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Food of Irish hares *Lepus timidus hibernicus* in western Connemara, Ireland

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The diet of the Irish hare *Lepus timidus hibernicus* Bell, 1837, was investigated in western Ireland by analysis of faeces collected each month for a year from 3 areas of blanket bog, 1 of rough grassland and 1 of machair. A wide range of plant species was eaten but the main foods throughout the year were grasses and sedges on bog, and grasses at the other 2 sites, with sedges a minor food. Forbs were also important on machair, the study area where they were most plentiful. Shrubs (mainly *Calluna vulgaris* but *Thymus praecox* on machair) were an ancillary food everywhere, especially in winter, when they provided an otherwise scarce source of live tissue. Because there was no snow cover, however, shrubs did not dominate forage in winter as they do in other parts of the range of *L. timidus*. Seasonal variation in the diet and apparent food preferences are discussed.

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Introduction

The mountain or blue hare *Lepus timidus* Linnaeus, 1758, is found throughout the tundra and boreal zones of the Palaearctic. There are also isolated populations in the Alps and on high ground in northern Britain.

In continental Europe the winter diet of *L. timidus* is mainly the leaves, twigs and bark of shrubs and trees (Pulliainen 1972, Angerbjörn and Pehrson 1987, Pulliainen and Tukkari 1987). This is largely necessitated over most of its geographical range because of prolonged snow cover, which hides the herb layer (Pulliainen 1972). Similarly, on heather moorland in eastern Scotland, the winter food is also predominantly shrubs, although these are almost exclusively heather *Calluna vulgaris*, which was noted in 50–90% by volume of stomach contents by Hewson (1962) and Flux (1970) from November–March.

The mountain hare also occurs in Ireland as an endemic subspecies, the Irish hare *Lepus timidus hibernicus* Bell, 1837. In Ireland the climate is mild and prolonged lying snow is rare. The animal is widespread, from sea level to mountain tops (Barrett-Hamilton and Hinton 1910–1921). Such habitat diversification may possibly have been potentiated by lack of competition with the brown hare *Lepus*

europaeus Pallas, 1778, which was introduced into Ireland only at the end of the nineteenth century, and now apparently occurs only locally in the north-west (Fairley 1981).

Apart from a few casual observations, the sole information on the food of the Irish hare is from the analysis of stomach contents of 20 hares shot in winter on an upland area of Northern Ireland (Walker and Fairley 1968). *Calluna* formed 28% of the total material by volume, the remainder being almost all upland grasses and sedges, suggesting a more diverse winter diet than elsewhere in the geographical range of *L. timidus*.

In this paper we have investigated the food at 5 localities in the west of Ireland by analysis of faeces collected each month over a period of 1 year.

Study areas

Connemara is a windswept, little-cultivated district of some 2 000 km^2 with hills rising to 730 m. The climate is dominated by the Atlantic Ocean and in western Connemara mean annual rainfall is 1 600 mm, distributed fairly evenly over the year. Mean air temperature ranges from 15°C in July to 6°C in January–February and snow is rare. The median dates of the beginning and end of the grass-growing season (meteorologically defined) are 1 March and 1 January respectively (Connaughton 1973). The dominant vegetation is Atlantic blanket bog (Doyle 1990), on which 3 of our study areas were located, hereinafter known as the Bog Sites. The other 2 areas, referred to as the Grassland Sites, were chosen to represent other prevalent types of terrain: rough grazing and machair – natural grassland on calcareous sand behind dunes.

The areas of the study sites varied from 0.5–4.5 ha with the machair site 80 ha. Sites and locations were chosen from experience in initial searches, so that sufficient fresh hare droppings could be collected regularly. Landmarks enabling areas to be precisely relocated were also a consideration. Altitudes of all sites were less than 180 m a.s.l. Irish 1 km grid references are given in parenthesis after each site.

The Bog Sites were at Lough Fadda (L6645), Owengarve (L7256) and Monga Lodge (L7048), all a minimum of 3.9 km apart from each other. All are grazed by sheep. The commonest vascular plants on these are as follows, those marked with an asterisk being dominant. Dicotyledones: *Potentilla erecta*, *Drosera* spp, **Calluna vulgaris*, **Erica tetralix*, *E. cinerea*; Monocotyledones: Cyperaceae (sedges): *Scirpus caespitosus*, **Eriophorum angustifolium*, **Rhynchospora alba*, **Schoenus nigricans*, *Carex* spp; Gramineae (grasses): *Agrostis canina*, *A. stolonifera*, *Anthoxanthum odoratum*, **Molinia caerulea*.

The Grassland Site at Letterfrack (L7157 – 0.6 km from Owengarve) was in fact 0.5 ha of blanket bog, but almost entirely surrounded by rough grassland which is only lightly grazed, by ponies. Both bog and grassland are therefore available at this site. The grazing regime on the grassland has resulted in a dense mat of grass and few other herbs. The commonest vascular plants are all grasses: **Agrostis capillaris, Festuca ovina* and to a lesser extent *Molinia caerulea*.

The other Grassland Site, Creggoduff (L5743), is on a golf course situated on machair and is 6.0 km from the nearest other study area. Because of the much greater area of this site, and because both the greens and fairways are mown and in use in daylight hours, and identification of the vegetation on them consequently difficult, assessment of the commonest vascular plants is tentative. Dicotyledones: *Trifolium repens*, **Lotus corniculatus*, **Galium verum*, *Achillea millefolium*, *Senecio jacobaea*, *Campanula rotundifolia*, *Euphrasia tetraquetra*, **Thymus praecox*, **Rhinanthus minor*, *Plantago lanceolata*; Monocotyledones: Juncaceae (rushes) *Luzula campestris*; Cyperaceae: *Carex flacca*; Gramineae: *Holcus lanatus*, *Lolium perenne*, **Festuca rubra*, *Sesleria albicans*. A greater number of species of forbs (ie broad-leaved herbs) and grasses was noted on this site than on any other.

Materials and methods

Samples of the vascular plants from all study sites were collected in summer and deep-frozen, and the commonest and dominant species at each site noted. Reference preparations of epidermis were made from upper and lower leaves and, where possible, from stems using the method of Sherlock and Fairley (1993). Each preparation was mounted on a microscope slide in glycerinated gelatine, drawn or photographed, and characteristic features noted.

From April 1993 to March 1994 samples of fresh hare faeces were gathered from all sites during the last 10 days of each month and stored in 4% formalin. Each site was evenly covered by walking up and down over roughly the same route every month for 1 h.

From each sample 10 pellets were selected at random and placed in a 2% aqueous solution of sodium hydroxide for 3 days, which was then thoroughly stirred and neutralised with 40% glacial acetic acid. Experiments with varying concentrations and time periods showed that this separated the epidermal fragments without damaging them.

The epidermal fragments were prepared using the method of Sherlock and Fairley (1993), which filters off smaller unidentifiable particles and clears the remaining material, which is then transferred to glycerine and shaken to homogenise and suspend it; 1.5 ml of the suspension was examined on a 75 × 50 mm microscope slide under a 70 × 46 mm coverslip. Two such slides were scrutinized at × 100 on a graduated stage. Computer-generated coordinates were used to select 60 random, non-overlapping fields of view. This number was a trade off between minimising standard error and keeping labour within practical limits. Epidermis in each field was identified against reference drawings/photographs. After all samples had been examined, fresh slides were prepared again from the first 5 samples and analysed to be sure that initial lack of practice had not affected results. There was, in fact, little difference between the paired data sets.

In most cases it was possible to determine epidermal fragments to genus and usually also to species. However, some particles bore insufficient features to allow them to be assigned to anything more precise than unidentified dicotyledon or monocotyledon. All of the latter were probably grasses, sedges or rushes, judging by their elongated cells. It was often difficult to decide on the species of *Agrostis* fragments possibly because *A. stolonifera* hybridizes with *A. canina*, *A. gigantea* and *A. capillaris*, and the specific identifications are therefore tentative.

The result for each food category in each faecal sample is expressed here as percentage frequency – the number of fields in which a category c occurred n_c divided by Σn_c for all categories × 100. This is independent of the dilution of the faecal samples which, because of the method of preparation, was slightly variable. Statistical assessment of variation of a category between samples was based on the number fields of view in which the category occurred in each sample. Departure from the null hypothesis (that expected proportions in the samples were the same) was investigated with the χ^2 test. The 0.1% level of significance was used throughout. This conservative approach was dictated partly by the somewhat variable dilutions, for which no allowance could be made, and which inevitably distort differences between samples. In addition, the large number of valid (Siegel and Castellan 1988) tests involved (eg 30 in Table 1) also tends to enhance chance significance.

Results

Numbers of droppings in samples ranged from 11–239 with a median of 30.5. There was no evident pattern of seasonal variation in numbers at any site.

Combined results for food categories from each of the Bog Sites are given in Table 1. Despite the many significant differences between food categories, the diets at all 3 sites were similar. Results from the Grassland Sites are shown in Table 2. Evidently a wide variety of plants was eaten on all study areas. In order to

Table 1. The overall annual composition of diet of *Lepus timidus hibernicus* on the Bog Sites expressed as percentage frequency. "S" indicates that the species is a shrub or small tree, * – variation between sites for this category significant at the 0.1% level based on the number of occurrence,. + – < 0.1.

Category	Lough Fadda	Owengarve	Monga Lodge
1	2	3	4
Dicotyledones			
Polygala serpyllifolia	0.3	–	–
Stellaria alsine	+	–	–
Ulex europaeus S	–	0.1	0.1
**Ulex gallii* S	3.0	–	–
Lotus corniculatus	–	–	+
**Potentilla erecta*	0.7	1.7	1.9
Galium palustre	0.5	0.3	0.6
**Calluna vulgaris* S	14.5	10.3	14.8
Erica tetralix S	0.8	0.8	0.8
Erica cinerea S	2.8	2.9	2.2
Euphrasia frigida	–	–	+
Pedicularis sylvatica	0.3	–	+
Betula pubescencens	–	–	+
Unidentified dicotyledons	3.9	3.2	4.2
Monocotyledones			
**Narthecium ossifragum*	0.8	1.0	2.4
Potamogeton polygonifolius	+	–	–
Juncaceae (rushes)			
Juncus inflexus	–	–	0.1
Juncus effusus	+	+	0.1
Cyperaceae (sedges)			
**Scirpus caespitosus*	2.8	6.8	2.7
**Eriophorum angustifolium*	4.4	3.9	7.2
**Rhynchospora alba*	3.8	1.2	4.6
**Schoenus nigricans*	11.5	5.1	7.0
**Carex* unidentified	5.2	3.0	1.4
**Carex* echinata	0.5	0.2	–
Carex panicea	+	0.1	0.1
**Carex flacca*	0.4	3.0	8.0
**Carex binervis*	7.7	2.2	4.7
Gramineae (grasses)			
**Agrostis* unidentified	9.2	11.2	4.4
**Agrostis canina*	1.2	3.6	0.2
**Agrostis stolonifera*	2.4	6.2	2.1
**Agrostis capillaris*	2.8	8.5	2.0
**Anthoxanthum odoratum*	–	2.1	1.2
**Holcus lanatus*	+	1.8	3.8
**Molinia caerulea*	8.1	8.0	12.1
Phragmites communis	0.1	–	0.2
**Nardus stricta*	–	1.0	0.8
Dactylis glomerata	–	–	0.1
**Cynosurus cristatus*	0.4	1.3	0.1
* *Lolium perenne*	0.1	–	1.9

Table 1 – concluded.

1	2	3	4
**Festuca unidentified*	–	0.8	–
Festuca ovina	0.4	0.3	0.6
Festuca rubra	+	0.1	0.2
*Unidentified monocotyledons	11.3	9.3	7.0
Pteridophyta (ferns)			
Pteridium aquilinum	–	+	–
Blechnum spicant	0.2	–	–
Total occurrences	4506	4387	4003

Table 2. The overall annual composition of diet of *Lepus t. hibernicus* on the Grassland Sites expressed as percentage frequency. "S" indicates that the species is a shrub or small tree, + – < 0.1.

Category	Letterfrack	Ceggoduff	Category	Letterfrack	Ceggoduff
Dicotyledones			Monocotyledones		
Ranunculus acris	–	0.4	*Narthecium ossifragum*	0.9	–
Polygala vulgaris	–	0.4	Cyperaceae (sedges)		
Ulex europaeus S	0.2	–	*Scirpus caespitosus*	1.7	–
Trifolium unidentified	–	2.4	*Eriophorum angustifolium*	0.8	–
Trifolium pratense	–	0.5	*Rhynchospora alba*	0.2	–
Trifolium repens	–	0.1	*Schoenus nigricans*	0.2	–
Anthyllus vulneraria	–	3.1	*Carex unidentified*	0.8	1.9
Lotus corniculatus	–	0.2	*Carex arenaria*	–	0.4
Potentilla erecta	1.7	–	*Carex panicea*	–	0.1
Sorbus acuparia S	+	–	*Carex flacca*	3.6	3.4
Sedum acre	–	0.1	*Carex binervis*	0.9	–
Galium verum	–	0.4	Gramineae (grasses)		
Galium palustre	0.2	–	*Agrostis* unidentified	11.5	5.0
Bellis perennis	–	0.8	*Agrostis canina*	2.4	0.5
Senecio jacobaea	–	+	*Agrostis stolonifera*	11.3	3.4
Hieracium pilosella	–	0.1	*Agrostis gigantea*	–	1.2
Campanula rotundifolia	–	1.3	*Agrostis capillaris*	10.7	2.4
Calluna vulgaris S	5.6	–	*Ammophila arenaria*	–	0.3
Erica tetralix S	0.2	–	*Anthoxanthum odoratum*	9.1	5.2
Erica cinerea S	0.9	–	*Holcus lanatus*	6.3	6.9
Centaurium erythraea	–	0.2	*Molinia caerulea*	3.5	–
Euphrasia unidentified	0.1	0.1	*Phragmites communis*	0.1	–
Euphrasia frigida	0.1	–	*Nardus stricta*	8.0	–
Euphrasia tetraquetra	–	+	*Dactylis glomerata*	–	2.6
Rhinanthus minor	–	+	*Cynosurus cristatus*	0.9	1.7
Thymus praecox S	–	5.8	*Lolium perenne*	–	12.8
Prunella vulgaris	–	0.3	*Festuca* unidentified	6.9	17.4
Plantago coronopus	–	0.4	*Festuca ovina*	0.2	3.0
Plantago lanceolata	–	0.4	*Festuca rubra*	0.3	0.6
Rumex crispus	–	0.1	Unidentified monocotyledons	8.3	6.3
Rumex acetosa	–	0.1			
Unidentified dicotyledons	2.4	7.3			
			Total occurrences	4090	3591

Table 3. The overall annual composition of the diet of *Lepus t. hibernicus* at all five study sites expressed as percentage frequency of the main categories of plants consumed. Unidentified monocotyledons and dicotyledons have been omitted.

Category	Lough Fadda	Owengarve	Monga Lodge	Bog Sites Combined	Letterfrack	Creggoduff
Calluna vulgaris	17.1	11.8	16.6	15.2	6.2	0
Other shrubs	7.7	4.3	3.6	5.2	1.5	6.7
Other dicotyledons	2.2	2.3	3.0	2.5	2.4	13.4
Total dicotyledons	27.0	18.4	23.2	22.9	10.1	20.1
Schoenus nigricans	13.5	5.8	7.9	9.1	0.3	0
Carex species	16.3	9.7	16.0	14.0	5.9	6.8
Other sedges	12.9	13.6	16.3	14.3	3.0	0
Total sedges	42.7	29.1	40.2	37.4	9.2	6.8
Agrostis species	18.2	33.6	9.9	20.6	40.2	14.5
Molinia caerulea	9.6	9.1	13.6	10.8	3.9	0
Lolium perenne	0.1	0	2.2	0.8	0	14.8
Festuca	0.5	1.4	0.9	0.9	8.4	24.3
Other Grasses	0.6	7.2	6.9	4.9	27.2	19.5
Total grasses	29.0	51.3	33.5	38.0	79.7	73.1
Others	1.2	1.3	3.0	1.8	1.0	0
Total occurrences	3824	3840	3556	11220	3652	3105

provide a more general picture of the data in Tables 1 and 2, the main Categories of vegetation consumed at each site (hereinafter "Categories", with a capital C) are summarised in Table 3, with unidentified monocotyledons and dicotyledons omitted.

A total of 73 food categories for all sites varied significantly by month, but many appeared in relatively small quantities and variation was often irregular. To condense this information, Table 4 provides the data on variation for Categories contributing at least 5% of the overall diet. Although it is not possible to test variation statistically for Categories comprising more than 1 species, all consisting of a single species varied significantly between months.

General trends at the Bog Sites are clearest when the results for April–September are compared with those from October–March. In the latter period there was more *Calluna*, more *Carex* (although amounts of the latter were about the same in both periods at Owengarve) and less Other sedges, *Agrostis*, and *Molinia*. *Molinia* also peaked at all 3 sites in late spring or early summer. In contrast *Schoenus nigricans* appeared in the droppings more often in winter at Lough Fadda and Owengarve, and less often at Monga Lodge. Although Other shrubs at Lough Fadda showed no clear pattern of variation, most of the *Ulex gallii* was consumed in summer, with a peak of 10% in May.

Table 4. Variation in the main food Categories of *Lepus t. hibernicus* by month expressed as percentage frequency.

Site and food category	Month											
	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Lough Fadda												
Calluna vulgaris	16.2	13.8	10.1	11.1	14.5	10.7	12.7	15.4	17.7	21.7	17.9	17.9
Other shrubs	5.4	11.3	5.6	10.7	8.1	1.5	5.7	3.9	7.2	5.1	4.4	8.8
Schoenus nigricans	13.2	10.5	11.5	6.2	3.9	9.4	9.6	13.7	16.8	17.6	16.0	15.2
Carex species	9.5	10.7	12.2	6.2	8.4	9.2	13.1	25.2	21.9	17.3	20.8	18.5
Other sedges	10.0	12.5	15.0	12.4	13.0	19.6	17.9	7.8	4.2	3.3	5.3	2.4
Agrostis species	16.5	8.7	14.1	23.8	27.0	17.3	14.2	13.4	9.9	15.1	7.9	13.7
Molinia caerulea	5.7	15.3	14.1	13.1	3.2	14.2	10.7	2.2	0.6	1.5	5.7	5.2
Owengarve												
Calluna vulgaris	15.8	6.0	6.0	2.7	5.9	2.5	8.3	11.7	16.2	20.3	18.0	16.8
Schoenus nigricans	10.5	–	–	1.9	1.2	–	0.3	1.0	11.7	17.2	15.6	7.7
Carex species	9.4	10.2	6.4	7.2	7.1	13.6	13.9	12.7	2.0	2.7	8.4	6.1
Other sedges	5.8	23.1	16.9	22.8	21.0	17.3	9.2	3.7	2.0	2.4	6.9	5.8
Agrostis species	20.2	25.2	35.1	32.2	35.1	37.1	42.3	33.5	26.5	11.7	18.6	29.0
Molinia caerulea	11.4	15.0	9.3	12.3	12.7	13.6	–	–	0.8	7.6	6.0	4.8
Other grasses	0.6	1.3	9.3	3.5	5.1	3.7	–	11.5	14.2	6.5	2.7	7.4
Monga Lodge												
Calluna vulgaris	13.2	18.3	13.3	14.0	14.5	9.9	17.7	16.7	15.3	15.7	14.9	15.6
Schoenus nigricans	–	–	–	10.2	17.1	11.8	17.0	12.2	7.5	3.6	1.3	3.0
Carex species	17.1	8.7	17.8	12.7	4.1	12.3	19.9	14.7	19.0	14.3	14.9	14.8
Other sedges	12.3	8.4	21.5	16.0	20.1	26.0	21.3	16.0	18.2	4.8	6.7	2.5
Agrostis species	12.3	11.0	3.9	5.1	8.6	7.7	2.8	3.8	7.2	14.8	11.7	15.3
Molinia caerulea	16.2	22.8	15.7	13.7	16.5	14.2	4.6	14.1	14.7	10.1	0.6	3.0
Other grasses	8.1	6.1	9.1	5.9	1.8	1.9	–	–	0.6	10.1	22.5	7.7
Letterfrack												
Calluna vulgaris	9.2	5.1	0.6	–	0.3	–	–	3.2	5.9	10.0	14.7	15.9
Carex species	7.4	0.6	7.5	12.4	2.1	2.7	0.3	0.3	0.9	5.0	3.0	14.1
Agrostis species	12.0	28.6	39.4	32.9	43.6	40.1	49.1	46.5	47.2	44.3	29.6	30.8
Festuca species	8.5	3.3	5.6	5.2	8.5	7.2	10.5	6.4	6.5	10.4	13.2	5.4
Other grasses	28.1	20.8	28.3	20.2	33.9	33.8	23.7	28.0	25.4	13.6	25.1	9.2
Creggoduff												
Other shrubs	1.9	2.0	1.5	3.1	1.9	3.9	3.0	5.8	12.7	13.7	16.5	6.6
Other dicotyledons	3.8	3.3	13.6	10.3	13.9	15.6	11.5	16.4	20.4	10.7	7.7	11.6
Carex species	3.2	3.0	16.6	4.5	11.4	8.1	6.7	6.4	1.8	2.2	2.9	1.3
Agrostis species	18.3	25.0	8.0	8.9	12.7	10.1	8.5	11.9	3.2	10.4	14.7	17.9
Lolium perenne	9.9	8.7	1.8	7.6	4.4	15.6	18.1	18.6	19.4	18.5	16.8	16.6
Festuca species	21.8	20.3	18.9	22.3	18.4	19.9	27.0	21.9	27.5	24.1	22.3	10.3
Other grasses	25.0	20.7	26.6	29.6	22.5	13.7	13.3	8.0	3.5	8.1	8.1	19.4

At Letterfrack, the pattern for *Calluna* was similar to that on the Bog Sites. *Molinia caerulea* was rarely seen in the faeces from August–February, and, as at the Bog Sites, peak feeding was in late spring and early summer; the highest figures were for April (9.6%) and May (17.6%).

At Creggoduff the hares fed upon 3 Categories more intensively in at least part of the winter: Other shrubs, *Agrostis* species and *Lolium perenne*. (Incidentally, at Monga Lodge, the only site besides Creggoduff where *Lolium* was recorded in the faeces in anything but traces, there was also significant seasonal variation: *Lolium* was recorded only in January–March and in May.) By contrast, 3 Categories appeared least in the faeces from Creggoduff in winter: Other dicotyledons (January–May), *Carex* species (December–May) and Other grasses (September––January).

Discussion

Clearly the hares exploited a wide variety of vegetation at all sites and the apparent abundance of several plant species was reflected in the diet. As *L. timidus* is adapted to living on tundra, it is hardly surprising that Irish hares exploit a range of vegetation on bog – all the commonest species were utilised except *Drosera*. However, the main items were grasses and sedges, with *Calluna* a significant minor food. One of the major differences between these sites – the much greater amount of *Agrostis* in the faeces from Owengarve – was probably because the Letterfrack site, with rough grazing, is only 0.6 km away, well within the daily movement recorded for *L. timidus* in Scotland (Hewson 1991). Otherwise the results from the 3 Bog Sites agree fairly well, share several seasonal trends, and probably give a good indication of the diet of Irish hares on blanket bog. In a much smaller study, Walker and Fairley (1968) obtained comparable data from an upland area in north-east Ireland in December–April. Their figure of 28% for *Calluna* corresponds to 15–17% for the Bog Sites for the same period. Moreover the residue was also mainly upland grasses and sedges.

As in Scotland (Hewson 1962, Flux 1970), at the Bog Sites and Letterfrack browsing on *Calluna* increased in winter. Unlike herbs, heather does not die back completely in winter and is therefore a source of live matter. Note that at Letterfrack, with extensive grassland available, the hares still browsed heather in winter to much the same extent as on the Bog Sites, whereas from June––October, when live grass was plentiful, heather almost disappeared from the faeces.

Of the remaining shrubs, only 1 was found in the droppings from the Bog Sites in anything except traces: *Ulex gallii* at Lough Fadda, the only site where it grew. Most of this browsing was in summer, particularly in May, presumably to avail of fresh shoots which, because *Ulex* is a legume, might be expected to be high in nitrogen. Hewson (1962) observed mountain hares in Scotland feeding off new growth of *Ulex* in July.

Molinia caerulea is the dominant grass on the Bog Sites, and was grazed throughout the year. Nevertheless it was taken less than *Agrostis* (Table 3). Hubbard (1984) mentions that this grass has little agricultural value and is grazed only when young by cattle and sheep. This corresponds with the seasonal pattern of feeding at Letterfrack, where alternative grasses were commoner. Here *Molinia* was eaten almost exclusively from March–July and mainly in late spring/early summer, when the flush of new growth would have provided fresh tissue.

At Letterfrack the hares fed mainly on grass, and the scarcity of other herbs is apparent in the faeces (Table 3). The dominance of *Agrostis* is also reflected in the food (Tables 2 and 3). Although *Festuca ovina* was commoner, *Anthoxanthum odoratum* and *Nardus stricta* appeared more often in the droppings, and *Holcus lanatus* appeared almost as frequently as *Festuca* (Table 2). The preference for *Nardus* by hares here is remarkable: Hubbard (1984) describes it as tough and wiry and usually not grazed by cattle or sheep, except in spring when young.

It is unnecessary to postulate any special feeding adaptations in the Irish subspecies of the mountain hare to account for differences between our results and those from elsewhere in Europe.

Snow cover in winter over most of its range forces *L. timidus* to depend predominantly on shrubs and trees for food. These are obviously much less important to the Irish hare because of the absence of snow.

Information on the summer diet of free-living mountain hares in continental Europe is scarce, for several studies have taken the form of feeding experiments on captive animals (Helminen *et al.* 1966, Pulliainen 1972, Lindlöf and Pehrson 1978, Johannessen and Samset 1994). However, in southern Norway Johannessen and Samset (1994), by direct observations on radio-tagged hares, recorded percentages of plants eaten as grasses 30%, sedges 18%, forbs 45% and shrubs 8%. The last figure is within the range of values recorded for shrubs in summer in Connemara. The hares in both Ireland and Norway depended mainly on herbs. But the Norwegian animals tended to select forbs and this is relevant to our results in that forbs were also important at Creggoduff, where they were most plentiful. In Finland, Seiskari (1963) determined preferred plants by keeping hares in open-bottomed cages on various stands of vegetation. These animals again favoured forbs and grasses and showed a preference for leguminous plants.

On heather moors in eastern Scotland, Hewson (1962) and Flux (1970) recorded heather in the stomachs of mountain hares as 20–60% by volume from April to October. Iason and Waterman (1988) noted it at 49% by percentage of plant fragments in stomachs. The remainder of the diet is mainly cotton sedge *Eriophorum* spp. and grasses, with smaller amounts of *Carex* sedges and dicotyledons. Heather was evidently more important than in the present study. Nevertheless, heather is more abundant on the moors of eastern Scotland than in the wetter climate of western Scotland and western Ireland, where grazing by sheep is also commoner (Watson and Hewson 1973). Furthermore, in eastern Scotland heather is actively managed as the main food of adult grouse *Lagopus lagopus*, including

burning to produce areas of young plants (Hewson 1984), which hares prefer (Hewson 1962, 1976, 1984). There is no such management in western Ireland.

The machair system at Creggoduff presented vegetation communities fundamentally different from the other sites. Yet here again the hares ate a range of species. Grasses were the main food but there is much less reliance on *Agrostis* than at the other Grassland Site. *Festuca* was more important and *Lolium perenne* a major food species. In the British Isles the latter grass is regarded as the most valuable species of all for grazing by domestic animals (Hubbard 1984, Robson *et al.* 1989). The hares also fed on forbs to a much greater extent at Creggoduff. By far the most important to the hares were *Trifolium* species and *Anthyllus vulneraria*, both legumes and therefore likely to be rich in nitrogen. The remaining leguminous species, *Lotus corniculatus,* which was probably dominant, rarely appeared in the droppings. Cyanogenic forms of this plant, which discourage herbivores, occur at frequencies of 70–95% in areas where the January isotherm does not fall below 5°C (Crawford 1989), a condition prevailing at Creggoduff.

The dominant shrub at Creggoduff, *Thymus praecox*, was commonly eaten and, like *Calluna* elsewhere, particularly in winter, when it would have provided living tissue. *Lolium perenne* was also utilised more heavily in winter and autumn. This may be because it provides palatable grazing for a long period (Hubbard 1984). (The hares also selected it in winter at Monga Lodge.) The reduction in feeding on dicotyledonous herbs in winter was doubtless because they had died back.

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