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Diet of the Italian hare (*Lepus corsicanus*) in a semi-natural landscape of southern Italy

Abstract: The food habits of the endangered Italian hare have not received adequate attention from researchers. In this study, the diet composition of this species and its seasonal variation were assessed by analysing faecal pellets in a semi-natural landscape in the south of Italy. The results showed that hares feed on 62 species of plants during the year, with a conspicuous presence of herbaceous ones (e.g., *Trifolium pratense*, *Brachypodium sylvaticum*, *Festuca arundinacea*) as these occurred at high frequencies in most of the faecal samples. In spring, diet composition was characterised by a high percentage of Graminaceae (>37%). In the other seasons, hares also included fruits (e.g., *Prunus spinosa*, *Pyrus piraster*, *Malus sylvestris*), which, in autumn, accounted for >27%. There were significant differences among seasons ($p<0.001$) in terms of Margalef's richness, Shannon diversity, and Buzas and Gibson's evenness. The smallest values of richness and diversity were observed in spring. Dietary overlap was low between spring and the other seasons; conversely, there was substantial overlap (>70%) in the diets during the other seasons with a more pronounced similarity between summer and autumn (Sørensen, C_s=0.80; Morisita-Horn, C_{MH}=0.73).

Keywords: diet; faecal analysis; *Lepus corsicanus*; micro-histological identification.

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Introduction

During the past decades, the Italian hare (*Lepus corsicanus* de Winton, 1898) has undergone a considerable contraction in the peninsular Italy and, therefore, it is listed in the International Union for Conservation of Nature Red List of Threatened Species (Angelici et al. 2008). The main factors that are believed responsible for the population decline of the species are illegal hunting, habitat fragmentation, and a possible competition with the European hare (*Lepus europaeus* Pallas, 1778) (Angelici et al. 2008). As for other endangered species, a detailed knowledge of the Italian hare's diet could be of basic importance for its conservation and management. The study of food habits of several *Lepus* spp. has brought about successfully focused and comprehensive conservation management strategies (Puig et al. 2006, Paupério and Alves 2008, Lorenzo et al. 2011). Most of these studies are based on the micro-histological identification of indigestible plant fragments in the faecal pellets (Baumgartner and Martin 1939, Dusi 1949). This is considered the most appropriate and non-invasive technique for understanding the diet composition of herbivores.

To date, few studies on the dietary preferences of the Italian hare are available (De Battisti et al. 2004, Trocchi and Riga 2005, Freschi et al. 2011). However, new research activities are taking shape, as shown by a recent study aimed at comparing the diet composition in two different sites in a regional park situated in the south of Italy (Freschi et al. 2014). In this study, conducted in a semi-natural landscape of the same protected area, the diet composition and its seasonal variation were evaluated.

Materials and methods

Study site

The present study was carried out within the regional park "Gallipoli Cognato Piccole Dolomiti Lucane" (headquarter coordinates: 40°30′49.65″N, 16°8′35.70″E), in the centre of the Basilicata region (south of Italy). This park has an area of 270 km^2 and run through five municipalities featuring different geomorphological and micro-climatic conditions. Since 2006, the park has promoted a conservation initiative within the "Italian Action Plan for the

Italian hare" (Trocchi and Riga 2001), the main objective of which is to recover a native population of Italian hares in the Basilicata region. Within this conservation initiative, the exclusive presence of the Italian hare was ascertained in many different areas of the park. Among them, we chose a study site of 1.60 km^2, lying within 386–720 m asl (Figure 1). At the time of the current study, the index of occurrence of the Italian hare in the site (provided by the park) was 14 hares/km^2. The mean annual air temperature in this site is typically 15°C, with extreme values registered in August (35°C) and in February (-2°C). The annual rainfall is between 550 and 700 mm, with most precipitation occurring during October–December, while the least is registered from June to July. Vegetation of this site is mainly peculiar to the habitat 6210 Semi-natural dry grasslands and scrubland facies on calcareous substrates (*Festuco-Brometalia*) (Habitats Directive, 92/43/EEC), and comprises spread thickets of dwarf bushes (e.g., *Crataegus monogyna*, *Prunus spinosa*, *Pyrus amygdaliformis*, *Phyllirea latifolia*), and isolated oaks (mainly *Quercus virgiliana*). This area is extensively grazed by different native breeds of cattle, sheep, and goats, whose proper management in terms of rotational grazing, stocking density, and season of grazing has a positive effect on biodiversity (Freschi et al. 2012).

Collection and analysis of faecal pellets

Sampling was conducted from December 2011 to November 2012 along eight replicate transects (2 m×200 m) spatially distributed in order to comprise the plant community that characterises our site. Fresh pellets were collected monthly in each transect from different droppings. From each collection, a minimum of six pellets, of various sizes and formats, were mixed to form a single composite sample. Throughout the year, 96 samples were analysed (eight per month).

The processing and the analysis of faecal samples were carried out by using the methods of Paupério and Alves (2008) and Uresk (1978), with some modifications. Briefly, samples were first individually ground in a mortar and then cleared in a 0.05 M solution of NaOH for 2 h. Thereafter, samples were washed with distilled water over a 63-µm sieve and the retained material was collected over filter paper, dried, and coloured with Bismarck brown. Successively, five microscope slides were obtained from each sample. Finally, in each slide, the first 10 non-overlapping fragments were counted in systematic transects across a slide along alternate rows. A total of 400 fragments were recorded in each month.

Plant taxa were identified by comparing the different features and dimensions of the epidermal cells and other valuable taxonomical structures (e.g., trichomes, stomata form) of the recovered fragments with those of a plant reference material prepared (methods described by Maia et al. 2003) by collecting monthly leaves, stems, flowers, and fruits of the plants found in the study site. This reference material is related to 124 plant species and is available at the Laboratory of Environmental and Applied Botany – University of Basilicata.

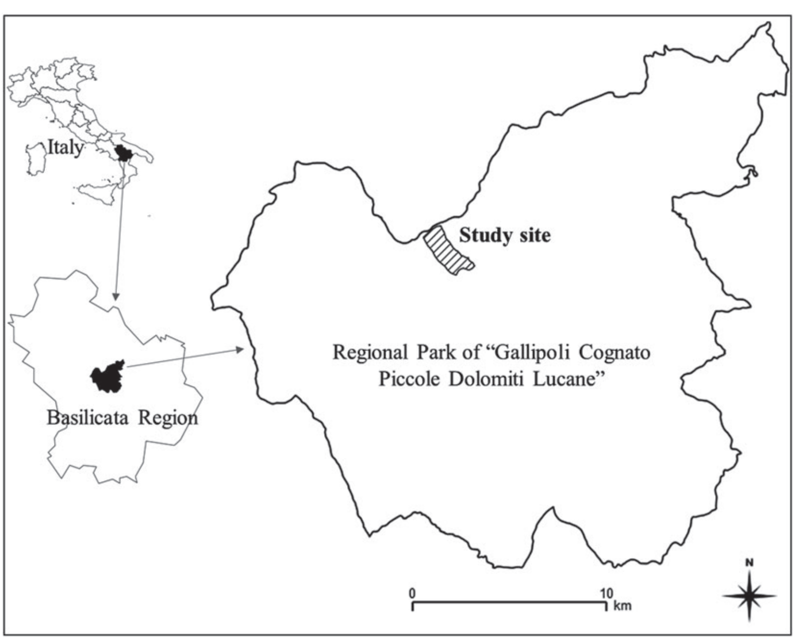

Figure 1 Location of the study site within the regional park "Gallipoli Cognato Piccole Dolomiti Lucane" (southern Italy).

The nomenclature of the identified taxa has been done according to Conti et al. (2005). The plant taxa identified in faecal pellets were also grouped taxonomically into families. The fragments that were not identified to species level were classified as "unidentified" and were not included in our dataset.

Statistical analysis

Monthly data were summed up to obtain seasonal and annual amounts of identified plant taxa fragments. Seasons were defined as spring (1 March–31 May), summer (1 June–1 August), autumn (1 September–30 November), and winter (1 December–29 February). Seasonal and annual values were used to calculate the relative frequency (*rf*) of a plant taxon (or family) by season and year (i.e., annual consumption), respectively:

$$rf = \frac{n}{N} \times 100,$$

where n is the number of identified fragments attributed to a given taxa in a given season (or in the year) and N is the total number of identified fragments in that given season (or in the year).

Diet diversity, based on species richness (D) (Margalef 1958), diversity (H) (Shannon and Weaver 1949), and evenness (E) (Buzas and Gibson 1969) indices, was calculated for each month and evaluated on a seasonal basis. Differences in richness, diversity, and evenness among seasons were analysed using the non-parametric Kruskal-Wallis (KW) one-way analysis of variance test, followed by the multiple-comparisons post-test.

The Sorensen similarity index (C_s), which takes the presence or absence of a species into account (Sørensen 1948), and the Morisita-Horn index (C_{MH}), which also takes species abundance into account (Morisita 1959), were used to compare the dietary similarity or overlap between seasons. Both indices vary between 0 (no overlap) and 1 (complete overlap). C_{MH} values were classified according to the scale proposed by Langton (1982): $0<C_{MH}\leq 29$, small overlap; $30\leq C_{MH}\leq 59$, medium overlap; and $C_{MH}\geq 60$, high overlap.

Results

Diet composition

Over an observation period of 1 year, a total of 630 faecal pellets were processed (Table 1). Concerning seasons, 181 pellets were used in spring, 155 in summer, 167 in autumn, and 186 in winter. More than 90% of the total fragments taken into consideration (4800 fragments, 1200 per season) were identified and attributed to 62 plant species from 20 botanical families (Tables 2 and 3). Only five families (Graminaceae: 14 taxa; Liliaceae: 10 taxa; Rosaceae: 8 taxa; Compositae and Leguminosae: 7 taxa in both families) contained >79% of the annual diet. The following five taxa represented 32.84% of the annual diet: *Trifolium pratense* (7.65%), *Brachypodium sylvaticum* (7.28%), *Prunus spinosa* (6.98%), *Festuca arundinacea* (5.71%), and *Allium subhirsutum* (5.22%).

In spring, 25 taxa in nine families were observed: among them, seven were included in the Graminaceae, and represented 37.79% of the diet. The most eaten species was *Brachypodium sylvaticum* (26.31%), whereas the relative frequencies of the remaining taxa ranged from 0.15% (*Cynodon dactylon*) to 3.92% (*Festuca arundinacea*). Six species belonging to Liliaceae accounted for more than a quarter (27.18%) of the spring diet; *Allium triquetrum* (8.58%) and *Leopoldia comosa* (5.67%) were the most eaten species. Plantaginaceae (two taxa) was the third most eaten family (10.76%).

In summer, 44 taxa belonging to 15 families were identified. Graminaceae, represented by 11 species, accounted for 31.60% of the diet: *Festuca arundinacea* (6.97%), *Brachypodium sylvaticum* (6.04%), and *Lolium perenne* (5.34%) were the most observed. Liliaceae was the second family for consumption (eight taxa, 18.13%): *Allium subhirsutum* was the most observed one (4.42%). Rosaceae, which had relative frequencies >13%, comprised five taxa: *Prunus spinosa* was the most eaten one (7.20%). The relative frequencies of Leguminosae (three taxa) and Compositae (four taxa) were 12.55% and 8.37%, respectively, with *Trifolium pratense* (11.85%) and *Picris hieracioides* (4.42%) being the most ingested. In addition to Rosaceae, five families were not observed in spring: Apiaceae, Betullaceae,

Table 1 The number of analysed pellets and (identified and unidentified) fragments in study site for each month.

	January	February	March	April	May	June	July	August	September	October	November	December	Total
Processed pellets	62	64	63	60	58	57	48	50	52	56	59	60	630
Identified fragments	356	361	365	357	363	368	366	359	370	362	351	346	4324
Unidentified fragments	44	39	35	43	37	32	34	41	30	38	49	54	476

Table 2 Distribution (% of identified fragments) of plant species utilised by the Italian hare.

Taxa	Family[a]	Season				Annual consumption
		Spring	Summer	Autumn	Winter	
Achillea collina	Co	0	0	0.42	0.13	0.17
Aegilops geniculata	Gr	0	0	0	1.70	0.66
Agrimonia eupatoria	Ro	0	0	0.30	0.04	0.1
Allium subhirsutum	Li	4.94	4.42	4.04	6.62	5.22
Allium triquetrum	Li	8.58	0.46	1.15	1.61	2.04
Bellevalia romana	Li	0	0	0.24	0	0.07
Brachypodium pinnatum	Gr	0	2.09	1.51	0.61	1.11
Brachypodium sylvaticum	Gr	26.31	6.04	4.04	4.61	7.28
Bromus racemosus	Gr	0	0	0	0.57	0.22
Buglossoides purpurocaerulea	Bo	0	0	0.30	0	0.08
Capsella bursa pastoris	Cr	0	0.23	0.06	0	0.07
Carex distachya	Cy	0	0.70	1.21	5.66	2.68
Carex flacca	Cy	5.52	4.49	1.75	2.92	3.24
Carpinus orientalis	Be	0	0.46	0.66	0	0.29
Centaurea solstitialis	Co	0	0.93	0.42	0.09	0.35
Cichorium intybus	Co	0	1.63	1.15	0.57	0.89
Cirsium strictum	Co	0	1.39	2.59	4.57	2.8
Colchicum neapolitanum	Li	0	1.63	1.27	3.79	2.17
Crataegus monogyna	Ro	0	0.23	3.07	2.87	2.02
Cynodon dactylon	Gr	0.15	0.46	1.33	2.22	1.35
Cytisus hirsutus	Ar	0	0	1.69	3.09	1.67
Dactylis glomerata	Gr	0	2.32	2.41	0.70	1.45
Daucus carota	Um	0	0	0	0.04	0.02
Eryngium campestre	Ap	0	0.70	0.30	0	0.24
Festuca arundinacea	Gr	3.92	6.97	5.85	5.44	5.71
Festuca heterophylla	Gr	1.16	2.79	2.83	1.78	2.22
Fraxinus ornus	Ol	0	0	0	0.04	0.02
Gagea lutea	Li	0.58	0.46	0	0	0.17
Gladiolus italicus	Ge	0	0.46	0.18	0	0.15
Hermodactylus tuberosus	Ir	5.81	0	2.47	3.18	2.59
Hypochoeris achyrophorus	Co	0	0	0	0.17	0.07
Lathyrus digitatus	Le	0	0	0.12	0	0.03
Lathyrus venetus	Le	0	0	0.18	0.04	0.07
Leopoldia comosa	Li	5.67	3.72	0.06	0.04	1.5
Lolium perenne	Gr	0	5.34	7.53	2.00	4.04
Lolium rigidum	Gr	1.89	1.63	0	0.39	0.72
Luzula forsteri	Ju	7.27	0.70	0.72	1.26	1.68
Malus sylvestris	Ro	0	0	0.54	1.26	0.64
Melica ciliata	Gr	0	0.23	1.81	0	0.56
Muscari atlanticum	Li	4.65	3.72	0	0	1.35
Muscari neglectum	Li	2.76	2.32	0.18	0.30	0.99
Ornithogalum excapum	Li	0	1.39	2.59	1.61	1.65
Picris hieracioides	Co	0.73	4.42	3.68	3.18	3.3
Plantago lanceolata	Pl	7.12	3.02	1.08	1.74	2.46
Plantago serraria	Pl	3.63	0.70	2.05	1.65	1.79
Poa trivialis	Gr	2.47	2.09	0.06	4.79	2.61
Prunella vulgaris	La	0.29	0.23	0.42	0.70	0.47
Prunus spinosa	Ro	0	7.20	14.10	3.79	6.98
Pyrus piraster	Ro	0	3.02	5.91	6.27	4.73
Ranunculus repens	Ra	0	0	0.96	0.26	0.37
Romulea bulbocodium	Ir	1.89	2.32	0.48	2.70	1.9
Rosa canina	Ro	0	1.63	1.63	4.57	2.58
Sanguisorba minor	Ro	0	0	0.06	0	0.02
Sesleria autumnalis	Gr	1.89	1.63	0.24	0.04	0.66
Silene alba	Ca	0	0.23	0.06	0	0.07

(**Table 2** Continued)

Taxa	Family[a]	Season				Annual consumption
		Spring	Summer	Autumn	Winter	
Sorbus torminalis	Ro	0	1.86	2.17	2.35	1.92
Spartium junceum	Le	0.15	0.23	0.18	0.17	0.19
Stachys officinalis	La	0	0	0.18	0	0.05
Thymus longicaulis	La	1.60	1.16	1.69	0	0.91
Trifolium angustifolium	Le	0	0	0	1.09	0.42
Trifolium pratense	Le	0.44	11.85	10.07	5.70	7.65
Trifolium stellatum	Le	0.58	0.46	0	1.04	0.57

[a]Plant families: Ap, Apiaceae; Ar, Aristolochiaceae; Be, Betulaceae; Bo, Boraginaceae; Ca, Caryophyllaceae; Co, Compositae; Cr, Cruciferae; Cy, Cyperaceae; Ge, Geraniaceae; Gr, Graminaceae; Ir, Iridaceae; Ju, Juncaceae; La, Labiatae; Le, Leguminosae; Li, Liliaceae; Ol, Oleaceae; Pl, Plantaginaceae; Ra, Ranunculaceae; Ro, Rosaceae; Um, Umbelliferae.

Table 3 Distribution (% of identified fragments) of plant species by family utilised by the Italian hare.

Family	Season				Annual consumption
	Spring	Summer	Autumn	Winter	
Apiaceae	0	0.70	0.30	0	0.24
Aristolochiaceae	0	0	1.69	3.09	1.67
Betulaceae	0	0.46	0.66	0	0.29
Boraginaceae	0	0	0.30	0	0.08
Caryophyllaceae	0	0.23	0.06	0	0.07
Compositae	0.73	8.37	8.26	8.71	7.58
Cruciferae	0	0.23	0.06	0	0.07
Cyperaceae	5.52	5.19	2.95	8.58	5.91
Geraniaceae	0	0.46	0.18	0	0.15
Graminaceae	37.79	31.60	27.61	24.86	28.59
Iridaceae	7.70	2.32	2.95	5.88	4.50
Juncaceae	7.27	0.70	0.72	1.26	1.68
Labiatae	1.89	1.39	2.29	0.70	1.43
Leguminosae	1.16	12.55	10.55	8.05	8.93
Liliaceae	27.18	18.13	9.52	13.97	15.16
Oleaceae	0	0	0	0.04	0.02
Plantaginaceae	10.76	3.72	3.13	3.40	4.25
Ranunculaceae	0	0	0.96	0.26	0.37
Rosaceae	0	13.94	27.79	21.16	18.99
Umbelliferae	0	0	0	0.04	0.02

Caryophyllaceae, Cruciferae, and Geraniaceae. However, they accounted for only 2.08% of the hare's seasonal diet.

In autumn, the highest number of taxa (52 of 62) and families (18 of 20) was observed. Rosaceae (seven taxa) and Graminaceae (10 taxa) were the most ingested (27.79% and 27.61%, respectively); *Prunus spinosa* (14.10%) and *Lolium perenne* (7.53%) were the most observed in each family. Other important contributors were Leguminosae (four taxa, 10.55%), Liliaceae (seven taxa, 9.52%), and Compositae (five taxa, 8.26%), with *Trifolium pratense* (10.07%), *Allium subhirsutum* (4.04%), and *Picris hieracioides* (3.68%) being the most observed taxa for each family. Aristolochiaceae, Boraginaceae, and Ranunculaceae occurred marginally in the autumn diet.

The winter diet was composed of 48 taxa in 14 families. The most ingested families were Graminaceae (12 taxa, 24.86%), Rosaceae (seven taxa, 21.16%), and Liliaceae (six taxa, 13.97%), which altogether accounted for almost 60% of the winter diet. The most observed species were *Festuca arundinacea* (5.44%), *Pyrus piraster* (6.27%), and *Allium subhirsutum* (6.62%). Compositae (six taxa, 8.71%), Cyperaceae (two taxa, 8.58%), and Leguminosae (five taxa, 8.05%) had a relative frequency of around 8%, with *Cirsium strictum* (4.57%), *Carex distachya* (5.66%), and *Trifolium pratense* (5.70%) being the most frequently observed species. Oleaceae and Umbelliferae (both 0.04%) were found only in this season.

Seasonal variation in dietary diversity and similarity

The results of univariate measures of diet diversity are in Table 4. A significant effect of season on diet richness was observed (KW: $H=81.36$, $df=3$, $p<0.001$). In the spring season, Margalef's index (D) was significantly low as compared with the other seasons. The value of D was maximum (7.10±0.16) in the summer season. The diet of the Italian hare was significantly diverse among seasons (KW: $H=83.00$, $df=3$, $p<0.001$). The Shannon diversity index (H) showed higher values during the summer season (3.35±0.01) as compared with winter (3.00±0.14) and autumn (2.91±0.10), while it was lower during the spring season (1.99±0.57). Diet evenness (E) also varied significantly among seasons (KW: $H=43.12$, $df=3$, $p<0.001$). The value of E was maximum in the spring season (0.73±0.18), while it was minimum in autumn (0.57±0.04).

Table 4 Univariate measures of diet diversity (mean±SD).

Indices				Season	Significant comparisons[a]
	Spring (sp)	Summer (su)	Autumn (au)	Winter (wi)	
Margalef, *D*	3.07±0.17	7.10±0.16	4.97±0.72	4.54±0.64	sp-su, sp-au, sp-wi, su-au, su-wi
Shannon, *H*	1.99±0.57	3.35±0.01	2.91±0.10	3.00±0.14	sp-su, sp-au, sp-wi, su-au, su-wi
Buzas and Gibson, *E*	0.73±0.18	0.65±0.01	0.57±0.04	0.71±0.02	sp-au, su-au, su-wi, au-wi

[a]Seasons were compared with the use of non-parametric KW test for multiple comparisons ($p<0.05$).

The Sørensen qualitative similarity index (C_s) between the spring and autumn diets was 0.55 (Table 5), with 21 species shared by the two diets. According to the Morisita-Horn quantitative index (C_{MH}), the degree of dietary overlap was "low" (C_{MH}=0.27). When comparing the spring and winter diets, the C_s value was 0.60 (22 shared species) whereas the C_{MH} value was 0.38, indicating a medium overlap between the diets. The spring and summer diets showed a relative high value of C_s (0.70; 24 shared species). However, if taking species abundance into consideration, the degree of dietary overlap can be defined "medium" (C_{MH}=0.44). All the remaining comparisons yielded C_{MH} and C_s values >0.70, with the highest degree of dietary overlap in diet between summer and autumn (C_{MH}=0.85; C_s=0.83; 40 shared species).

Discussion

It is well known that the use of faecal pellet analysis for determining diet composition in herbivores has some limitations that may produce biased evaluations. A major limitation is generally related to differential digestion of different plant species (Holechek et al. 1982). For instance, the percentage of forbs is generally underestimated, whereas grass and browse species tend to be overestimated. Nevertheless, this method is widely used to investigate food habits in different herbivores. Moreover, it is particularly useful for endangered species, as it does not interfere with the behaviour of the animals and does not require handling/collecting/killing individuals. Therefore, given the threatened status of the Italian hare, we considered this method the most appropriate for studying its food habits.

Table 5 Univariate measures of diet overlap.

Comparisons	Sørensen, C_s	Morisita-Horn, C_{MH}
Spring vs. autumn	0.55	0.27
Spring vs. winter	0.60	0.38
Spring vs. summer	0.70	0.44
Summer vs. winter	0.76	0.74
Autumn vs. winter	0.80	0.73
Summer vs. autumn	0.83	0.85

In line with our previous research aimed at comparing the spatial variation in diet composition (Freschi et al. 2014), the current study found that, of all the plant species identified in the faeces, only a small fraction of them was ingested at relatively high rates. A similar result was described in a study on *Lepus granatensis* (Rosenhauer, 1856) in a mountain ecosystem of the Iberian peninsula (Paupério and Alves 2008). Our results showed that 5 of 20 botanical families constituted the bulk of the diet throughout the year (i.e., Graminaceae, Liliaceae, Rosaceae, Compositae, and Leguminosae). The most observed taxa were herbaceous plants: *Trifolium pratense*, *Brachypodium sylvaticum*, *Festuca arundinacea*, and *Allium subhirsutum*. Previous studies reported that the plant species most frequently appearing in the diet of *Lepus timidus hibernicus* (Bell, 1837), *L. granatensis*, and *L. europaeus* were *Festuca rubra*, *Anthoxanthum odoratum*, and *Poa lanuginosa*, respectively (Wolfe et al. 1996, Puig et al. 2006, Paupério and Alves 2008). A recent study conducted on *L. europaeus* from Australia's Snowy Mountains found *Dactylis glomerata* to be an important contributor to the hare's diet (Green et al. 2013), representing >43% of plant species identified in summer.

Overall, these results indicate that the type of habitat in which hares are distributed strongly influences their feeding habits, which vary among species and inside a species. The preference observed in respect of herbaceous plants is consistent with previous findings (De Battisti et al. 2004, Trocchi and Riga 2005, Freschi et al. 2011, 2014), and it is also common among other *Lepus* spp., such as *L. europaeus* (Frylestam 1986, Chapuis 1990, Wray 1992, Kontsiotis et al. 2011), *L. t. hibernicus* (Tangney et al. 1995, Wolfe et al. 1996, Dingerkus and Montgomery 2001), *L. granatensis* (Paupério and Alves 2008), *L. californicus* (Gray, 1837) (Johnson and Anderson 1984), and *L. flavigularis* (Wagner, 1844) (Lorenzo et al. 2011). However, in this study, Rosaceae fruits (e.g., *Prunus spinosa*, *Pyrus piraster*, *Malus sylvestris*) were also found to be important contributors to the hare's diet. The consumption of high-value nutritive foods (fruits of *Malus* sp., *Pyrus* sp., and *Rubus* sp.) has also been reported in a recent study on *L. europaeus* from mountainous areas of northern Greece (Kontsiotis et al. 2011).

The Italian hare heavily ingested herbaceous plants through all seasons. In spring, when abundant supply of food resources is available in the site, hares were specialized grazers on herbaceous plants: in fact, the few species identified in this season were mostly herbaceous species. This pattern of feeding strategy is common among herbivores, as they specialize when resource levels are high and generalize when they are low (Westoby 1974, Belovsky 1978). In the present study, hares consumed a high percentage of Graminaceae, probably to fulfil their energy requirements, followed by Liliaceae. Given their 70–80% water composition, it is likely that these succulent plants represented a favourite water source for hares. This, however, does not exclude the possibility that hares eat some of these plants (mainly *Allium* spp.) to take advantage of their anti-parasitic properties (Soffar and Mokhtar 1991, Guarrera 1999, Waller et al. 2001). In a certain way, the latter hypothesis would appear to be corroborated by a previous study concerning plant defence compounds (Bryant et al. 1992). It is likely that the high consumption of herbaceous plants in spring made the diet less rich and less diverse than in the other three seasons. However, except for autumn, there were no significant differences in terms of diet evenness between spring and the other seasons, meaning that there was an even distribution of the species eaten by hares. It is also likely that the low trophic overlap observed between spring and the other seasons is a consequence of the high consumption of herbaceous plants in the diet.

In summer, diet richness and diversity increased significantly, which was a result of the increased number of different taxa identified in this season. Although most of these taxa were herbaceous plants, we observed a decrease of Graminaceae and Liliaceae, and an increase of Leguminosae and Compositae, thus indicating that hares also seek plants showing higher protein content and digestibility when available. The preference for groups of plants with higher nutritional value in this season is in common with other *Lepus* spp., such as *L. europaeus* (Homolka 1982, Chapuis 1990, Wray 1992), *L. t. hibernicus* (Wolfe et al. 1996), and *L. granatensis* (Paupério and Alves 2008). According to Paupério and Alves (2008), the decrease in grasses consumption observed in summer, and the subsequent increasing ingestion of alternative plant groups, could reflect an attempt to compensate for the lower quality of the herbaceous plants (i.e., lower protein and water content) in order to maintain the reproductive activity during this season. Moreover, in the present study, hares also shifted from feeding on herbaceous plants to consuming fruits (e.g., *Prunus spinosa*), much of which begin to ripen in this season.

In autumn, the diet was still mainly represented by herbaceous plants, although a slight decrease in their consumption was observed as compared with summer, as several plants were found senescent in this season. By contrast, more ripe fruits were available in the site, so that Rosaceae became the first family for consumption in the hare's diet. This finding confirms a clear preference for food with higher carbohydrates content when available. This pronounced food preference in autumn probably led to a significant decrease in diet richness, diversity, and evenness as compared with the summer diet. However, diets in autumn and summer showed the greatest degree of diet overlap of all the seasons, as indicated by both the similarity indices. This means that the diets shared a great number of species, and that the percentage occurrence of the common species was very similar.

There were no significant differences between autumn and winter in terms of diet richness and diversity; besides, the diets had a large overlap. However, in winter, a slight reduction in Graminaceae, Rosaceae, and Leguminosae was observed, which was complemented with the increasing ingestion of other plant families (e.g., Liliaceae, Compositae, Cyperaceae, Iridaceae). Several taxa belonging to these families were available in the site as they were in a regrowth stage, an event occurring between the autumn and winter months. Given the high soluble cell content of growing plant tissues (Van Soest 1982), hares consumed all the sprouts they could get, taking advantage of the first access to nutritious growth. This is most likely reflected by the more even diet in winter, due to the balanced consumption of the plants identified in this season. Compared with previous studies on other *Lepus* spp., the diet-switching capabilities of the Italian hare feeding on twigs and bark from trees were not observed in this study. This feeding strategy is well known in certain mountain areas (Pulliainen and Tunkkari 1987, Hiltunen 2003, Hjalten et al. 2004, Rödel et al. 2004), where the snow cover limits the access to ground vegetation. This event is rare in our study site, as the weather conditions are never so particularly severe for a long time.

On the basis of the present study, we conclude that the Italian hare is a generalist herbivore as its diet included several plant species, although it heavily relied on herbaceous plants (mainly Graminaceae) across seasons. This species also displayed an opportunistic behaviour, as hares can also incorporate other plant sources into their diets as a result of low graminoid abundance or quality, or in response to a new resource available during certain seasons (e.g., fruits). The knowledge of these aspects could be useful to develop management plans not only for hare population but also for the landscape itself. Moreover, this kind of landscape, often featuring a mosaic of low-intensity agriculture and of natural and structural elements (e.g., field margins, hedgerows, patches of woodland or scrub, stone walls), should be protected, as it plays an important ecological role in protecting plant and animal species of conservation concern (Calaciura and Spinelli 2008). In this context, further studies about the feeding niches of all herbivores (wild and domestic species) present in this landscape would be of great help in understanding their impact on available resources and, hence, in better managing them.

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