The following table contains the records from nine birds representing three species during the 1952 season.

Host	*Date*	*Postition of parasite*	*Species of tick*
Whitethroat	7/9/52	Gape	*I. frontalis* (Panzer) 1N*
,,	12/9/52	—	*I. reduvius* (L.) 1N
Willow Warbler	26/7/52	Gape	*I. reduvius* (L.) 1N
,, ,,	14/8/52	Gape	*I. reduvius* (L.) 1L†
,, ,,	25/8/52	Eye	*I. reduvius* (L.) 2L
,, ,,	–/8/52	—	*I. reduvius* (L.) 1L
,, ,,	–/8/52	—	*I. reduvius* (L.) 2L
Blackbird	29/7/52	Eyes and beak	*I. reduvius* (L.) 7L
,,	5/3/52	Gape and eye	*I. reduvius* (L.) 15N

* N=nymph † L=larva

I am indebted to my friend Dr Don R. Arthur for his help with the identification of the ticks.

A STUDY OF THE VEGETATION OF THE COASTAL SLOPES OF LUNDY

By P. D. Gabbutt

The aim of the investigation, initially, was to analyse differences in the plant populations of the east and west coasts of Lundy (Part I). From this preliminary work two, later, lines of research were undertaken to investigate :—

(a) the differences in the Bracken, *Pteridium* population on the two sides of the island (Part II).

(b) the plants associated with the Thrift, *Armeria* in the gullies of the west coast (Part III).

Geology

Excellent accounts of the geology of Lundy can be found in several papers (1, 2, 3 and 4). Quite simply, the island is of volcanic origin, consisting for the most part of granite with a small area of slate at the South-East tip. All the areas investigated were on the granite formations.

Climate

The climate of Lundy, as might be inferred from its position, is peculiar. The prevalent wind is from the west and naturally it is the west side of the island which receives the full weight of the gales and storms from the Atlantic. The east coast is for most of the year, the lee-side and only suffers from the rare easterly gales. It is therefore comparatively sheltered.

Despite the strong winds and gales, the general climate is equable. Although maximum temperatures are 7 to 10 F. lower than those recorded on the mainland, the minimum temperatures

are 7 to 10 F. higher in the winter. Snow seldom falls and ice is a rarity. Rainfall is less than on the mainland (i.e. less than 35 ins) but the prevalence of mist renders the amount of moisture available very great. Briefly the climate is equable and humid but suffers from gales from the west.

Part I

Areas on the east and west sides of the island were selected which were reasonably alike topographically, these being; the slopes of the north side of Jenny's Cove on the west coast, and the north flank of Brazen Ward on the east coast (See Map).

Both were open slopes on the sidings of the island; both contained about the same number of boulder projections per unit area—1 to 5·75 sq. metres and neither was hemmed in by large granite formations. The selection was taken as far as it was modified by the natural differences between the two slopes. The slope lengths were measured by standard surveying methods and it is apparent that the slopes at Jenny's Cove were shorter and steeper than those at Brazen Ward.

Estimation of soil pH.

The following method was used. The vegetational covering was removed and the soil exposed. A graduated cork-borer was pushed into the soil until the 5 cm. mark was reached. The soil obtained was thoroughly mixed and a sample was tested with B.D.H. Universal Indicator. The samples were selected according to a grid-pattern on the slopes at both sites. Three samples of soil every 20 metres across the slope and every 25 metres down the slope.

The results are shown in Table I. It must be borne in mind that the figures quoted are related to a comparative scale and are not absolute.

Table I

Positions UP slope at 25 metres intervals from cliff edge	*pH Readings**							
	1	2	3	4	5	6	7	8
Jenny's Cove . .	5	5	4	4	4			
Brazen Ward . .	5	4	4	3	3	2	3	3

* Using B.D.H. Universal Indicator

Nevertheless several conclusions may be safely made:—

(a) the soil at both sites is acid. It varies but is usually of peaty texture, and is associated with the acidic granite rock formation.

(b) generally speaking the soil at Jenny's Cove is less acid than that at Brazen Ward. This is probably due (see Part III) to the effect that sea water spray has on buffering the soil acidity.

(c) it may be noted that there is a tendency for the soil to be less acid on the lowest slopes at Brazen Ward and this may indicate that some sea salt is carried up this slope.

The soil is acid, but it is less acid on the west coast due to sea salt buffering and this is reflected in the readings on the lowest slopes of the east coast.

Species-frequency.

The following method was used. The slope was divided into grids, each of 5 metres square and ½ sq. metre quadrats were placed at the points of intersection of the grid. The presence or absence of all species was noted. The grid was illustrated graphically and it was easy to see changes in the slope plant community with respect to a single species. It must be borne in mind that the method only indicates proportions of the species occurring and in no way gives an absolute result.

The results are shown in Table II and the differences between the two sites in Table III.

TABLE II

Species	*% frequency at Jenny's Cove*	*% frequency at Brazen Ward*	*Difference in % compared to Jenny's*
Pteridium aquilinum	45	64	−19
Armeria maritima	26	16	10
Holcus lanatus	78	55	23
Festuca ovina	58	43	15
Agrostis sp.	41	48	−7
Carex disticha	54	36	18
Sedum anglicum	52	14	38
Potentilla erecta	38	40	−2
Erica cinerea	27	8	19
Calluna vulgaris	27	7	20
Rumex acetosella	33	23	10
Plantago coronopus	20	1	19
Trifolium sp.	6	4	2
Achillea millefolium	20	2	18
Hydrocotyle vulgaris	12	—	12
Thymus serpyllum	19	10	9
Anthoxanthum odoratum	8	9	−1
Galium saxatile	3	14	−11
Viola canina	1	18	−11
Centaurea umbellatum	—	11	−11
Lonicera periclymenum	—	14	−14
Leontodon leysseri	63	17	46
Rubus sp.	—	25	−25
Digitalis purpurea	—	26	−26
Luzula campestris	19	16	3
Chrysanthemum leucanthemum	—	16	−16
Senecio jacobea	—	11	−11
Crithmum maritimum	—	19	−19

TABLE III

% frequency	*Less as compared with Jenny's Cove*	*More as compared with Jenny's Cove*
20%	*Rubus sp.*	*Leontodon leysseri* *Sedum anglicum* *Holcus lanatus* *Calluna vulgaris*
15%	*Pteridium aquilinum* *Viola canina* *Chrysanthemum* *Senecio jacobea*	*Erica cinerea* *Carex ovalis* *Plantago coronopus* *Achillea millefolium*
10%	*Galium saxatile*	*Festuca ovina* *Teucrium scorodonia* *Armeria maritima* *Hydrocotyle vulgaris*

Besides the differences between the two sides several other points may be noted :—

(a) *Rubus, Digitalis, Senecio, Chrysanthemum,* and *Lonicera* were not recorded from the site on the west coast.

(b) *Calluna, Medicago, Thymus, Anthoxanthum, Erica* and Trefoil were only recorded on the upper slopes at both Jenny's Cove and Brazen Ward.

(c) *Armeria* and *Crithmum* were only present on the lower slopes at Jenny's Cove and Brazen Ward, together with such 'casuals' as *Silene maritima* and *Spergularia rupicola.* The last three species were very abundant on the inaccessible cliff-faces.

PART II

As has been indicated in PART I there is a difference in frequency of *Pteridium* on the two slopes amounting to some 20 per cent.

With such a relatively large plant it seemed that some of the other differences between the two slopes might be related to this discrepancy.

A purely subjective analysis of the *Pteridium* on the two slopes showed that on the whole the plants on the west coast were small, and grasses and other species competed with them, whilst on the east coast the whole slope was dominated by the *Pteridium* canopy.

The differences were quantitively examined and in all cases the results are based on 200 measurements made at random.

The results are summarized in Table IV.

TABLE IV

	Measurement at Jenny's	*Measurement at Brazen*	*Measurement at E.*
A. The ht of *Pteridium* fronds in cms	25.4	72.9	53.1
B. The number of fronds in a ½ metre square	11.7	13.1	13.0
C. % coverage	60	98.7	89.0
D. Soil in depth in cms	13.1	33.1	33.0

The height of the *Pteridium* frond was measured from soil level to the tip of the highest frond found in the ½ metre square when estimating per cent coverage. Plants at Jenny's Cove were on the average three times smaller than those at Brazen Ward.

The per cent coverage was estimated by using a ½ metre square which had been further divided into twenty-five squares. The squares were counted in which *no* grass or other species were visible through the *Pteridium* stands when viewed from above. This was the per cent coverage factor. It was considerably higher at Brazen Ward.

The soil depth was measured (at the same time as the other measurements were taken) by pushing a graduated tube into the soil until it would go no further. The average soil depth at Jenny's Cove was 2½ times less deep than at Brazen Ward.

Better established *Pteridium* clumps on the west coast were examined and the results in Table IV under 'at E', are shown.

The *Pteridium* seems to have just as big a chance of establishing itself on the west coast as it has on the east coast—B. ; although its height is severely cut—A. The fronds on the west coast were smaller and did not cover other species as much—C. Where the soil was deeper the fronds were higher—A and D (See Table IV).

It is interesting to note the measurements on the better established clumps on the west coast. The soil depth here and at Brazen Ward was of the same order, yet the height of the fronds on the west side still fell short of those recorded at the east coast site.

The vegetation of the two sidings differs in composition and in construction. On the east side the *Pteridium* is dominant and forms a protective cover over almost the whole slope ; whilst on the west coast this species is smaller and other species compete on an equal footing.

Beneath the canopy of the *Pteridium* of the east side occurs a number of species. Some of these species are common to both sites, whilst others are only found at Brazen Ward ; for instance, *Rubus sp., Senecio jacobea, Chrysanthemum* and *Lonicera.*

Of the species which occur at both sites, some like *Viola canina* flourish better at Brazen Ward, whilst others are better suited to the more 'open' association at Jenny's Cove. These include, *Leontodon leysseri, Sedum anglicum, Holcus lanatus, Calluna vulgaris, Achillea millefolium, Erica cinerea* and *Carex ovalis.*

Some species show a gradient up or down the slopes at both sites. *Armeria* and *Crithmum maritimum* occur only on the lower slopes. Other species, such as, *Calluna vulgaris, Erica cinerea, Medicago sp., Thymus serpyllum, Anthoxanthum odoratum,* and *Lotus corniculatus* are restricted to the upper slopes of the sidings.

The two serious problems facing species on the sidings are dessication and salting (for salting see Part III).

Wind effects, either direct or indirect, may be mitigated by such factors as :

(a) topographic shelter where the east side is the lee-side to the prevalent westerly winds.

(b) Shelter beneath the *Pteridium* cover as for such species as *Galium saxatile* and *Viola canina.*

(c) A reduction of transpiration by a reduction in leaf area as in the case of the *Pteridium,* which is compensated at Brazen Ward by increased water supplies in the soil.

(d) An ability to 'stand up to' the high wind effects by most of the species of the 'open' community of the west side.

The formulation of these factors to explain the differences in the composition of flora on the two sides depends on the interpretation of the results obtained on measuring the *Pteridium.*

The difference in the *Pteridium* communities amounts to a difference in per cent coverage and in height which seems to be linked in some way to the soil depth. With the comparatively shallow soil as found on Lundy, there is less chance of water shortage at greater soil depths. If then the amount of available water is a governing factor in determining the height of the *Pteridium* fronds then the differences in the two communities are explainable at least in part by the difference in soil depths (i.e. where these differences are related to the *Pteridium* canopy).

Part III

An additional indirect effect of the wind operating on the species on the west coast of Lundy is 'salting'. It is quite apparent that during westerly gales sea spray is blown up the cliff slopes. The fact that sea spray is spread up a slope depends on several factors (discussion later).

The direction of the wind is important. The west coast is only affected by winds from the westerly points of the compass.

TABLE V

Year	*Gales recorded on Lundy over Force 6*		*Actual no. of days on which winds of F.6 recorded*	
	Westerly	*Easterly*	*Westerly*	*Easterly*
1947	11	3	46	4
1948	12	5	68	6
1949	13	5	52	5
1950	10	5	69	5
1951	16	6	74	8
1952 up to Aug. 27th	4	1	8	2
TOTALS	66	25	317	30

The great predominance of westerly over easterly gales is shown in Table V. Not only is the actual number of gales higher (of the westerlies) but the actual length of each gale is longer.

An attempt was made to try to estimate the amount of salt water which was deposited on the slopes during a wind of known velocity.

The method employed was as follows. A number of Petri dishes of a constant size were employed in pairs, 5 metres apart, at given distances up a slope from the H.W.M. These dishes had a number of filter papers in them (the sites were made as open as possible, e.g. by flattening the vegetation). These were left out on the slopes during weather in which wind velocities were are least Force 6 (Beaufort Scale).

The amount of sea water deposited is related to the titratable chloride present. This was estimated by titrating 10 ccs against N/100 $AgNO_3$, after having made up the solution in a known and constant quantity of distilled water (using pot. chromate as indicator). The results are shown in Table VI.

TABLE VI

Time of exposure 18 hours.

Distance up slope in metres		2/7/52		5/7/52	
		W. gale F. 6		*W. gale F. 8*	
H.W.M.+	30 metres	6.5	8.2	31.2	18.6
	50	2.1	3.0	12.6	16.3
	70	0.7	1.1	8.5	5.2
	90	—	—	3.0	2.1
	110	—	—	0.9	2.0

The readings represent no. of ccs. of $AgNO_3$ (N/100) required for equilibrium with indicator.

From the results it can be seen :—

(a) There is a gradation in the amount of sea spray carried up the cliff slope.

(b) In winds of higher velocity the salt spray is carried higher up the slope and at a given site more salt is deposited in unit time.

It may be noted that no positive results were obtained when the dishes were put out in winds of Force 3–4.

The surface soil was collected, as in the pH measurements of Part I and both estimates of pH and of chloride content were undertaken at eight gullies on the west coast.

Measurements were made in both cases on

(a) 2-7-52 after a Force 6 gale which was accompanied by heavy rain.

(b) 10-8-52 in hot sunshine after a period of five days in which no rain had fallen.

pH readings.

Estimated using a B.D.H. colorimeter in conjunction with the indicator Bromo-Thymol Blue (effective range pH 6·0—7·6). Results are shown in Table VII.

TABLE VII

I. Lowest levels of gullies.

Date	*Gully*							
	1	2	3	4	5	6	7	8
2/7/52	6.6	6.6	6.4	6.4	6.4	6.6	6.8	6.8
10/8/52	6.4	6.0	6.0	6.2	6.4	6.2	6.0	6.2

II. Highest levels of gullies.

Date	*Gully*							
	1	2	3	4	5	6	7	8
2/7/52	6.6	6.4	6.2	6.0	6.2	6.2	6.4	6.4
10/8/52	6.0	*5.0	*5.0	*5.0	*6.2	5.0	6.0	6.2

* Estimated using B.D.H. Universal Indicator.

The pH readings on the highest levels of the slope were always lower than those on the lower levels (i.e. more acid), and were considerably more so after no rain had fallen for several days.

The pH readings at both levels were nearer neutral after the rain than those taken during a spell of hot weather.

It seems apparent that there is a gradient up the slope from acid to more acid conditions; that persistent rain lowers the pH and that warm conditions greatly accentuate the difference in pH between the upper and the lower parts of the slope.

Estimation of chloride content.

This was undertaken on the same soil samples as the pH estimations. The method involved weighing 2 gm. samples of the air dried soil, steeping in 30 ccs. of distilled water, filtering, and titrating 10 ccs. of the filtrate against N/100 $AgNO_3$ using Potassium chromate as indicator. Results are shown in Table VIII.

TABLE VIII

I. Lowest levels of gullies.

Date	*Gully*							
	1	2	3	4	5	6	7	8
2/7/52	2.6	1.6	14.2	2.2	2.6	3.5	2.1	1.8
10/8/52	8.2	13.0	14.0	6.0	9.2	3.6	12.9	14.1

II. Highest levels of gullies.

Date	*Gully*							
	1	2	3	4	5	6	7	8
2/7/52	2.0	2.1	0.7	6.0	1.8	2.8	3.2	1.6
10/8/52	6.6	10.5	2.1	5.8	6.1	3.6	3.5	1.9

(Results expressed as in Table VI.)

It seems apparent there is a gradient of 'salting' up the slope ; the readings at the top of the slope are always less than those at the bottom of the slope. Due to a drying out process the 'salting' increases after a spell of sunny weather, and readings are higher at both levels. There are, however, considerable differences in the readings in the gullies both in actual amount of 'salt' recorded and in the variability of differences between the two dates.

Situations of the gullies (see Map).

All the eight gullies examined were on the west coast and varied in length from 150 to over 300 metres (measured from cliff edge up the line of the slope). They all were comparatively small gullies, sloping down gently at first and then more steeply. They were hemmed in on both sides by granite formations and ended abruptly on the cliff edge some 20—35 metres above the sea.

Species frequency in the gullies.

The results are shown in Table IX on the 1–5 notation.

There is a gradual change in the plant assemblages situated at different heights on the slope which seems related not to their actual height above sea level but to the distance of the species from the cliff edge. That is there is no discernible difference in the flora of the gullies which are 20 or 40 metres respectively above sea level (the range is of course small). Several species are found throughout the gullies, for instance, *Holcus lanatus, Festuca ovina, Agrostis sp., Carex disticha* and *Rumex acetosella.* Some species are confined to the lower levels such as *Armeria maritima* and *Plantago coronopus* whilst others, such as *Calluna vulgaris* and *Erica cinerea* are limited to the higher slopes.

Map of Lundy

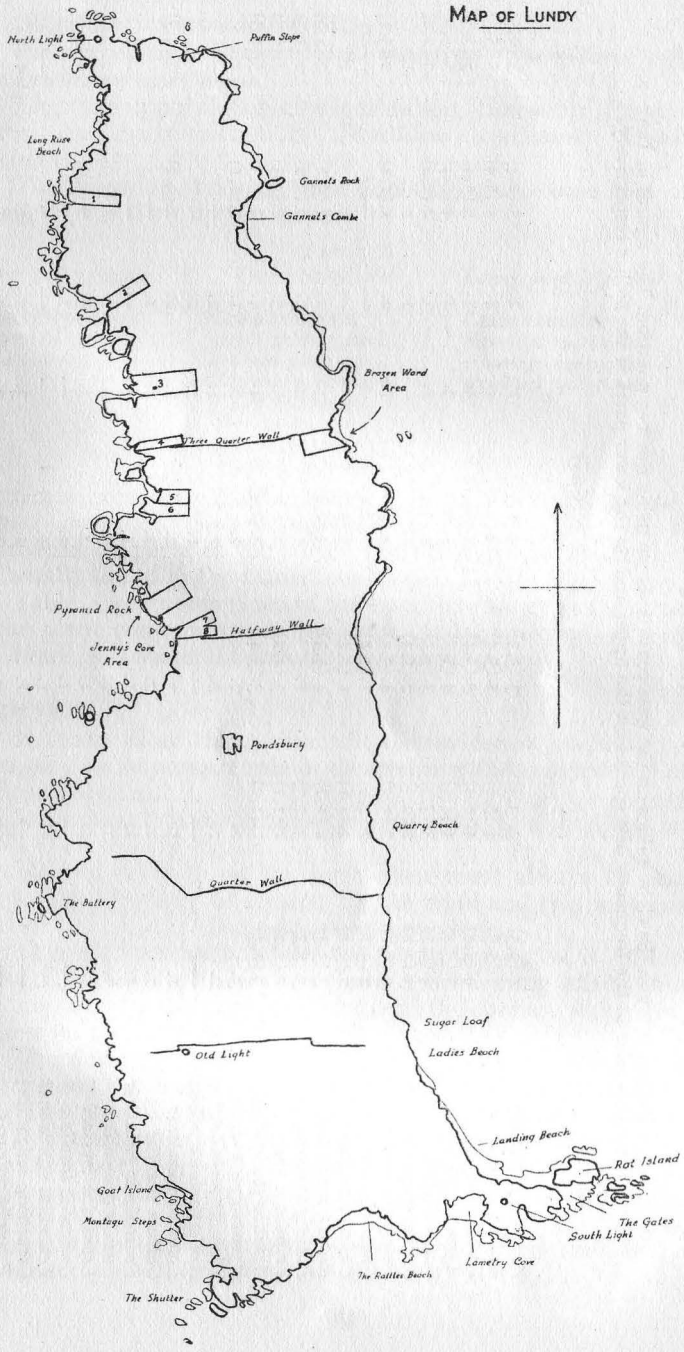
North Light
Puffin Slope
Long Roze Beach
Gannets Rock
Gannets Combe
1
2
3
Brazen Ward Area
4
Three Quarter Wall
5
6
Pyramid Rock
7
8
Halfway Wall
Jenny's Core Area
Pondsbury
Quarry Beach
Quarter Wall
The Battery
Sugar Loaf
Old Light
Ladies Beach
Landing Beach
Rat Island
Goat Island
Montagu Steps
The Gates
South Light
Lametry Cove
The Rattles Beach
The Shutter

Table IX

Species frequency in the eight gullies on the west coast is shown using the 1–5 notation. The figures in the brackets refer to the frequency of a species on the upper and on the lower parts of the gullies respectively.

Species	*Gully* 1	2	3	4	5	6	7	8
Armeria maritima	4.(3,5)	3.(3,4)	3.(3,3)	3.(2,5)	2.	2.	3.(2,4)	3.(2,5)
Holcus lanatus	5.(5,5)	4.(5,4)	5.(5,4)	5.(5,5)	4.	4.	4.(5,4)	5.(5,5)
Festuca ovina	4.(5,4)	4.(4,4)	5.(5,4)	5.(5,4)	5.	5.	5.(5,4)	5.(5,5)
Agrostis sp.	5.(5,4)	4.(4,4)	4.(5,3)	4.(5,3)	5.	4.	4.(5,4)	5.(5,5)
Carex disticha	4.(4,5)	3.(3,3)	3.(4,3)	4.(3,4)	2.	3.	2.(2,2)	3.(2,4)
Sedum anglicum	3.(3,2)	2.(2,3)	2.(1,3)	1.	—	1.	1.	1.
Potentilla erecta	3.(5,1)	2.(3,3)	4.(5,3)	3.(4,2)	1.	2.	1.(1,1)	2.(3,1)
Erica cinerea	2.(3,1)	2.(4,2)	1.(2,1)	1.(1,1)	—	—	—	—
Calluna vulgaris	2.(3,1)	2.(4,1)	1.(1,2)	1.(1,1)	—	—	1.	1.
Rumex acetosella	3.(3,4)	2.(1,2)	4.(4,3)	3.(2,4)	3.	2.	2.(3,2)	3.(4,3)
Plantago coronopus	3.(2,3)	3.(2,3)	1.	1.	2.	3.	2.(3,2)	2.(1,3)
Trifolium sp.	2.(2,2)	1.(1,1)	3.(4,2)	2.	5.	5.	4.(4,3)	4,(5,3)
Achillea millefolium	3.(2,3)	2.(1,2)	3.(3,4)	3.(2,4)	4.	4.	3.(3,3)	5.(5,5)
Hydrocotyle vulgaris	3.	2.	2.	2.	2.	1.	1.(1,1)	1.
Thymus serpyllum	2.	2.	2.	2.	1.	2.	—	—
Anthoxanthum odoratum	—	—	—	1.	2.	2.	—	—
Lotus corniculatus	1.	1.	3.	2.	2.	4.	2.(3,1)	3.(4,3)
Galium saxatile	1.	1.	2.	1.	1.	1.	—	—
Pedicularis palustris	1.	1.	1.	1.	—	—	—	—
Luzula campestris	1.	1.	2.	3.	4.	2.	1.(2,0)	2.(3,1)
Leontodon leysseri	1.	1.	1.	2.	4.	5.	3.(4,2)	4.(3,4)
Anagallis tenella	—	—	1.	1.	—	1.	—	—
Teucrium scorodonia	—	—	1.	1.	—	—	—	—
Cerastium vulgatum	—	—	1.	1.	3.	2.	2.	1.
Prunella vulgaris	—	—	—	1.	2.	2.	1.	1.

Other species recorded were :—

From the lower slopes, *Silene maritima, Spergularia rupicola* and *Crithmum maritimum.*

From the upper slopes, in wet situation, *Juncus sp., Ranunculus repens.* In dryer situation, *Pteridium aquilinum, Euphrasia officinalis.*

The following summary (see Table X) gives some idea of the change in the flora up the slopes.

TABLE X

Upper part of gullies	*Transitional zone*	*Lower part of gullies*
Grass complex	Grass complex	Grass complex
Calluna vulgaris	*Leontodon leysseri*	*Armeria maritima*
Erica cinerea	*Luzula campestris*	*Plantago coronopus*
	Thymus serpyllum	*Achillea millefolium*
	Potentilla erecta	
	Trifolium sp.	
	Lotus corniculatus	
	Achillea millefolium	

Grass complex=*Holcus lanatus, Festuca ovina, Agrostis sp., Rumex acetosella. Sedum anglicum* is always found on rocky formations on parts of the slope. The other species in Table VIII are usually found in the transitional zone.

Table X gives some idea of the essential change in the structure of the plant community up the slope. It is, however very plastic and there is considerable overlap in several cases.

Discussion.

It seems clear that, from all the evidence available, wind must play an important role in determining the composition of the cliff communities.

It is difficult to determine the effect that the wind has on soil depth or on the vegetation.

Soil stabilization on the west coast must always be difficult due to the high rate of erosion by the wind and this may in part account for the less luxuriant vegetation there.

The effect of the wind on the vegetation again is difficult to estimate. Certainly high winds have a dessicating effect and this may account for the absence of some of the species, which are only present on the east coast.

The direction and the velocity of the wind are important in determining the amount of sea spray which is blown up a particular cliff. The prevalent wind is from the west and it is naturally that side of the island which must receive considerably more salt than the east coast. The actual spray is formed by the action of the waves against the rock formations at the base of the cliffs. The disposition of these rocks, their distance from the cliffs, the state of tide and the slope of the cliff must all be contributing factors in determining the height to which the spray is blown.

The results obtained, by using filter papers in Petri dishes, gives an indication of the sea water deposited in a known time. The chloride content shows a gradation up the slope and varies with the wind velocity even when the latter is measured by such a subjective method as the Beaufort scale (see Table VI).

The sea water deposited on the slopes plays a part in buffering the soil acidity. It has been shown that the soil pH readings from the lowest parts of the west coast slopes, tend more to neutrality than those taken on the higher parts (see Table VII).

The effect of the rain which often accompanies the westerly winds is shown in that it affects firstly the soil by causing leaching of the mineral salts and will nullify at least in part the effect of 'salting'. Secondly it tends to lower the soil pH. As has been pointed out before (5) and it is true here, most of the rain falls in the winter months when the westerly gales are more frequent. Leaching does not, then occur often in the summer and it is quite probable that throughout the growing period of the plants, on the lower slopes in particular, the chloride content of the soil is fairly high.

It has been shown that there is a comparatively small number of species which inhabit the cliff slopes. This number is even more reduced on the west coast and there is a well-marked difference in the *Pteridium* stands on the two coasts.

There is a gradation of species up the gullies of the west coast, with *Armeria* occupying the lower levels and the 'heathers' the upper levels. The halophytic situation of the *Armeria* lessens up the slope, the 'heathers' being on typically acid soil of pH 5+. In between these two extremes there is a soil of intermediate condition supporting variable flora which is eliminated at one end by the halpohytic conditions of the lower slopes and at the other by the 'heather' community. It is apparent that *Armeria* is a plant that can withstand heavy 'salting' and appears in such conditions.

Acknowledgements.

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