

Grasshopper Warbler, Sedge Warbler, Whitethroat and Willow Warbler, all of which featured prominently during Colin McShane's visit in May; and Flycatchers (Spotted in Spring and Autumn, Pied all in Autumn).

Among the Pied Flycatchers was one with a Danish ring, but details of the date and exact place of ringing have not been received yet. Other controls and recoveries for the year are listed below. They include a Meadow Pipit moving to Portugal in Autumn, a fast-moving Willow Warbler from Ireland and a Lundy-bred Kittiwake which has emigrated to France.

RECOVERIES AND CONTROLS, 1982

EF98114 Kittiwake. Ringed as pullus on Lundy 7.7.73. Observed breeding at Goulien, Finistere, France 17.4.82. Sexed as female on behaviour. Reared two young. (350km; bearing 125 degrees)

BO08302 Meadow Pipit. Ringed as full grown on Lundy 21.9.82. Found near Bucelas, Estremadura, Portugal 31.10.82 (1408km; 194 degrees)

5B4792 Willow Warbler. Ringed as first year bird at Out Head, St. Andrews, Fife, Scotland 21.7.81. Controlled on Lundy 5.5.82. (589km; 192 degrees)

OA7409 Willow Warbler. Ringed as first year bird at Fornaght Bog, Dunmore East, Waterford, Eire 3.9.82. Controlled on Lundy 11.9.82. (194km; 125 degrees)

THE VEGETATION OF LUNDY ISLAND

TRUDY A. WATT* and K. J. KIRBY†

*Department of Agricultural and Forest Sciences, University of Oxford, Agricultural Science Building, Parks Road, Oxford, OX1 3PF.

†Nature Conservancy Council, P.O. Box 6, Godwin House, George Street, Huntingdon, Cambridgeshire PE18 6BU.

INTRODUCTION

Lundy has received much attention from botanists who have examined the distribution of specific plants e.g. the "Lundy Cabbage" (*Rhynchosinapis wrightii*) and *Rhododendron ponticum* (Marren, 1971 and 1972); the vegetation of particular areas, e.g. Pondsbury (George and Stone, 1979) or differences between the coasts (Gabbutt, 1952). Some effects of the larger animals on the flora have also been described (Gillham, 1955). Vascular plant records for Lundy have been summarised by Westcott (1969) and a map showing the distribution of eight broad vegetation types has been produced by C. G. Taylor (Dunn and Bristow, 1971).

This paper describes a recent survey which complements past work by sampling the vegetation systematically over the whole island. The results are analysed to reveal ecological groupings of species.

Lundy was probably once covered with some form of low scrub woodland, such as in parts of the western Scottish islands. There is evidence for the presence of pre-historic man on the island (Gardner, 1956). These early settlers cleared the scrub, as on the mainland of Devon and Cornwall, leading to the development of heather moorland (Hubbard, 1970). In 1752 the island was "overgrown with ferns and heath which made it impossible to go to the extreme [north] of the island", but by 1787 "many deer and goats were seen browsing at the northern end" (Loyd, 1925). The vegetation at the north end was destroyed by fire once in each of the last two centuries and most recently, in 1934 (Langham and Langham, 1970; Gillham, 1955). Parts of the island have been cultivated in the past, particularly at the south end around the settlement. During the Second World War about 200 ha, out of the total 445 ha, grew potatoes and oats (Rendall, 1979). Most of this land has since reverted to grassland. Sheep, ponies and cattle are kept on the island; there are also rabbits, goats and Sika deer. Grazing pressure is, therefore, high.

The soil of the west coast and of the northern part of the east coast is raw humus, pH 4.5, whereas that of the plateau is mainly a humose ranker, pH 6.0 (Dawes, 1979). The west coast is subject to salt spray to a much greater degree than the sheltered east side (Gabbutt, 1952). Much of the east coast, towards the southern end of the island, is covered by rhododendron thickets and in some of the gullies there are a few trees and shrubs (Hubbard, 1970; Dawkins, 1974).

The following divisions of the island can be recognised:

- (a) North-south divisions, delineated by the cross walls — North End, Middle Park, Pondsburly, South End.
- (b) East-west divisions, separating out the exposed western coast (and including the north and south coasts), the plateau and the sheltered east side of the island. These are shown in Fig. 1.

North End consists of heather moorland on shallow peat; Middle Park and South End are both predominantly grassland; Pondsburly has a large pond surrounded by poorly-drained peat with heath and bog species. The east side of the island has extensive stands of *Pteridium aquilinum* while the west is notable for its areas of tussocky *Armeria-Holcus* communities.

METHODS

Sample points were marked in a grid on a 1:13000 map. Points were 200m apart in the east-west direction and 500m apart in the north-south direction (Fig. 1). Minor adjustments were made to increase the number of sample points where the exact position would otherwise have been just over the sea. A total of forty-seven points were marked.

The survey was carried out in September 1981. In the field the approximate position of each point was located by map and compass. The final position was fixed by walking forward twenty paces and putting the plot where the final foot fell.

At each point a one metre-square quadrat was set out. All vascular plants within the plot were recorded and their abundance estimated using the Domin scale. Vegetation height, slope and aspect were noted. A small hole was dug to examine the top 150mm of soil. Brief notes were made on the management of the plot and of the surrounding area — in particular the intensity of grazing and by what type of animal.

The vascular plant records were subjected to Principal Components Analysis of species, leaving out those species that were both recorded once only and were also rare in the plot (scored as 2 or 1). Distribution maps were produced for the individual species and for groups of species.

Nomenclature follows Clapham, Tutin and Warburg (1962).

RESULTS

Forty-five plots were recorded; two plots on the east coast could not be used because of the dense rhododendron cover.

Species recorded

Sixty-seven species were recorded from a vascular plant flora of about 400 for the island.

Holcus lanatus was the most abundant species recorded, being present in more than 75% of the plots (Table 1) and both *Agrostis* spp. and *Festuca rubra* occurred in more than 50% of the samples. It was thought that most of the *Agrostis* was *A. stolonifera* but many samples were heavily grazed and identification to species level was difficult. *Calluna vulgaris*, *Pteridium aquilinum*, *Potentilla erecta*, *Anthoxanthum odoratum* and *Galium saxatile* occurred in a third to a half of the samples. These results reflect the predominance of acid grassland and heath communities over much of the island.

Twenty-six species were recorded from only one or two samples. These included several species which elsewhere in the country have some affinity with woodlands — e.g. *Rubus fruticosus*, *Dryopteris aemula*, *Glechoma hederacea*, *Silene dioica* and *Endymion non-scriptus*. There were also others which are common in neutral grassland, e.g. *Plantago lanceolata*, *Bellis perennis*, *Lolium perenne*, *Cynosurus cristatus*, *Taraxacum officinale* and *Dactylis glomerata*.

Figure 1. Position of quadrats.

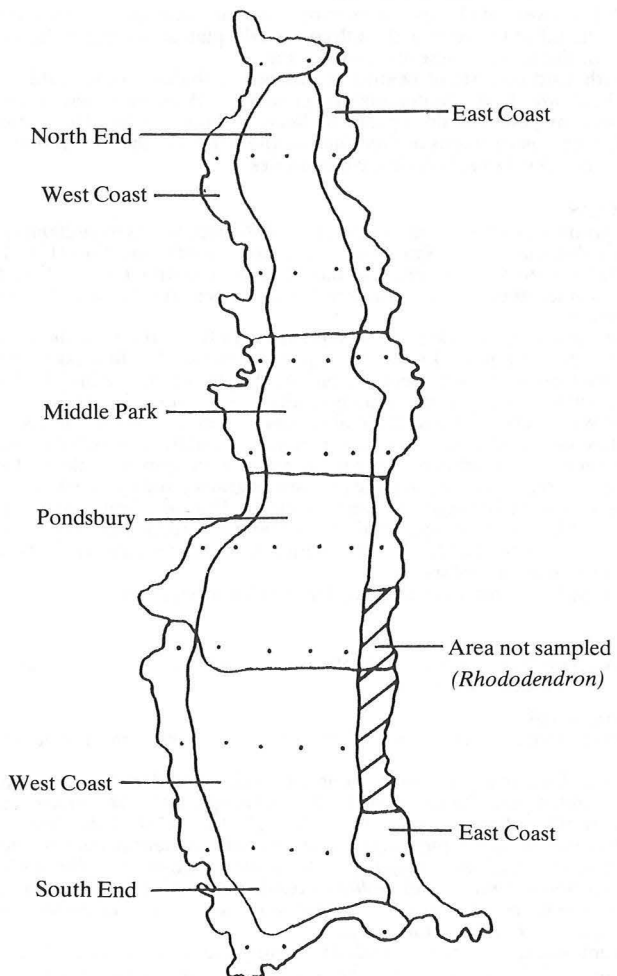


Figure 2. Height of vegetation (cm).

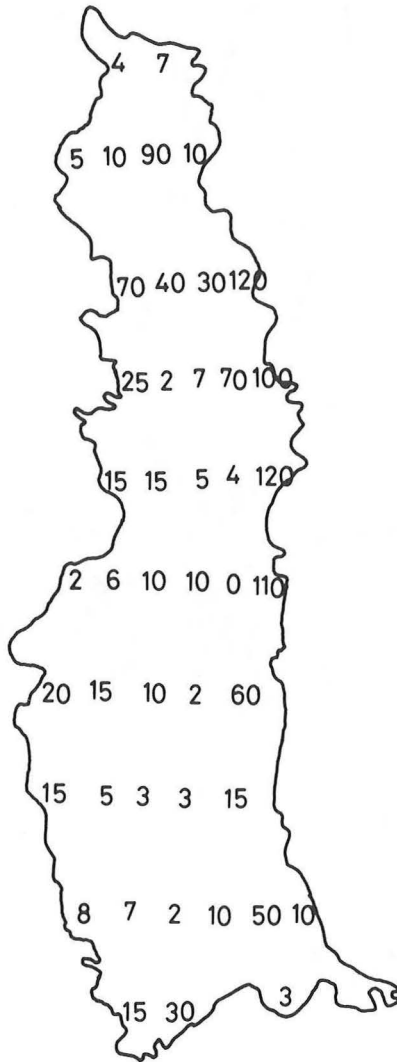
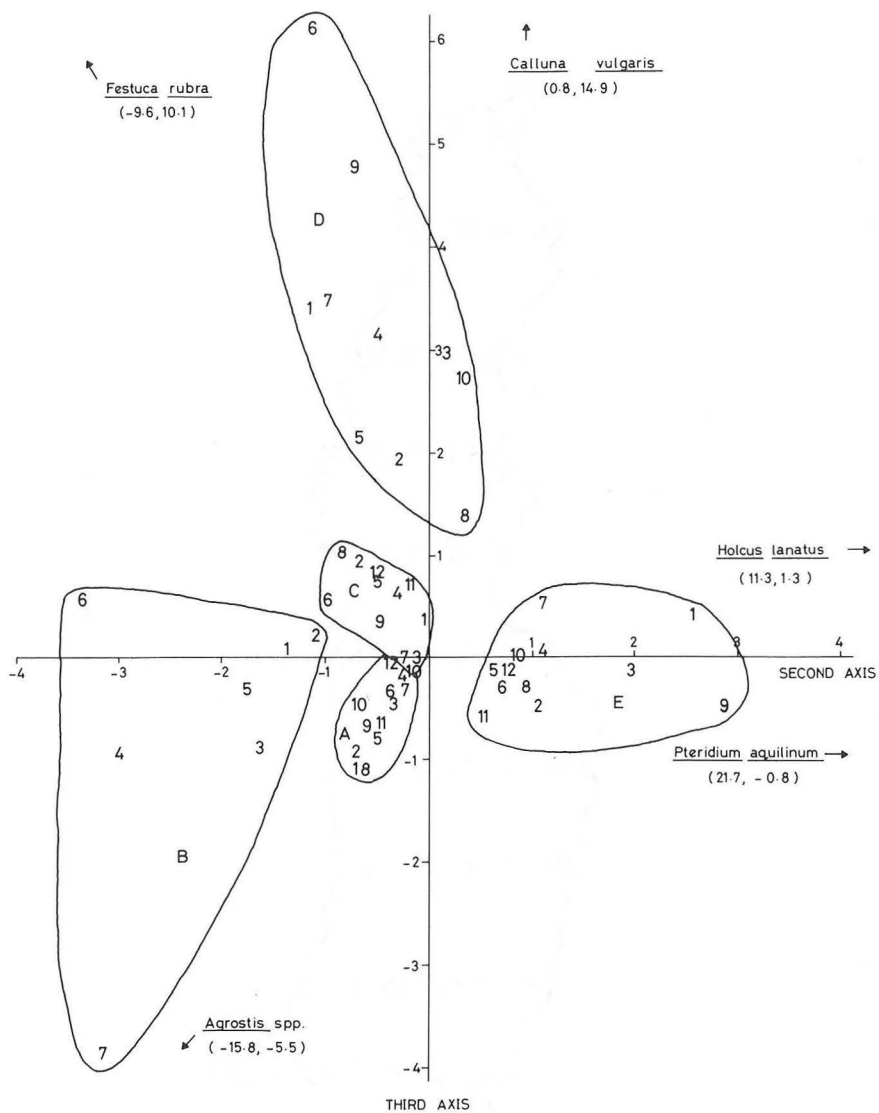


Figure 3. The five main groups of species and five outlying species revealed by Principal Components Analysis.



Between one and fourteen species were recorded per quadrat; the most species-rich plots being close-grazed turf and some of the wetter areas. The most species-poor plots were in areas of *Calluna vulgaris* on thin peat. *Pteridium aquilinum*-dominated areas were not particularly species-poor although in September the competition from *P. aquilinum* might be expected to be much greater than that of the more open, lower growing *Calluna vulgaris*. Amongst the *Calluna* areas were large patches of bare rock, the result of the fire in 1934 destroying the peat (Gillham, 1955). Elsewhere most plots showed almost complete vegetation cover.

Vegetation height and grazing pressure

A zone of *P. aquilinum* dominance in the east was picked out by vegetation heights of 100cm or more (Fig. 2), although amongst the *P. aquilinum* there were patches of grass that were heavily grazed to a short turf by rabbits. *Calluna*-heath and boggy areas tended to have vegetation about 10-20cm high as did the areas of tussocky *Armeria-Holcus* on the west coast. Most of the plateau grassland was grazed to a height of 2-8cm, but with the occasional taller clump of less palatable species such as *Juncus* or *P. aquilinum*.

In the south of the island there were some fields, with stock-proof walls, that were shut up for hay early in the year, but none of the main cross-walls appeared to be completely stock-proof. These walls did, however, form some barrier to the free movement of animals. During the period of the survey the Soay sheep were mostly among the heather at the North End; Welsh mountain sheep were the main grazers in Middle Park, with cattle and ponies becoming more common towards the southern end of the island. Rabbits were seen in all sections. Deer and goats were not seen, but are believed to be mainly in the north and east of the island.

Principal Components Analysis

The Principal Components Analysis (Gauch, 1982) operated on a correlation matrix of the species x plots table of Domin values. A series of axes was constructed, first through the maximum spatial variation and then through the next highest spatial variation etc. This produced an ordination of species. The analysis brought out three axes. These accounted for 33%, 18% and 9% of the variance respectively. The first axis was related to the frequency with which a species was recorded; this was because all the species had been used in the analysis, except for about ten that both occurred only in one plot and were rare in that plot. The second and third axes of the analysis brought out specific ecological groupings (Fig. 3).

Five of the commonest species (*Agrostis* spp., *Calluna vulgaris*, *Festuca rubra*, *Holcus lanatus* and *Pteridium aquilinum*) were drawn out to the extremes of the axes while the rest separated into five groups (A-E) around the origin. The division between groups A and C was arbitrary. The species in each of the groups are identified in Table 1 and their distributions are shown in Fig. 4.

Group A contained mostly species typical of lowland and neutral grassland and our records for this group were confined almost entirely to plots from the southern end of the island. Most were recorded once or twice only.

Group B also contained grassland species, but while common in the South End they occurred as far north as Middle Park. They were more abundant than Group A species, but like that group they showed a strong preference for the plateau rather than the sides of the island. Of the five "extreme" species, the pattern of distribution and abundance of *Agrostis* spp. most closely resembled that of this group (Fig. 5).

Group C species showed more of a northerly and westerly distribution although still tending to be commonest on the plateau. The species in this group included some characteristic of acid rather than neutral grassland e.g. *Nardus stricta*, *Galium saxatile*, and some bog species such as *Anagallis tenella*, *Sphagnum* spp., and *Scutellaria minor*.

Group D species showed an even stronger north and west bias and were totally absent from the south east corner. Their distribution is thus almost exactly complementary to that of Group A. Group D species were those of heathland or of bog (rather than dry grassland) or were members of the salt-influenced communities of the western side of the island. *Calluna vulgaris* was related to this group in the analysis (Fig. 5).

TABLE 1. The number of times species were recorded and their distribution

	Number of Records	Distribution of records						
		WS	PL	ES	SE	PY	MP	NE
Group A								
1 Achillea millefolium	3		3		2	1		
2 Bellis perennis	2		2		1	1		
3 Bromus mollis	2		2		2			
4 Cerastium spp.	2		2		1	1		
5 Cynosurus cristatus	1		1		1			
6 Dactylis glomerata	3		1	2	3			
7 Juncus bufonius	2		2		2			
8 Lolium perenne	2		2		2			
9 Plantago lanceolata	1		1			1		
10 Poa annua	4	1	3		3	1		
11 Ranunculus repens	3		3		2	1		
12 Thymus drucei	3	1	2		2	1		
Group B								
1 Carex panicea	4		4		1	1	1	1
2 Hypochaeris radicata	4		3	1	2	1	1	
3 Leontodon taraxacoides	7	1	6		3	1	2	1
4 Lotus corniculatus	11	2	9		6	2	3	
5 Poa pratensis	8	1	5	2	4	4	4	
6 Sieglingia decumbens	11	1	10		4	4	3	
7 Trifolium repens	10		10		6	2	2	
Group C								
1 Anagallis minima	3	2	1				1	2
2 Anagallis tenella	3		2			1		1
3 Galium saxatile	15	3	9	3	3	3	6	3
4 Juncus articulatus	1		1			1		
5 Juncus effusus	4		4		1	2		1
6 Luzula campestris	10	2	6	2	2		6	2
7 Nardus stricta	2		2			1		1
8 Plantago coronopus	7	5	2		1	2	2	2
9 Rumex acetosella	13	4	8	1	6	2	2	3
10 Scutellaria minor	1		1					1
11 Spergularia rupicola	1	1			1			
12 Sphagnum spp.	2		2			1		1
Group D								
1 Armeria maritima	9	9			3	2	1	3
2 Carex pilulifera	4		4			3	1	
3 Erica cinerea	7	4	2	1	3	1	1	2
4 Erica tetralix	5	1	4		1	3		1
5 Eriophorum angustifolium	9	3	6		1	2	3	3
6 Molinia caerulea	5		5			4		1
7 Potentilla erecta	19	4	14	1	3	5	6	5
8 Rhododendron ponticum	2		1	1		1	1	
9 Salix repens	4		4			4		
10 Sedum anglicum	12	10	1	1	4	2	2	4

TABLE 1. The number of times species were recorded and their distribution

	Number of Records	Distribution of records						
		WS	PL	ES	SE	PY	MP	NE
Group E								
1 Anthoxanthum odoratum	16	2	11	3	5	2	6	3
2 Carex binervis	1		1			1		
3 Digitalis purpurea	4			4	1	1	1	1
4 Dryopteris aemula	1			1			1	
5 Endymion non-scriptus	2			2			1	1
6 Glechoma hederacea	1			1			1	
7 Hydrocotyle vulgaris	4	2	2			2		2
8 Rubus fruticosus	2		1	1	1	1		
9 Rumex acetosa	10	4	2	4	1	4	3	2
10 Teucrium scorodonia	2	1	1					2
11 Viola lutea	6		4	2	2		2	2
12 Viola riviniana	1			1		1		
The "Extreme" Five								
Agrostis spp.	30	8	18	4	11	6	8	5
Calluna vulgaris	15	6	7	2	4	3	3	5
Festuca rubra	25	10	11	4	6	7	7	5
Holcus lanatus	36	11	19	6	11	8	8	9
Pteridium aquilinum	15	5	4	6	3	3	5	4
Excluded from the analysis								
Betonica officinalis	1			1	1			
Prunella vulgaris	1		1		1			
Sagina procumbens	1			1	1			
Silene dioica	1			1	1			
Taraxacum officinale	1		1		1			
Ulex europaeus	1			1	1			
Vicia sp.	1		1		1			
KEY								
Number of Plots								
WS = West side	13							
PL = Plateau	24							
ES = East side	8							
	—							
	45							
	—							
SE = South End	14							
PY = Pondsbury	11*							
MP = Middle Park	10							
NE = North End	10							
	—							
	45							
	—							

* Plot 21 is strictly in South End because Quarter wall passes it to the north, but it has been included in Pondsbury because it is in the same line as the other plots which are all in Pondsbury.

Figure 4. The distribution of species groups from Principal Components Analysis. (Each figure represents the number of species from the group found in the quadrat).

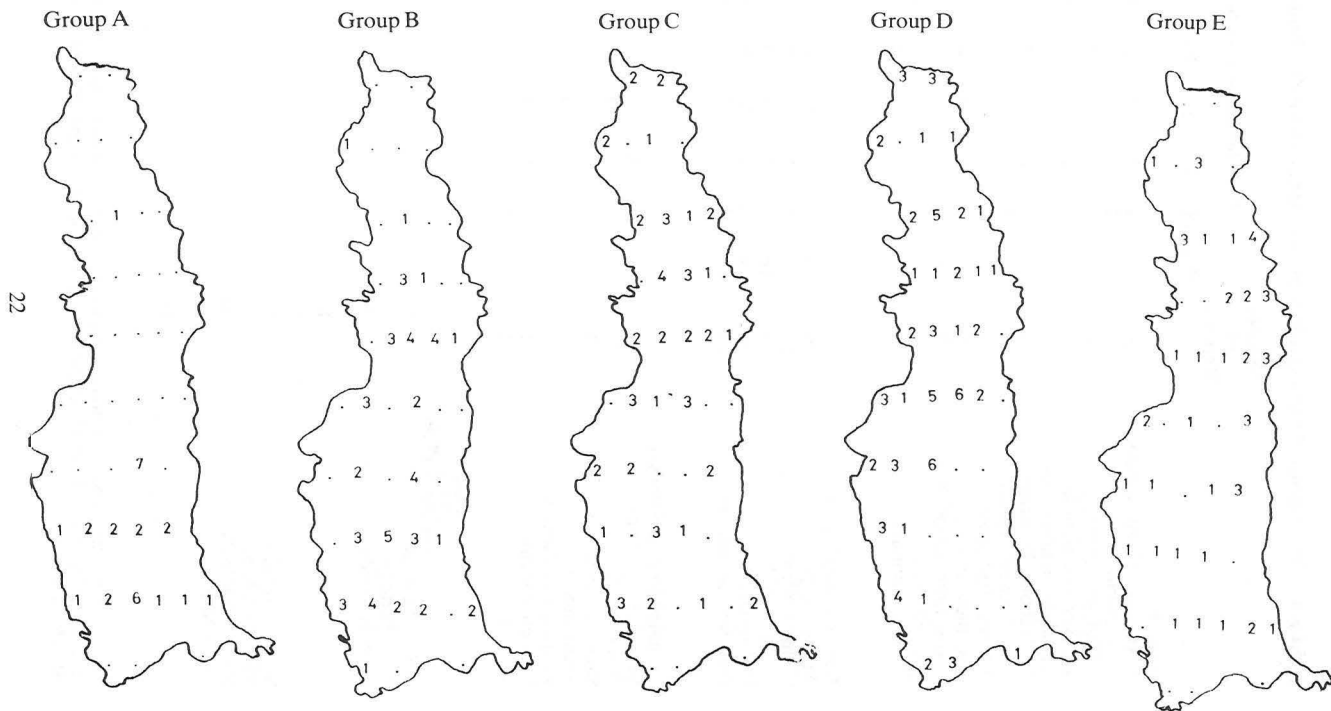
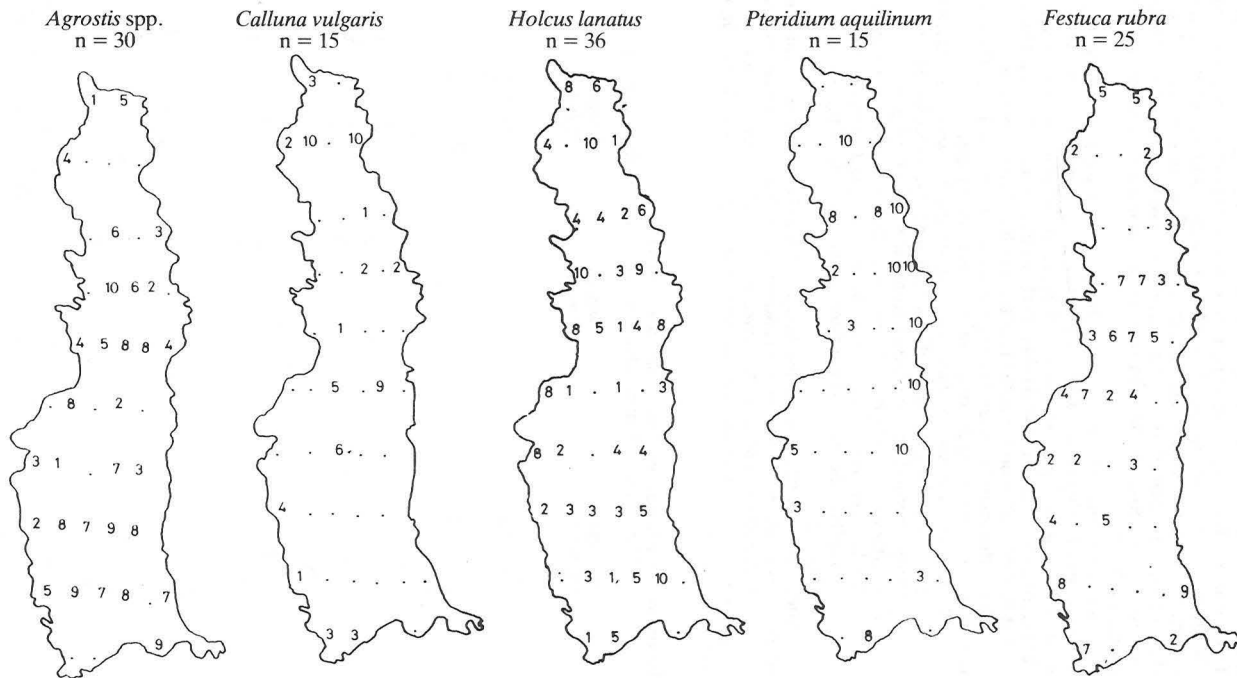


Figure 5. Distribution of some of the commonest species.
 (Figures are Domin values for the species in the quadrat).



Group E species showed a strong easterly bias in their distribution. They included those species that, elsewhere in Britain, often form part of woodland communities. Of the five "extreme" species both *Holcus lanatus* and *Peridium aquilinum* were associated with this group. The distribution of *P. aquilinum* fits with the group in that, while not confined to the east side, it was most luxuriant there. *Holcus lanatus*, however, was abundant on both sides of the island although less common on the plateau (Fig. 5).

Festuca rubra did not appear to be associated with any of the groups in the analysis. Its distribution showed a fairly strong bias towards the sides (especially the west, where it was part of the salt-influenced community) but it was also very abundant in the grassland of Middle Park on the plateau (Fig. 5). Unlike *Agrostis* spp. it was not common in the fields of the south end of the plateau.

The differences between the vegetation on the two sides of the island can be illustrated by comparing the distribution of two sets of species:

- (i) *Armeria maritima*, *Sedum anglicum*, *Anagallis minima*, *Plantago coronopus* and *Spergularia rupicola*, all of which are coastal species in Britain and which were recorded almost entirely from the west side (Fig. 6).
- (ii) *Endymion non-scriptus*, *Silene dioica*, *Rubus fruticosus*, *Digitalis purpurea*, *Viola riviniana*, *Glechoma hederacea*, and *Dryopteris aemula*, all "woodland herbs" and confined to the east side of the island in our records (Fig. 7).

Species of wet peaty areas also had a restricted distribution in this survey. Four of the plots in the Pondsburry section and one in the North End were characterised by an abundance of *Erica tetralix*, *Molinia caerulea*, *Salix repens* and *Juncus* spp. Other bog species such as *Anagallis tenella*, *Sphagnum* spp. and *Scutellaria minor* were also found in these plots.

Figure 6. Distribution of some salt-tolerant species.
(Figures are Domin values for the species in the quadrat).

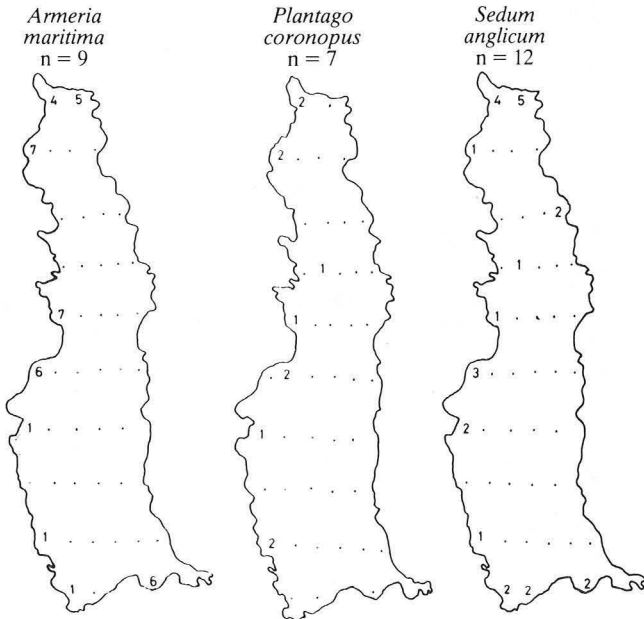
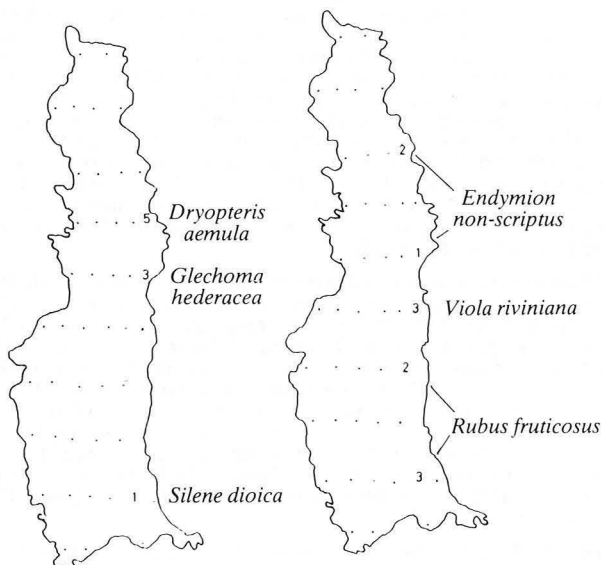


Figure 7. Distribution of some “woodland herb” species.
(Figures are Domin values for the species in the quadrat).



DISCUSSION

The differences in the vegetation on Lundy can be considered under three headings:

- (a) the differences between the four sections of the plateau (South End, Pondsbury, Middle Park and North End);
- (b) differences between the plateau and the sides;
- (c) differences between the east and west sides.

The results of this survey can also be compared with other studies.

(a) **Differences between the four plateau sections.** The variations between South End, Pondsbury, Middle Park and North End in terms of the species and vegetation present appear to be mainly due to their differing management histories. North End is farthest from the modern settlement and has probably not been cultivated in historical times. Grazing by domestic stock may also be lighter for the same reason. It remains therefore as semi-natural heather moorland. In Pondsbury the poor drainage would also discourage cultivation as long as other land were available, so that here too heath and bog species such as *Erica tetralix*, and *Calluna vulgaris* survive over large areas. South End and Middle Park were probably the main cultivated areas in the past although both are now grassland. The South End, however, includes smaller fields; is more intensively managed and may in parts have been resown. The greater frequency for neutral grassland species in South End compared to Middle Park reflects this difference in management.

(b) **Differences between the plateau and the sides.** A major difference between the plateau and both sides of the island is the greater predominance of *Holcus lanatus* on the sides and of *Agrostis* spp. on the plateau. Dawes (1979) records a higher pH (6.0) for the plateau than from the sides (4.5), but a survey of the grassland around Sheffield (Grime and Lloyd, 1973) showed that both grasses are commonly found on soils of each pH level. Differences in the level of grazing could, however, explain the difference in abundance of the species. The plateau seemed to be more heavily grazed than the sides although this is only partly reflected in the figures for the vegetation height per plot. The species that showed a bias in their distribution towards the plateau rather than the sides included many grasses and low-growing herbs able to tolerate heavy grazing, eg *Agrostis* spp. and *Trifolium repens*. *Agrostis* spp., unlike *H. lanatus*, form a large proportion of the diet of the Sika deer on Lundy (Bathe and Scriven, 1975). In contrast, *Holcus*, more common on the sides of the island, is intolerant of intense defoliation (Watt, 1979; Watt and Haggard, 1980) and of heavy treading (Brown and Evans, 1973).

(c) **Differences between the east and west sides.** On the west coast, *H. lanatus* and the maritime species *Armeria maritima* coexist over large areas. It has been suggested that the balance between these species is maintained by the preferential grazing of *H. lanatus* by rabbits (Gillham, 1955). Although it is not a halophyte, *H. lanatus* can tolerate a certain amount of salt spray (Gillham, 1953). *Holcus lanatus* collected from the western cliffs of Lundy has a greater tolerance of salt spray than both an agricultural cultivar of *H. lanatus* and *Lolium perenne*. (Watt, in press). However, there is evidence that *Agrostis stolonifera* also has salt-tolerant ecotypes (Ahmad and Wainwright, 1977) and it is found on cliffs exposed to salt spray (Goldsmith, 1973). So, the effect of salt spray *per se* is unlikely to be the reason for the small amount of *Agrostis* spp. on the western slopes.

Gillham (1955) studied the vegetation near rabbit warrens on the west and east coasts. She found *Armeria maritima*, *Plantago coronopus* and *Sedum anglicum* commonly on the west side; *Digitalis purpurea* only on the east side and *Holcus lanatus* on both sides, in agreement with this survey.

The work of Gabbutt (1952) also concentrated on the sides. His records, showing the greater frequency of *Pteridium aquilinum*, *Rubus fruticosus* and *Viola* spp. on the east and of *Sedum anglicum*, *Armeria maritima*, *Plantago coronopus*, *Hydrocotyle vulgaris* and *Erica cinerea* on the west, were matched in this survey. As here, Gabbutt found that *Pteridium aquilinum* was taller on the eastern side. *Potentilla erecta*, *Thymus drucei*, *Trifolium repens* and *Anthoxanthum odoratum* showed no east-west difference in Gabbutt's study and in this work they were common on the plateau. *Calluna vulgaris* showed some bias towards the west in both cases but, as Gabbutt noted, it was also common on the plateau.

Leontodon taraxacoides (= *Leyserii*) was recorded by Gabbutt as far commoner in the west, but this survey showed it to be most abundant on the plateau. *Galium saxatile* and *Holcus lanatus* were recorded more frequently on the east and west respectively by Gabbutt, but this survey did not show such trends. *Holcus lanatus* was, however, rather more abundant on the sides than on the plateau and the communities in which it was present were very different.

The eastern slopes are much more sheltered than the western ones, but competition from *Pteridium aquilinum* is severe. Seeds of *Holcus lanatus* and of *Agrostis tenuis* have shown 98% and 83% germination respectively, in very low light (Grime and Hunt, 1975), but *H. lanatus* has the faster maximum relative growth rate (Grime and Jarvis, 1975). Thus, while shade from *P. aquilinum* is unlikely to affect the germination of either species, the greater relative growth rate of *H. lanatus* may allow it to make more efficient use of the light before the canopy closes over it. This may be one factor accounting for the greater abundance of *H. lanatus* rather than *Agrostis* spp. on the east side.

Comparison with previous survey

This survey, which was at a low sampling intensity (0.01%) but spread over most of the island systematically, can be compared with Taylor's vegetation map of the island (Dunn and Bristow, 1971). Taylor's map shows the distribution of eight broad vegetation types. These were heather moorland, bracken dominated areas, watercourse areas, mixed woodland, rhododendron, rough grassland, cultivated grassland and unvegetated areas. Such a map picks up many small patches of variation which a sample survey will miss.

On the other hand, our survey has subdivided Taylor's "rough grassland" category. Firstly, this area tends to contain neutral grassland species in the South End (e.g. *Lolium perenne*, *Bellis perennis*, *Plantago lanceolata* and *Cynosurus cristatus*), whereas, in Middle Park, it contains more acid species (e.g. *Festuca rubra*, *Galium aparine*, and *Luzula campestris*). Secondly, there is a clear difference between "rough grassland" on the west side (containing e.g. *Armeria maritima*, *Plantago coronopus* and *Sedum anglicum*) and that on the plateau (containing *Anthoxanthum odoratum*, *Trifolium repens* and *Sieglingia decumbens*).

ACKNOWLEDGEMENTS

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