and plant cartography (Martínez and Dalmasso 1993). Five different large habitats used by brown hares (Huayquerías, Zaino, Guadalosos, Aparejo and Escoriales) were selected. Sandy soils dominated by grasses characterized Guadalosos and Zaino, the latter with a more pronounced slope and a higher proportion of phanerophytic shrubs. A succession of basaltic outcrops codominated by grasses and chamaephytes characterised Escoriales, Aparejo and Huayquerías, the latter with bigger outcrops and a higher proportion of forbs. Sand deposits partially buried the basaltic steps in Aparejo. Phanerophytes in Aparejo and chamaephytes in Escoriales dominated the shrub stratum. Percentages of the total plant cover in sandy habitats (Guadalosos and Zaino) were significantly higher ($H = 79.68$ $p < 0.001$ Kruskal–Wallis test) than in rocky habitats (Aparejo, Escoriales and Huayquerías).

Field and laboratory design

During 1992–1993, five samplings were conducted in five 10-km^2 areas, representative of the five above-defined habitats. Samplings corresponded to winter (July), spring (October), summer (December and February), and autumn (May). Throughout the year, 50 faecal samples were collected in each sampling area, and 30 transects were traversed to determine plant cover (as an estimator of food availability) by the point-quadrat method (Daget and Poissonet 1971). High branches unaccessible to hares were only detected in some specimens of three phanerophytes (*Lycium*, *Berberis* and *Anarthrophyllum*), and did not affect food availability due to their scarcity in the environment. Faecal samples composed of 10 fresh pellets were collected from 10 groups of faeces selected from each sampling area. All 30-m transects were randomly distributed within each sampling area, separated from each other by more than 100 m. The number of transects was slightly higher in microhabitats with a more complex topography. Faecal samples were analysed by the microhistological method of Baumgartner and Martin (1939), modified by Duci (1949), using plant reference material from La Payunia stored in the Ruiz Leal Herbarium (IADIZA, Argentina), and described by Puig et al. (1996). Genus levels, and species level when possible, were reached during plant cuticle identification.

Statistical analyses

Only the 29 plant species consumed by hares at least on one occasion (51% of those recorded in all five habitats) were considered. Plant species were grouped into five categories according to life form: grasses, forbs, succulents, chamaephytes, and phanerophytes. Diversities in food availability and diet were estimated using the Shannon–Wiener function (H', Colwell and Futuyma 1971). The percentage of overlap (O, Hurlbert 1978) was applied to estimate similarities between microhabitats or diets. Plant cover, diversity, proportion of plant species and categories were analysed by the Kruskall-Wallis ANOVA and the Tukey test (H and q, Zar 1984) for multiple comparisons among the five habitats and the five dates, in order to detect significant spatial and temporal differences in availability and diet. The level of significance obtained was mostly $P \leqslant 0.001$, otherwise it is mentioned on the text.

The association between relative frequencies of species occurrence in diet and availability was analysed by the Spearman's rank correlation coefficient (r_S, Siegel 1986). Feeding selection was detected through significant differences between observed and expected dietary proportions by using the χ^2 test (Zar 1984). The confidence interval of Bailey (Cherry 1996) identified the selective use of the main species (species with frequencies equal to or higher than 5% in their availability and/or in the diet). Plant use was qualified as preference, indifference or avoidance depending on whether availability was, respectively, located below, within or above the confidence interval of the dietary frequency.

Results

Food availability in the different habitats

Grasses dominated the plant species available to brown hares (79%), associated with low and high shrubs (13% chamaephytes, 5% phanerophytes). Succulents and forbs showed low availabilities (2% and 0.6%). Main plant species in availability were the grasses *Stipa* and *Panicum*, associated with two grasses (*Poa, Sporobolus*) and the chamaephyte *Acantholippia* (Tab. 1). A higher availability of forbs occurred in early summer ($H = 24.44$, Tab. 2), whereas a lower availability of *Poa* occurred in winter ($H = 26.77$, Fig. 1).

Similarities in plant species availability were higher ($H = 14.94$) between sandy habitats ($O = 0.52$) and between rocky habitats ($O = 0.51$), than similarities found between sandy and rocky habitats ($O = 0.30$). Plant diversity was higher in Guadalosos and Escoriales than in the other habitats ($H = 23.36$). The rocky habitat Escoriales differed by a lower availability of grasses ($H = 19.78$, Tab. 2), and a higher availability of succulents ($H = 44.70$). A higher proportion of forbs ($H = 45.18$) was detected in the rocky habitat Huayquerías, and a higher proportion of phanerophytes ($H = 16.67$ $P = 0.002$) in the sandy habitat Guadalosos. Sandy habitats showed higher proportions of the grass *Panicum* ($H = 92.85$, Fig. 2), the phanerophytes *Berberis* and *Adesmia* ($H = 42.80$, $H = 19.70$). Rocky habitats exhibited higher proportions of the grasses *Stipa* and *Poa* ($H = 84.99$, $H = 49.91$), the chamaephytes *Junellia* and *Hyalis* ($H = 44.02$, $H = 48.16$), and the phanerophyte *Prosopidastrum* ($H = 21.39$). Higher availabilities were detected in Guadalosos and Huayquerías for the grass *Sporobolus* ($H = 60.36$), and in Zaino and Aparejo for the phanerophyte *Lycium* ($H = 34.95$).

Diet of the brown hare

Grasses occupied a high proportion in the diet (68%), complemented by phanerophytes (21%) and chamaephytes (10%), with low proportions of forbs and succulents (1% and 0.1%). The main dietary species were the grass *Poa*, followed by the grasses *Panicum*, *Bromus*, the chamaephyte *Acantholippia*, and the phanerophytes *Adesmia* and *Prosopidastrum* (Tab. 1).

Early and late summer differed from the other sampling seasons by a higher dietary diversity ($H = 32.81$, Tab. 2), higher proportions of the grasses *Panicum, Hordeum, Sporobolus* and *Stipa* ($H = 16.64$ $P = 0.002$, $H = 14.63$ $P = 0.006$, $H = 21.09$, $H = 60.52$, Fig. 1), the forb *Doniophyton* ($H = 22{,}41$), the chamaephyte *Junellia* ($H = 35.13$), the phanerophytes *Lycium, Adesmia* and *Berberis* ($H = 45.15$, $H = 31.85$, $H = 17.47$ $P = 0.002$). Winter was characterized by higher proportions of the phanerophytes *Ephedra* and

Table 1. Mean proportion of plant species in food availability and in the diet of brown hares (Bailey intervals for dietary proportions are between brackets), and type of use classified as preference (P), indifference (I) or avoidance (A). The acronysm (Acr) for each species is mentioned.

Acr	Plant species	Availability	Diet (Bailey interval)	Type of use
Grasses				
Ho	*Hordeum* spp.	0.001	0.034 (0.001–0.120)	I
Br	*Bromus brevis*	0.001	0.081 (0.016–0.185)	P
Po	*Poa lanuginosa*	0.102	0.409 (0.252–0.538)	P
St	*Stipa* spp.	0.348	0.028 (0.000–0.111)	A
Sp	*Sporobolus rigens*	0.098	0.003 (0.000–0.065)	A
Pa	*Panicum urvilleanum*	0.244	0.117 (0.034–0.233)	A
Ar	*Aristida* aff. *mendocina*	0.000	0.002 (0.000–0.063)	I
De	*Digitaria californica*	0.000	0.004 (0.000–0.067)	I
Forbs				
Qu	*Quenopodium pappulosum*	0.000	0.001 (0.000–0.061)	I
Go	*Gomphrena* sp.	0.000	0.000 (0.000–0.059)	I
La	*Lappula redowsky*	0.001	0.000 (0.000–0.059)	I
De	*Descurrainia* sp.	0.002	0.000 (0.000–0.059)	I
Le	*Lesquerella mendocina*	0.000	0.004 (0.000–0.067)	I
Lp	*Lecanophora heterophylla*	0.000	0.001 (0.000–0.062)	I
Ni	*Nicotiana spegazzini*	0.000	0.000 (0.000–0.059)	I
Pl	*Plantago patagonica*	0.002	0.002 (0.000–0.062)	I
Do	*Doniophyton* sp.	0.000	0.004 (0.000–0.068)	I
Succulents				
Ca	Cactaceae	0.023	0.001 (0.000–0.062)	I
Chamaephytes				
Ju	*Junellia seriphioides*	0.016	0.003 (0.000–0.064)	I
Ac	*Acantholippia seriphyoides*	0.052	0.089 (0.020–0.202)	I
Hy	*Hyalis argentea*	0.046	0.000 (0.000–0.060)	I
Ba	*Baccharis darwini*	0.002	0.001 (0.000–0.061)	I
At	*Atriplex lampa*	0.011	0.004 (0.000–0.069)	I
Phanerophytes				
Ep	*Ephedra ochreata*	0.004	0.013 (0.000–0.086)	I
Ly	*Lycium chilense*	0.011	0.010 (0.000–0.079)	I
Pr	*Prosopidastrum globosum*	0.006	0.078 (0.015–0.191)	P
Ad	*Adesmia* spp.	0.016	0.088 (0.019–0.192)	P
Be	*Berberis grevilleana*	0.007	0.002 (0.000–0.063)	I
An	*Anarthrophyllum rigidum*	0.008	0.021 (0.000–0.103)	I

Prosopidastrum ($H = 41.51$, $H = 15.31$ $P = 0.004$). Autumn was characterized by higher proportions of the grasses *Bromus*, *Poa* and *Digitaria* ($H = 16.36$ $P = 0.003$, $H = 15.86$ $P = 0.003$, $H = 17.97$ $P = 0.001$), the forb *Quenopodium* ($H = 16.51$ $P = 0.002$), and the phanerophyte *Anarthrophyllum* ($H = 32.85$). Dietary similarity ($H = 30.13$) was found to be lower between the rocky habitat Aparejo and both sandy habitats Guadalosos and Zaino ($O = 0.43$), than in the other cases ($O = 0.63$). Dietary diversity was higher in Huayquerías than in the other habitats ($H = 23.06$, Tab. 2). Grasses occupied a higher dietary proportion in the sandy habitat Zaino, and lower dietary proportions in the rocky habitats Aparejo and Escoriales, than in the other habitats ($H = 54.56$). *Poa* occupied a higher dietary proportion in sandy habitats and Escoriales ($H = 54.23$,

Table 2. Species diversity and proportion of plant categories in food availability and in the diet of brown hares (between brackets) per sampling date and habitat

	Diversity	Grasses	Forbs	Succulents	Chamaephytes	Phanerophytes
Sampling dates						
July	0.736 (0.820)	0.761 (0.557)	0.002 (0.014)	0.036 (0.006)	0.147 (0.144)	0.055 (0.279)
October	0.835 (0.809)	0.772 (0.649)	0.000 (0.004)	0.043 (0.000)	0.130 (0.119)	0.054 (0.228)
December	0.929 (0.870)	0.733 (0.728)	0.021 (0.023)	0.025 (0.001)	0.138 (0.058)	0.083 (0.189)
February	0.803 (0.810)	0.828 (0.762)	0.004 (0.014)	0.003 (0.000)	0.122 (0.067)	0.043 (0.157)
May	0.770 (0.766)	0.874 (0.688)	0.002 (0.009)	0.007 (0.000)	0.095 (0.100)	0.021 (0.203)
Sampling habitats						
Huayquerias	0.613 (0.862)	0.857 (0.741)	0.024 (0.035)	0.009 (0.001)	0.105 (0.164)	0.005 (0.059)
Zaino	0.479 (0.696)	0.907 (0.870)	0.001 (0.017)	0.001 (0.002)	0.030 (0.048)	0.061 (0.064)
Guadalosos	0.813 (0.708)	0.780 (0.739)	0.001 (0.003)	0.001 (0.000)	0.114 (0.002)	0.104 (0.256)
Aparejo	0.495 (0.807)	0.842 (0.437)	0.001 (0.001)	0.097 (0.000)	0.097 (0.225)	0.059 (0.338)
Escoriales	0.778 (0.748)	0.581 (0.598)	0.002 (0.007)	0.286 (0.005)	0.286 (0.050)	0.026 (0.340)

Fig. 2), *Panicum* in sandy habitats and Huayquerías ($H = 63.99$), *Stipa* in Guadalosos and Huayquerías ($H = 24.94$). Scarce grasses showed higher dietary proportions in rocky habitats, as *Hordeum* (Aparejo, $H = 34.80$) and *Bromus* (Escoriales, $H = 17.53$ $P = 0.002$), whereas *Digitaria* was more eaten in Zaino ($H = 30.40$). The grass *Sporobolus* showed lower proportions in Zaino and Escoriales ($H = 20.44$). Higher proportions were found for the forb *Lesquerella* in Zaino ($H = 30.40$), and for the phanerophyte *Berberis* in both sandy habitats ($H = 24.52$). Rocky habitats showed higher dietary proportions of forbs (Huayquerías, $H = 36.04$), chamaephytes (Aparejo and Huayquerías, $H = 69.63$), and phanerophytes (Escoriales and Aparejo, $H = 76.67$). Higher proportions were found in Huayquerías and Aparejo for the chamaephyte *Acantholippia* ($H = 67.29$), in Huayquerías for two forbs (*Quenopodium*, $H = 16.51$ $P = 0.002$, *Doniophyton*, $H = 34.68$) and the phanerophyte *Ephedra* ($H = 16.91$ $P = 0.002$), in Aparejo and Escoriales for the phanerophyte *Prosopidastrum* ($H = 78.89$), and in Escoriales and Guadalosos for the phanerophyte *Adesmia* ($H = 52.27$).

Wild and domestic herbivores present in the study area used 13 to 24 food items from the 29 plant species eaten by brown hares. Important dietary similarities with the brown hare were obtained for wild herbivores (plain vizcachas and mountain vizcachas, $O = 0.62$ and 0.61, respectively) as well as for domestic herbivores (goats and horses, $O = 0.64$ and 0.56).

Dietary preferences

The hare diet showed a significant association with plant availability in the complete study area ($R = 0.50$ $P = 0.006$), as well as in Aparejo ($R = 0.93$), Escoriales ($R = 0.85$), Zaino ($R = 0.61$), Guadalosos ($R = 0.54$ $P = 0.003$) and Huayquerías ($R = 0.38$ $P = 0.041$). The association was significant in all sampling seasons except in autumn.

A selective use of plant species and categories was detected according to annual means ($\chi^2 = 999.71$, $\chi^2 = 55.21$). Brown hares showed preference for phanerophytes, particularly *Prosopidastrum* and *Adesmia*, and for the grasses *Bromus* and *Poa* among the main species (Tab. 1). A use with indifference was detected for chamaephytes, particularly *Acantholippia* and *Hyalis*. Most grasses, particularly *Stipa*, *Sporobolus* and *Panicum* were avoided. Brown hares maintained the selective use of food throughout the year ($\chi^2 = 4406.99$ in July, 2359.86 in October, 954.31 in December, 1327.20 in February, 5815.25 in May). The use of most grasses, particularly *Panicum*, shifted to indifference during spring and summer, whereas the grass *Hordeum* was preferred during summer (Fig. 1). A preference for the chamaephyte

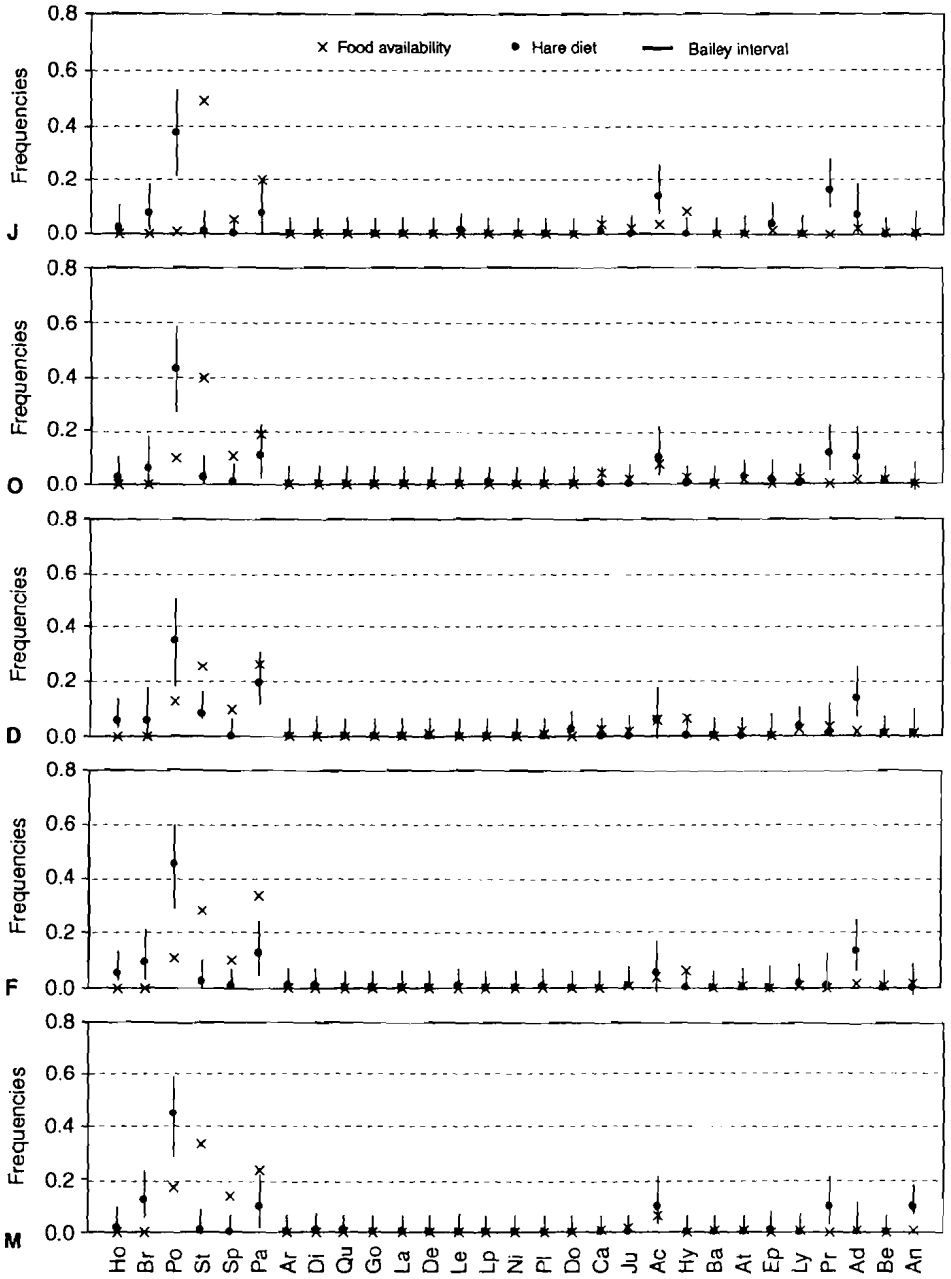

Fig. 1. Proportion of plant species in food availability and in the hare diet on July (J), October (O), December (D), February (F) and May (M), and Bailey intervals of dietary proportions for detection of selective use. Species identification is detailed in table 2.

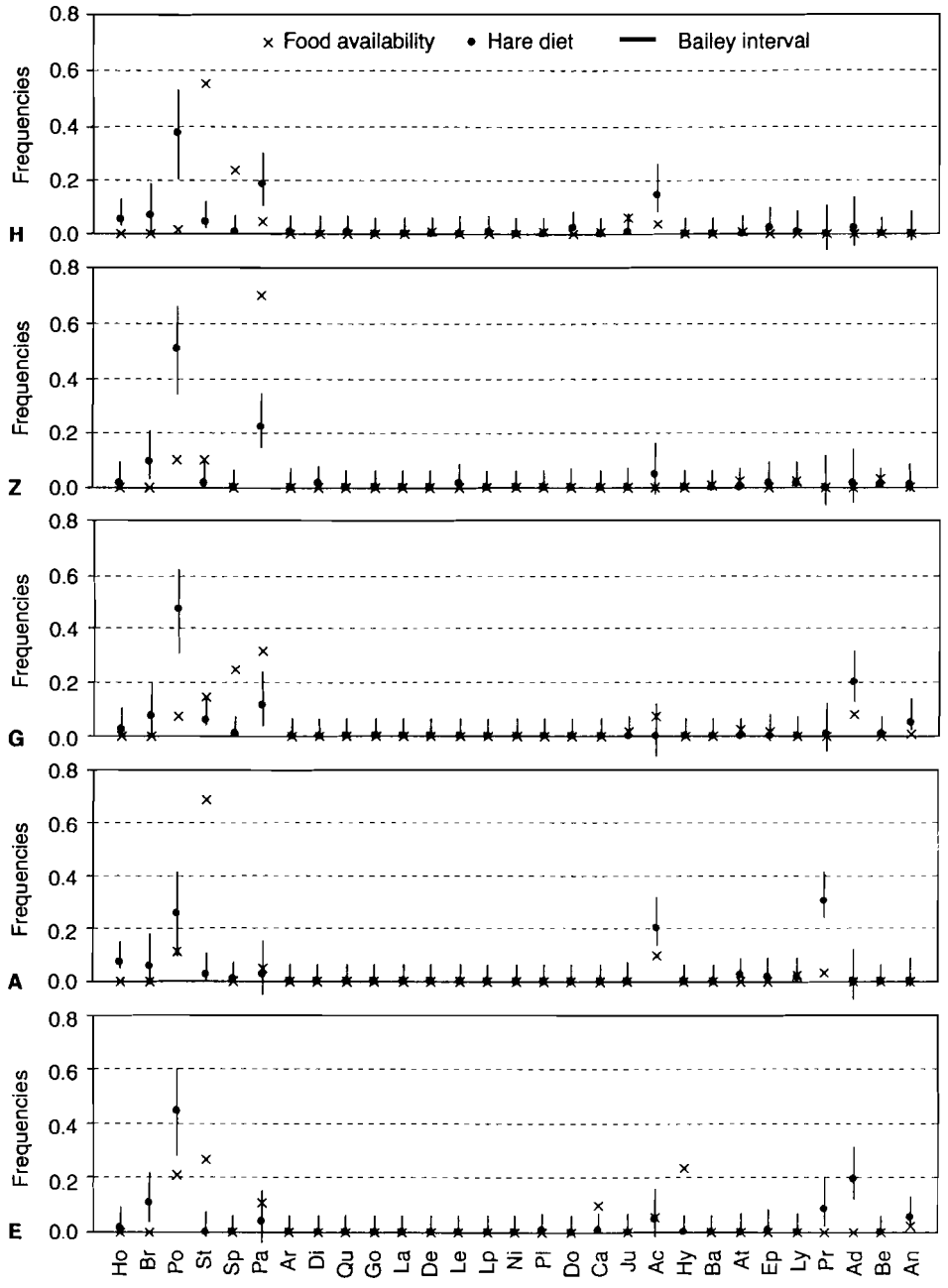

Fig. 2. Proportion of plant species in food availability and in the hare diet in the Huayquerías (H), Zaino (Z), Guadalosos (G), Aparejo (A) and Escoriales (E), and Bailey intervals of dietary proportions for detection of selective use. Species identification is detailed in table 2.

Acantholippia was detected in winter. The use of phanerophytes, particularly *Prosopidastrum,* shifted to indifference in early summer. The selective use of food was detected in all habitats analyzed (χ^2= 2083.50 in Huayquerías, 1991.52 in Zaino, 1443.69 in Guadalosos, 992.95 in Aparejo, 5995.43 in Escoriales), particularly preference for the grasses *Poa* and *Bromus*, and avoidance of *Stipa* except in the sandy habitat Guadalosos (Fig. 2). Grasses were used with indifference in both sandy habitats and Escoriales, where availability of *Stipa* was lower. The grass *Panicum* was used with indifference in Aparejo and Escoriales, and was preferred in Huayquerías, where its availability was lower. Phanerophytes were used with indifference in Zaino, where the preferred species showed low proportions. The chamaephyte *Acantholippia* was preferred in Zaino and Huayquerías, and avoided in Guadalosos.

Discussion

Dietary generalism in brown hares was confirmed in northern Patagonia, as their diet included all plant categories, and 51% of the available species recorded in the environment. The dominance of grasses in food availability is reflected by a considerable proportion in the diet, although used with indifference. The grasses preferred by brown hares (*Poa*, *Bromus*) were also preferred by other herbivores in the study area, such as guanaco (*Lama guanicoe*), plain and mountain vizcachas, cattle, horses, goats (Puig et al. 1996, 1998a, b, 2001). Grasses also constituted an important dietary component for brown hares in other environments of Argentina, associated with graminoids, shrubs and forbs (Bonino et al. 1986; Pelliza et al. 1997; Rosati et al. 2000; Kufner et al. 2001). The presence of phanerophytes as more or less isolated patches in the study environment enhances the dietary relevance of this plant category for brown hares, as they were intensively preferred throughout the year.

Seasonal changes in the diet of brown hares seem to correspond to differences in the quality or quantity of plant availability. The presence of sprouts during spring and summer accounted for the shift from avoidance to indifference in the use of several grasses intensively eaten, and even for the increase in the use of coarse grasses always used with avoidance. The summer increase in the dietary proportion of forbs agrees with increased availability of this plant category. A winter decrease in the availability of the main dietary item, the preferred grass *Poa*, is met by the increased use of two phanerophytes, and the shift from indifference to preference in the use of the chamaephyte *Acantholippia*. The diet of brown hares in other environments of Patagonia showed a similar pattern, with a winter increase in the shrub proportion, and a spring increase in the proportion of graminoids and forbs (Pelliza et al. 1997). The snowshoe hare (*L. americanus*) also switched from a diet of mainly woody browse during the winter (de Vos 1964; Litvaitis et al. 1985) to a diet of forbs, grasses, and leaves during the summer (Wolff 1980).

Several dietary differences among habitats reflected differences in food availability. A higher dietary proportion of forbs reflected the higher availability of this plant category in the rocky habitat Huayquerías, and accounted for the higher dietary diversity detected. However, brown hares did not show the preference for forbs detected in other herbivores present in the study area (Puig et al. 2001). A higher availability of intensively used species accounted for a higher dietary proportion, as occurred in sandy habitats with the grass *Panicum*, and the phanerophytes *Adesmia* and *Berberis*, as well as in rocky habitats with the grass *Poa* and the phanerophyte *Prosopidastrum*. A food availability dominated by *Stipa* and *Sporobolus*, avoided grasses characterized by their roughness (Wainstein and González 1962), might explain the higher dietary proportions of the chamaephyte *Acantholippia* in rocky habitats.

Diets of plain vizcachas (Puig et al. 1998a), mountain vizcachas (Puig et al. 1998b), goats and horses (Puig et al. 2001) showed the most important similarities with the hare diet in northern Patagonia. Sheep and goats also showed considerable dietary similarities with

brown hares in Central Patagonia (Bonino 1999), where hares presented a high dietary diversity compared with the other herbivores (Bonino et al. 1986). The active selection of unstocked pastures detected by Barnes et al. (1983) in feeding hares, could be a behaviour for avoiding potential competition with livestock. The important number of food items shared by several wild and domestic herbivores enhances the importance to protect plant communities in arid environments as northern Patagonia.

A higher proportion of dicots differentiated the mara's diet from the hare diet in central Monte (Campos et al. 2001), whereas a high dietary similarity was detected between hares and maras in the southernmost part of the Monte, as both diets were primarily based on shrub consumption, and included grasses and forbs especially in spring (Bonino et al. 1997). The restricted presence of maras observed in the study area stresses the importance of research on the mara's diet and its dietary overlap with brown hares in northern Patagonia, considering that a reduction in the distribution range of maras could be attributed to the expansion of hares since the end of the 19th century in South America.

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Zusammenfassung

Ernährung des Feldhasen (*Lepus europaeus*) und verfügbare Nahrung in Nordpatagonien (Mendoza, Argentina)

Der Feldhase, ein weltweit verbreiteter Leporide, ist seit seiner Einführung Ende des 19. Jhs. in ganz Argentinien verbreitet. Studien über die Ökologie der Ernährung der Hasen sind wichtig zur Evaluierung des Wettbewerbspontentials gegen andere ursprüngliche Herbivoren und Haustiere. Diese Studie analysiert die Nahrung der Feldhasen in Beziehung zur Verfügbarkeit der Nahrung, und die Diätüberlappung mit verschiedenen anderen Herbivoren in Nordpatagonien. Verfügbarkeit der Nahrung wurde durch Point-quadrat Transekte ermittelt, und die Nahrung durch mikrohistologische Analysen von Exkrementen. Die Studien wurden für fünf Habitate und mit fünf saisonalen Beispielen durchgeführt. Signifikante Unterschiede wurden festgestellt mit Kruskall-Wallis ANOVA und mit multiplen Vergleichen durch den Tukey Test. Die Selektion der Nahrung wurde festgestellt durch χ^2 Test, und die Nahrungsbevorzugung mit dem Confidence Interval von Bailey. Gräser (*Stipa, Panicum*) in Verbindung mit der Chamaephyte *Acantholippia* war die meist verfügbare Pflanzenkategorie. Gräser (*Poa, Panicum, Bromus*) und Phanerophyte (*Adesmia, Prosopidastrum*) hatten in der Hasennahrung Vorrang. Der Konsum von Phanerophyten sowie auch von *Prosopidastrum* und *Ephedra* stieg im Winter, wenn die Hauptnahrung *Poa* nicht verfügbar was. Ein höheres Verhältnis der Chamaephyte *Acantholippia* in der Diät ergab sich für steiniges Habitat, wo harte Grasarten immer vermieden werden. Hasen teilen die meisten Arten ihrer Nahrung mit verschiedenen wilden herbivoren Haustieren in Nordpatagonien. Der Mangel einer Vorliebe für Kräuter unterscheidet Hasen von anderen Herbivoren. Dennoch zeigten die Hasen große Ähnlichkeiten in ihrer Nahrung mit Talvizcachas und Bergvizcachas, Ziegen und Pferden; ein interspezifischer Nahrungswettbewerb ist also sehr wahrscheinlich.

References

Barnes, R. F. W.; Tapper, S. C.; Williams, J. (1983): Use of pastures by brown hares. J. Applied Ecol. **20,** 179–185.

Baumgartner, L. L.; Martin, A. C. (1939): Plant histology as an aid in squirrel food-habit studies. J. Wildl. Manage. **3,** 266–268.

Bonino, N. (1999): European hare and its interaction with Patagonia livestock. Rev. Arg. Prod. Anim. **19,** 227–231.

Bonino, N.; Bonvissuto, G.; Sbriller, A.; Somlo, R. (1986): Hábitos alimentarios de los herbívoros en la zona central del área ecológica sierras y Mesetas Occidentales de Patagonia. Rev. Arg. Prod. Anim. **6,** 275–287.

Bonino, N.; Sbriller, A.; Manacorda, M. M.; Larosa, F. (1997): Food partitioning between the mara (*Dolichotis patagonum*) and the introduced hare (*Lepus europaeus*) in the Monte desert, Argentina. Stud. Neotrop. Fauna Environ. **32,** 129–134.

Cabrera, A. L.; Willink, A. (1980): Biogeografía de América Latina. Second ed. Washington: Biological Series of the Organization of American States.

Campos, C.; Ojeda, R.; Monge, S.; Dacar, M. (2001): Utilization of food resources by small and medium-sized mammals in the Monte Desert biome, Argentina. Aust. Ecol **26,** 142–149.

Carman, R. L. (1976): En torno a la liebre y su introducción en la Argentina. La Prensa. August 15. Buenos Aires.

Cherry, S. (1996): A comparison of confidence interval methods for habitat use-availability. J. Wildl. Manage. **60,** 653–658.

Colwell, R. K.; Futuyma, D. J. (1971): On the measurement of niche breadth and overlap. Ecology **52,** 567–576.

Consejo Federal de Inversiones (1977): Proyecto de desarrollo ganadero del oeste de La Pampa, Tomo I. Buenos Aires.

Cossios, D. (2004): The european hare, *Lepus europaeus* (Mammalia, Leporidae), invasive species in south Peru. Rev. Peru. Biol. **11,** 209–212.

Daget, P.; Poissonet, J. (1971): Une méthode d'analyse phytologique des prairies. Critéres d'application. Ann. Agron. **22,** 5–41.

De Vos, A. (1964): Food utilization of the snowshoe hare on Manitoulin Island, Ontario. J. For. **62,** 238–244.

Duci, J. L. (1949): Methods for the determination of food habits by plant microtechniques and histology and their application to cotton tail rabbit food habits. J. Wildl. Manage. **13,** 295–298.

Godoy, J. C. (1963): Fauna silvestre. Vol. 1. Evaluación recursos naturales de la Argentina. Tomo 8. Buenos Aires: Consejo Federal de Inversiones.

González Díaz, E. F. (1972): Descripción geológica de la Hoja 30-d, Payún Matru (Mendoza). Carta Geológico-Económica de la República Argentina, Boletín 130. Buenos Aires: Dirección Nacional de Geología y Minería.

Grigera, D. E.; Rapoport, E. H. (1983): Status and distribution of the European hare in south America. J. Mammal. **64,** 163–166.

Hurlbert, S. (1978): The measurement of niche overlap and some relatives. Ecology **59,** 67–77.

Kufner, M. B.; Madoery, L.; Sepúlveda, L.; Giraudo, L.; Gavier, G.; Bechara, V. (2001): Ecología alimentaria de *Mazama gouazoubira* y *Lepus europaeus* en el norte chaqueño cordobés. Iheringia (in press).

Litvaitis, J. A.; Sherburne, J. A.; Bissonette, J. A. (1985): Influence of understorey characteristics on snowshoe hare habitat use and density. J. Wildl. Manage. **49,** 866–873.

Llanos, A.; Crespo, J. (1952): Ecología de la vizcacha (*Lagostomus maximus* Blainv.) en el nordeste de la provincia de Entre Ríos. Inf. Agricolas **6,** 289–378.

Macdonald, D.; Barret, P. (1995): Mammals of Britain and Europe. Collins Field Guide, London: Harper Collins Publishers.

Martínez, E.; Dalmasso, A. (1993): Flora y vegetación. Diseño del plan de manejo para Reserva La Payunia (Mendoza, Argentina). Multequina **2,** 19–22.

Pelliza-Sbriller, A.; Willems, P.; Nakamatsu, V.; Manero, A.; Solmo, R. (1997): Atlas Dietario de Herbívoros Patagónicos. Bariloche: Prodesar, Inta, Gtz.

Puig, S.; Videla, F.; Cona, M. I.; Monge, S. A. (2001): Use of food availability by guanacos (*Lama guanicoe*) and livestock in northern Patagonia (Mendoza, Argentina). J. Arid Environ. **47,** 291–308.

Puig, S.; Videla, F.; Monge, S. A.; Roig, V. G. (1996): Seasonal variations in guanaco diet (*Lama guanicoe* Müller 1776) and in food availability in northern Patagonia, Argentina. J. Arid Environ. **34,** 215–224.

Puig, S.; Videla, F.; Cona, M. I.; Monge, S. A.; Roig, V. G. (1998a): Diet of the vizcacha (*Lagostomus maximus*), habitat preferences and food availability in northern Patagonia, Argentina. Mammalia **62,** 191–204.

Puig, S.; Videla, F.; Cona, M. I.; Monge, S. A.; Roig, V. G. (1998b): Diet of the mountain

vizcacha (*Lagidium viscacia* Molina, 1782) and food availability in northern Patagonia, Argentina. Z. Säugetierkunde **63,** 228–238.

Rosati, V. R.; Vera Diaz, J. D.; Biurrum, F. N. (2000): Selección y superposición de dieta de tuco-tuco y liebre europea en la Reserva Laguna Brava, La Rioja, Argentina. IX Congreso Iberoamericano de Biodiversidad y Zoología de Vertebrados. Buenos Aires.

Siegel, S. (1986): Estadistica no Paramétrica. México: Edit. Trillas.

Taber, A. B. (1987): The behavioural ecology of the mara, Dolichotis patagonum. Diss. thesis, University of Oxford, Oxford.

Taber, A. B.; Macdonald, D. W. (1992): Spatial organization and monogamy in the mara *Dolichotis patagonum*. J. Zool. (London) **227,** 417–438.

Wainstein, P.; González, S. (1962): Valor forrajero de trece especies de *Stipa* de Mendoza. Rev Facul Cs. Agrarias Mendoza **9,** 3–18.

Wolff, J. O. (1980): The role of habitat patchiness in the population dynamics of snowshoe hare. Ecol. Monographs **50,** 11–30.

Zar, J. H. (1984). Biostatistical Analysis. 2nd ed. New Jersy: Prentice-Hall Inc.

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