THE ANDERSON HENRY PRIZE.

THE PLANT ECOLOGY OF COLONSAY.

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CONTENTS.

INTRODUCTION.

The island of Colonsay was visited by a party of students from the Edinburgh University Biological Society for three weeks in July, 1938. In the course of that visit the vegetation of the island was mapped, (Map I) and each natural formation was studied in as great detail as was possible in such a short time. The following essay is an account of the observations then made.

Colonsay is one of the smaller of the Inner Hebrides. It lies in latitude 56° 5' N., longitude 6° 15' W. and is approximately 9 miles long by 3 miles broad. There are no great heights in the island; Càrnan Eoin, the highest hill, is only 470 feet high. Two long valleys traverse the island from north-east to south-west. The more northern of the two contains the largest fresh-water loch in the island, - Loch Fada - and the grounds and farm of Colonsay House. The other includes Scalasaig and the farm and golf-course at Machrins. Most of the cultivated ground lies in these two valleys, though there are also a few small isolated crofting communities.

The geology of the island is rather complicated (Map II), but the different rock systems have a marked effect on the soil and vegetation.

The principal surface rocks are sandstones, mudstones, flags and grits, which together form the

central and eastern mass of hills. Encircling Kiloran Bay and near Scalasaig are two narrow bands of limestone. Large areas of phyllite are present in the west and south-west, and smaller intrusive plutonic masses appear occasionally. The frequent presence of perched boulders and scratched rocks is an indication of former extensive glaciation.

As a result of the glaciation, boulder clay is occasionally found as a surface deposit: blown sand, alluvium and raised beaches are other deposits which have not been directly derived from the weathering of the underlying rocks. These superficial deposits from the basis of the soil of the different crofting communities.

The natural vegetation of the island includes several different plant formations. (Map I).

Many of the hills in the interior are covered with heather; peat of varying depth is formed on these hills. This heath or moor is interrupted by grasslands in the valleys, and near the coast.

Grass heaths are present north of Balnahard, and on the two miles of cliff south of Cailleach Uragaig; grasslands are found in the two valleys and in a few areas in the south-west.

There are two small natural woods in the island, both on the north-east coast. The presence of stumps of willow and oak, along the shores of Loch

Fada, is an adequate proof of the former existence of a more extensive woodland.

The coastal vegetation is interesting. Sand dunes are present north of Rhuda a geodhan, at Kiloran Bay, north of Rudh' Àird Alanais and at Tràigh nam Bàrc. Considerable areas of blown sand are associated with the dunes. Salt marshes are present round The Strand, on the shore south of Cùirn Mhòra and in front of the sand dunes of Rudh' Àird Alanais. This salt marsh is absent from the east and north coasts.

The two largest lochs are Loch Fada and Loch an Sgoltaire. Loch Fada lies in a valley which has become blocked by the raised beach at Kilchattan; the bed of Loch an Sgoltaire is believed to have been scooped out by a glacier.

These different formations, along with the cultivated ground and the plantations, constitute the whole vegetation of the island.

Details of the pH, soil, and rocks, of each separate formation help to explain the differences in the vegetation.

PLANT FORMATIONS.

I. HEATHER-HEATH and MOOR.

Four typical areas of this formations were studied.

1. Ardskenish. Here the peat is only six inches deep, and the heath includes many subsidiary species as well as Calluna vulgaris.

Calluna vulgaris is dominant. Erica cinerea and two grasses - Festuca ovina and Sieglindia decumbens - are frequent. Other grasses occasionally present are Molinia coerulea, Nardus stricta and Aira caryophyllea. Holcus lanatus, and Anthoxanthum odoratum are rare. The rest of the vegetation consists of plants of Pedicularis sylvatica, Lotus corniculatus, Potentilla erecta, Scabiosa Succisa Carex sp. Empetrum nigrum, and, more rarely, Polygala serpyllacea, Orchis elodes and Salix repens. A large number of different species inhabit this shallow peat with marked success.

2. Balarumindubh. Here the peat is eighteen inches or more in depth. Calluna vulgaris is dominant, mixed with occasional plants of Erica cinerea. The only other species present are Potentilla erecta, Molinia coerulea, Arctostaphylos Uva-ursi, Pteris aquilina and Blechnum Spicant. These occur rarely. The strong growth of Calluna seems to have excluded most other species.

3. Dun Eibhne. The peat is one foot deep on a

foundation of solid rock. Calluna vulgaris is again dominant and Molinia coerulea frequent. The rest of the vegetation consists of occasional plants of Erica cinerea, Potentilla erecta, Anthoxanthum odoratum, Aira caryophyllea, and a species of Carex.

In these three areas the soil is acid with a pH of 3.

4. Hangman's Rock. Three different habitats can be recognised in this region.

(a) Dry Moor. The peat is deep with a pH of 5; this is higher than the pH of the other areas of moorland investigated. Calluna vulgaris is dominant and Erica cinerea frequent; Anthoxanthum odoratum, Potentilla erecta, Molinia coerulea, Salix aurita and S.repens, Sedum anglicum and a species of Carex are occasional, and Melica nutans and Orchis elodes are rare.

(b) Wet Moor. The peat is more acid in a few damp hollows; the pH is 3. Erica cinerea, Sieglindia decumbens, Scirpus caespitosus, Juncus articulatus and Sphagnum are present as frequently as Calluna vulgaris. Drosera rotundifolia, Narthecium ossifragum, Eriophorum angustifolium, Schoenus nigricans Anagallis tenella and Mentha aquatica grow in the damper ground; Potentilla erecta, Nardus stricta, Scabiosa Succisa and a few

other heath species are associated with the patches of heather.

(c) Gullies. Certain low-lying gullies traverse both wet and dry moors. The soil here is six inches of boulder clay, with a pH of 4·5, on a foundation of solid rock. Calluna vulgaris is absent from these gullies. Bracken is dominant, Holcus lanatus and Oxalis Acetosella frequent, Sieglindia decumbens, Viola Riviniana, Rumex Acetosella, Galium saxatile, and Potentilla sterelis occasional, and Blechnum Spicant, Cnicus arvensis and Scilla nutans rare. The shade and woodland species, such as Oxalis Acetosella and Scilla nutans thrive under the tall bracken. It is possible that they are remnants of a former woodland; the differences of sub-soil, however, are here sufficient to provide an adequate explanation of the local variations in the vegetation.

The dominant vegetation of the interior of the island is seen, on analysis, to be composed of several different associations. The depth of peat varies, so does the dampness of the peat. With a dry shallow peat many species are present; with a very wet soil a Sphagnum bog is formed. Between these two extremes is the heath or moor with Calluna vulgaris dominant, and few other moorland species present.

This last type of association is the most common in Colonsay.

II. GRASS-HEATH.

The moor of the west coast is interrupted by several extensive areas of grass-heath. A comparison of the vegetation and geological maps shows that the rock underlying the grass-heaths is phyllite. Patches of grass extends to the summit of the hills of phyllite, whereas the hills on other rock formations are usually heather covered.

The grass heaths were investigated north of Balnahard and at Kilchattan.

1. Balnahard. Here there is an extensive area of dry fibrous peat, with a pH of 4, on which the vegetation is predominantly grassy. Festuca ovina, Sieglindia decumbens and Aira praecox are the most frequent species; Poa annua is also present. Erica cinerea is locally abundant among the grass; Thymus Serpyllum, Achillea Millefolium, Plantago lanceolata, Trifolium repens and a species of Carex are occasional. A few plants of Luzula campestris, Sedum anglicum and Potentilla erecta complete the vegetation.

On the cliffs on the extreme north, Erica cinerea is absent. The peat here is sandy and more alkaline,- pH 5. Molinia coerulea and Festuca ovina are the most frequent grasses; Dicotyledons are infrequent.

2. Kilchattan. This grass heath resembles that at

Balnahard; Calluna vulgaris however, is present instead of Erica cinerea and Dicotyledons are more frequent. The soil is a light brown clay, and peat is not formed.

III. GRASSLAND.

Areas of less acid grassland were studied at Loch Fada and at Dùn Gallain. In these regions Calluna vulgaris is absent and peat is not formed. The soil underlying both grasslands is a gritty clay with a pH of 5.

1. Loch Fada. Festuca ovina, Sieglindia decumbens and Holcus lanatus are the most frequent grasses here; Anthoxanthum odoratum, Nardus stricta and Molinia coerulea are occasional. Trifolium repens, Prunella vulgaris, Euphrasia officinalis, Potentilla erecta and many other species of Dicotyledons appear among the grass.

At the eastern end of the grassland there is an area of srcub. Ulex europaeus is the most abundant species. The rest of the vegetation consists of occasional plants of Quercus pedunculata, Sorbus aucuparia, Rubus fruticosus, and Salix sp. Seedlings of Rowan are frequent.

The ground flora is composed of bracken intermixed with plants of Galium saxatile, Rumex Acetosa, Oxalis Acetosella, Holcus lanatus, Digitalis purpurea and Athyrium Filix-foemina.

2. Dùn Gallain. The composition of the grassland

at Dùn Gallain is similar to that at Loch Fada. Festuca ovina and Sieglindia decumbens are again the most frequent grasses; Holcus lanatus, however, is rather rare. Plantago Coronopus, Cynosurus cristatus and Armeria maritima, which are occasional in this flora, are absent from Loch Fada. Certain species of the Loch Fada flora, however, such as Nardus stricta Scabiosa Succisa and Ranunculus acris, are not found at Dùn Gallain.

The Dùn Gallain type of grassland reappears at Cill Choinnich, and on the northern slopes of Cùirn Mhòra. These regions have a similar rock structure:- the underlying rock in each case is an epidotic grit. The alkaline soil resulting from the weathering of this rock appears to be suitable for the development of grassland.

IV. WOODLAND.

There are two natural woods in the island. In the southern of the two, Quercus pedunculata, and Betula pubescens are frequent; Sorbus aucuparia and Corylus Avellana are occasional. Bracken and brambles are abundant in the undergrowth; Luzula sylvatica, Oxalis Acetosella, Galium saxatile, Anthoxanthum odoratum and Lastrea Filix-foemina are also present. In the second wood Betulla pubescens is abundant, Sorbus aucuparia occasional and Quercus pedunculata rare. The ground flora is the same as in the other wood. The depth of soil varies in different areas of

of these woods, but is usually under one foot. The subsoil is a glacial drift, with a pH of 5·5.

There are several plantations in the island. In the Mill Wood Pinus laricio and P.montana, Alnus rotundifolia and Rhododendrons are all present and thriving. Growth is luxuriant in these plantations, and there are many fungi.

V. LOCH.

There are only two large freshwater lochs - Loch Fada and Loch an Sgoltaire.

Loch Fada is the larger. On the south the hills descend steeply to the water's edge; Scirpus lacustris and Juncus bulbosus are the commonest plants on this shore of the loch. On the north shore, however, there is a considerable stretch of marshland. There is a well-marked transition from the vegetation of the open loch by way of the marshy strip at the edge, to the grassland bordering the road. Callitriche autumnalis and Potomageton heterophyllus are the most frequent deep-water plants. Nymphaea alba, Lobelia Dortmanna, and Carex inflata are found in zones nearer the edge, and are succeeded by Littorella uniflora, Menyanthes trifoliata, Juncus conglomeratus, Potentilla palustris, Alisma ranunculoides and Ranunculus Flammula. The strip of marsh is narrow at the western end of the loch, and merges rapidly into grassland. At the east, however, between the road across the loch, and the policies

of Kiloran House, the marshy land is over 100 yds. broad.

Loch an Sgoltaire is the water supply for Kiloran House and is free from surface vegetation. The surrounding hills are rather steep, and the sides and foot of the loch are rocky. Towards the south-west the slope of the hills is more gradual and a small area of marsh is developed. Carex inflata, Juncus bulbosus, J.conglomeratus and Potentilla palustris are the most common species of this marsh.

The other lochs of the island are smaller and very marshy round the edge. Most of them show a rapid transition from the floating water-lilies in the centre by way of shallow-rooted vegetation and marsh to dry heath or moor.

VI. SAND-DUNE.

Extensive areas of sand-dune are present on several parts of the coat line. A detailed investigation of the flora of these dunes was undertaken at Kiloran Bay and at Balnahard. The effect of the sand on the surrounding vegetation, and the transition from sand-dune to grassland or heath, were also studied.

1. Kiloran. In the unfixed stage the only plant on the dune is Ammophila arenaria. As the dune becomes more stable other plants appear. Carex arenaria is particularly abundant, but Trifolium repens, Lotus corniculatus, and Festuca rubra are also common. There are occasional plants of Galium verum, Achillea

Millefolium, Cnicus lanceolatus, Ranunculus repens and Geranium molle. Prunella vulgaris, Thymus Serpyllum, Valerianella olitoria, Veronica arvensis and Arctium Lappa are also present, though rarely. The pH of the surface sand varies from 7 - 7·5: that of the deep sand (2 ft.) is consistently 8. This difference in pH shows that a certain amount of leaching has taken place.

At a later stage of fixation Ammophila arenaria and Carex arenaria both decrease in frequency. Festuca rubra and Sieglindia decumbens, and various sand mosses are abundant.

In the final stage of fixation Ammophila arenaria, Carex arenaria and the above-mentioned mosses are all absent. Festuca rubra is the most frequent plant; Sieglindia decumbens is also common. Many of the Dicotyledons present in the earlier stages of fixation flourish in the fixed dune. Thymus Serpyllum becomes increasingly common and occasional plants of Linum catharticum, Campanula rotundifolia and Euphrasia officinalis are present. The soil is sand with a pH of 7 - 7·5.

The influence of the sand is apparent on areas of moorland far beyond the fixed dunes. The peat is intermixed with sand blown from the dunes, and has a pH of 5. Festuca rubra and Sieglindia decumbens are the most common species but, amongst them, especially in the vicinity of rocks, are

associated patches of Calluna vulgaris and Erica cinerea. Heath species such as Potentilla erecta and Carex Goodenowii are most plentiful amongst the heather. Some plants of the sand-dunes, e.g. Achillea Millefolium, Trifolium repens and Lotus corniculatus are restricted to the grassy patches; others e.g. Thymus Serpyllum and Prunella vulgaris are frequent in both grass and heather.

The frequency of different species in different areas of sandy soil is interesting. Ammophila arenaria, Carex arenaria, and several mosses are abundant in the unstable dune, but become gradually less frequent as the dune becomes more fixed. Festuca rubra and Sieglindia decumbens are absent from the fixed dune, but become more and more common away from the sea. In the peaty areas affected by the blown sand they are the most frequent grasses. Thymus Serpyllum shows an interesting gradation. It is absent from the unfixed dune, rare in the early stages of fixation and becomes increasingly common till it is abundant in the sandy peat beyond the dunes. Other species occur sporadically throughout the various stages of fixation. A greater diversity of species is present in the more alkaline soil near the sea, but a few of these typical seashore plants persist right to the sandy peat.

The influence of the sand on the moorland flora is shown by the restriction of typical heath

species like Calluna vulgaris to small patches, usually round stones.

A narrow band of limestone encircles Kiloran Bay, just beyond the area of sand dunes. The vegetation of this region is not markedly different from that of the neighbouring dunes, as calcicole species are present on both sand and limestone.

2. Rudh' a' Geodha. The stages of fixation of the unstable dune at Rudh' a' Geodha are very similar to those at Kiloran. Here, however, even in the unfixed dune, Ammophila arenaria is relatively less abundant. Other species such as Cerastium vulgatum, Cnicus lanceolatus, Erodium cicutarium, Sedum acre, Arctium Lappa and Taraxacum vulgare are occasional. The changes in pH and the leaching effect noticed at Kiloran are apparent here also.

Near the ordinary fixed dune, on the hill top, there is a small community in which Salix repens is very abundant. Festuca rubra, Holcus lanatus, Galium verum, Bellis perennis, Lotus corniculatus, Plantago lanceolata and Prunella vulgaris are frequent through the Salix.

Another unusual community is located in a hollow about 100 yards from the sea. The sand here is damp and rather badly drained. Festuca rubra is very frequent and other sand dune species are also present. There are tufts of Schoenus nigricans and of Nardus stricta; Pinguicula vulgaris is occasional; Juncus Gerardi and Campanula rotundifolia are rare.

The pH of this region is uniformly 6.5, which is lower than that of the surrounding dry sand-dune.

Certain peat pockets are present among the sand. The last association may be an earlier stage in their developments. Molinia coerulea is the most abundant species here, though Juncus articulatus, Carex Goodenowii, Anthoxanthum odoratum and Ranunculus Flammula are also frequent. Eriophorum angustifolium, Mentha aquatica, Triglochin palustre, Pedicularis sylvatica and Ranunculus acris are occasional, and Juncus conglomeratus is rare. The vegetation of this peat pocket is little affected by the underlying sand, although the pH is rather high - pH 5.

The transitional stages from sand dune to grassland or moor do not differ from those at Kiloran Bay. The presence of peat pockets in the sand quite near the sea, and the development of a community dominated by Salix repens, amongst the fixed dunes, are unusual features not observed elsewhere on the coast.

3. Ardskenish. The species on the sand dunes in this locality are the same as those at Kiloran Bay, but the change in pH is quite different. At an early stage of fixation the pH of the surface sand is 7 - 7·5, whereas that of the sand at a depth of one foot is 6 - 6·5, - the opposite effect to that apparent in all other districts. It may be that the sand

blowing over the surface at frequent intervals keeps the pH high, while the decaying plants covered by sand render the deeper layers of soil more acid.

A sharp contrast is apparent between the vegetations on the two slopes of a rocky hill. Sand has been blown up on to the southern slope, which is covered with vegetation typical of a fixed dune. On the northern slope a grassy heath has formed, with patches of Calluna vulgaris and Erica cinerea locally abundant, and Molinia coerulea, Potentilla erecta and Anthoxanthum odoratum occasional. In the more grassy areas Festuca rubra is most frequent; here Prunella vulgaris, Thymus Serpyllum and Trifolium repens are also present. The sand dune plants, which are frequent over the brow of the hill a few yards away, are absent. The soil consists of one foot of peat, with a pH of 5, on a foundation of sand.

At one time the sand must have extended further inland. Now, however, the region is out of range of the blown sand; the soil has become more acid and a heath vegetation has developed.

VII. SALT-MARSH.

This formation is less frequent than the sand-dune. The largest stretch is at The Strand.

Just above high water mark Glyceria maritima is abundant, Armeria maritima, Glaux maritima and Plantago maritima are frequent and Spergularia marginata and Salacornia stricta are occasional. No

other species are present. The pH here is 6·5.

At a distance of 10 yds. from the sea the vegetation changes.

Salicornia stricta and Spergularia marginata are both absent, and the soil is more acid. The species present, in order of frequency are Plantago maritima, Glyceria maritima, Glaux maritima, Festuca rubra, Juncus Gerardi, Armeria maritima, Plantago Coronopus and Aster Tripolium.

Still further inland these species decrease in frequency, and their place is taken by Festuca rubra, Trifolium repens, Euphrasia officinalis and other common grassland or heath plants. As the distance from the sea increases the soil becomes more acid; at a distance of 16 yards inland the pH is 5 on the surface, and 5 - 5·5 at a depth of 9 inches, - again the effect of leaching.

A stretch of salt-marsh 35 yards from the sea shows a retrogressive tendency. The surface soil is alkaline - pH 6·5-and the vegetation resembles that at the very edge of the sea. At a depth of 9 inches, however, the pH is 5, i.e. the same as that of the surrounding soil. Local differences in draining, and in flooding at spring tides, may account for this anomaly. This stage certainly cannot be taken as a direct one in the succession from salt-marsh to grassland or heath.

On the north-east edge of the salt marsh the

soil becomes water-logged, and a community in which Juncus conglomeratus is abundant is developed. Sieglindia decumbens, Nardus stricta, Euphrasia officinalis, Plantago maritima and P.lanceolata, Prunella vulgaris and Hydrocotyle vulgaris are also present in varying degrees of frequency. The soil is heavy and acid, with a pH of 4·5 on the surface and 5 at a depth of 9 inches.

On the eastern edges of the salt-marsh the invasion of heather is apparent. In the drier areas Calluna vulgaris is dominant. Erica cinerea and Empetrum nigrum are dispersed through the heather, and the remaining vegetation consists mainly of grasses - Molinia coerulea, Anthoxanthum odoratum, Festuca ovina, Nardus stricta and Poa annua. In the damper areas Calluna vulgaris is still abundant, but Empetrum nigrum and many of the grasses are absent. Eriophorum angustifolium and Scirpus caespitosus are frequent.

Peat is formed on both wet and dry regions. It is 15 to 18 inches deep with a pH of 4·5, on a foundation of sand. Apparently in this district the neighbouring moor is invading the salt-marsh.

CONCLUSION.

In the foregoing account of the plant ecology of Colonsay, seven different plant formations have been distinguished. These are:

I. Heather-heath and moor;
II. Grass-heath;
III. Grassland;
IV. Woodland;
V. Loch;
VI. Sand-dune;
VII. Salt-marsh.

These various plant formations are not isolated; transitional stages are present and specialised local communities may be included in any of the major formations.

The development of the formations is influenced by several factors. The pH of the soil and the drainage of the land both have an important bearing on the vegetation. The underlying rock strata may modify the flora; e.g. grassland in formed on phyllite, whereas moor is formed on different rocks in an otherwise similar situation a few hundred yards away. The superficial deposits in any area also affect the flora, irrespective of the underlying strata. Peat, sand and boulder clay bear very different types of vegetation, yet all may overlie the same type of rock. Secondary influences may alter

the vegetation; e.g. sand blowing on to moorland may lighten the peat, and make conditions suitable for the invasion of grassland species. Finally, in favourable situations, man may drain and manure the land, with a view to cultivation.

A consideration of these individual factors, and the estimation of their total effect, helps to explain the distribution of the different plant formations present in Colonsay.

The number of different natural habitats in the island, and the consequent variety in the flora, makes the island remarkably interesting. A more detailed investigation of the ecology of this island would greatly advance our understanding of the general botany of the Western Isles of of Scotland.

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MAP I. VEGETATION.

HEATHER-HEATH OR MOOR ----------

GRASS-HEATH ----------

GRASSLAND ----------

WOODLAND ----------

MARSH ----------

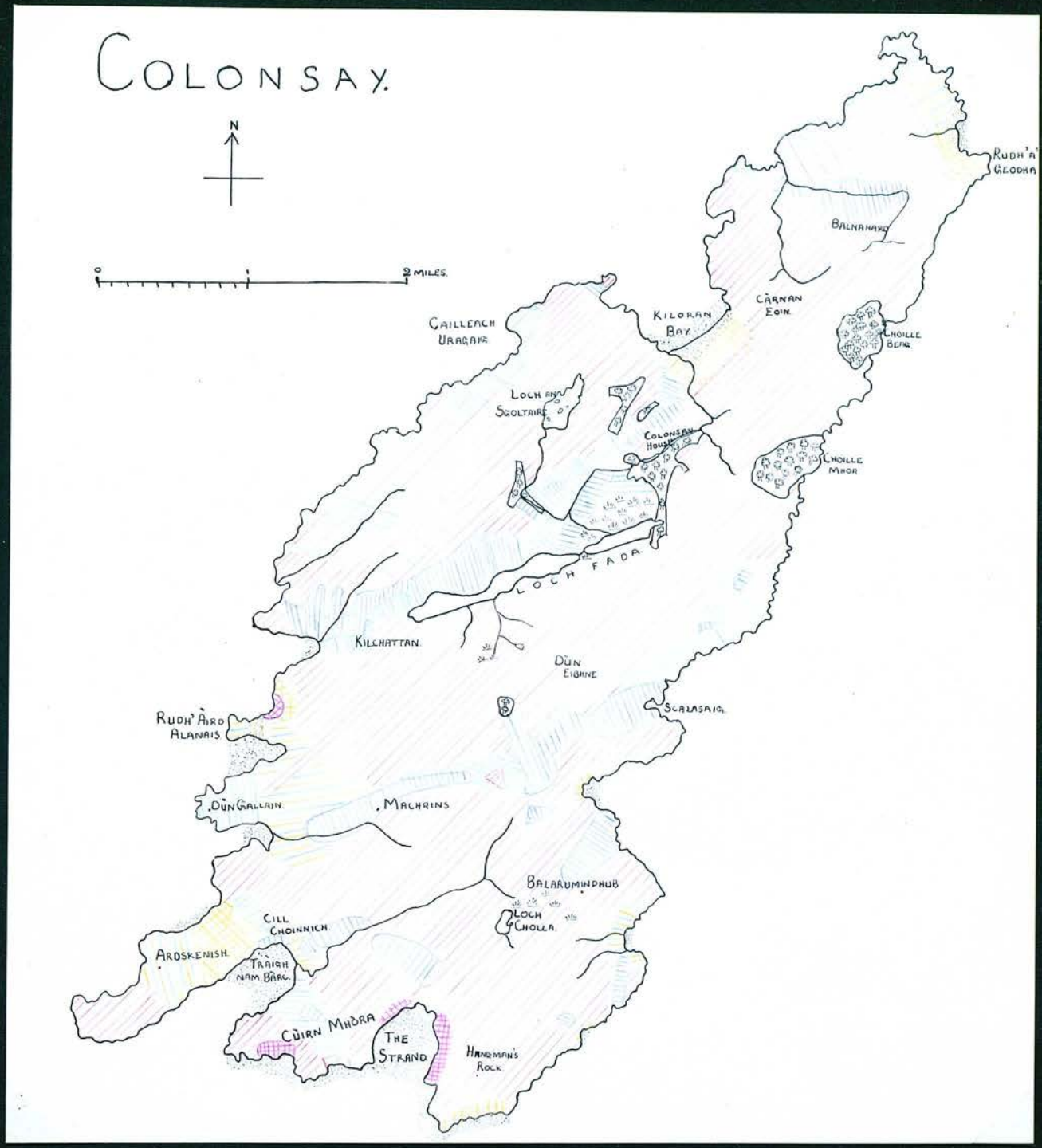
SAND-DUNE ----------

GRASSLAND WITH BLOWN SAND ----------

HEATH OR MOOR WITH BLOWN SAND -------

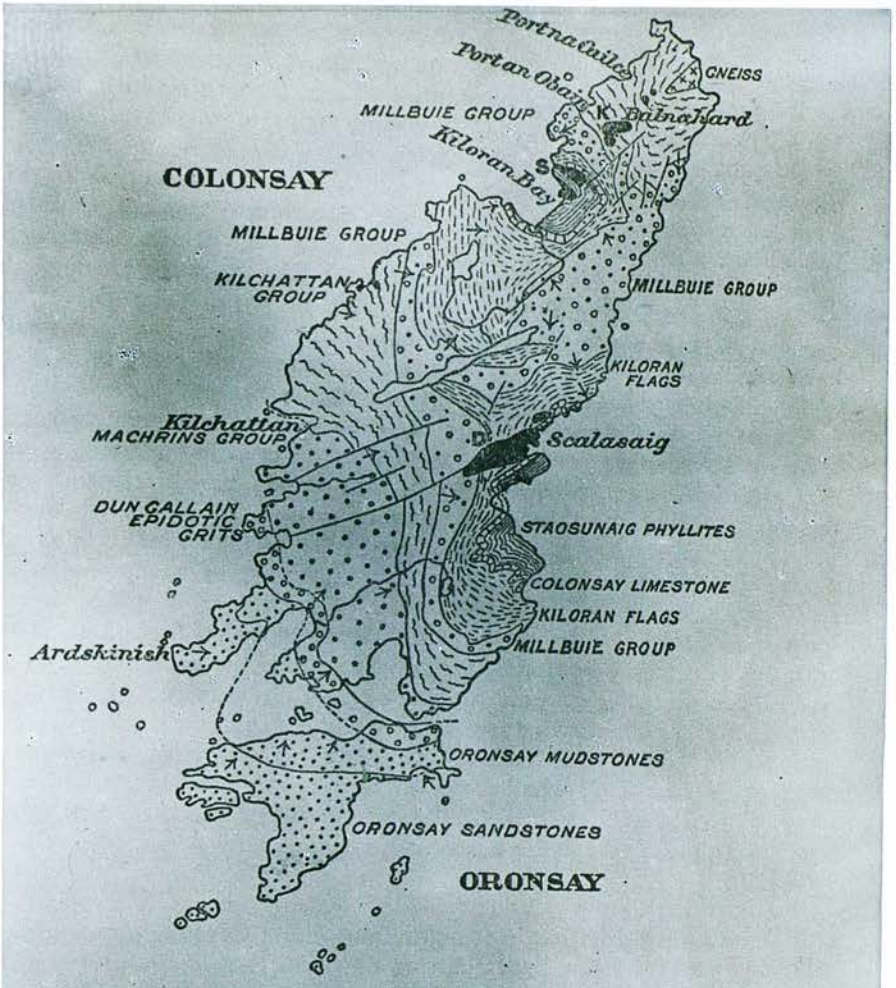
SALT-MARSH ----------

CULTIVATED AREAS ----------


COLONSAY.
N
0
1
2 MILES.
RUDH'A' GEODHA
BALNAHARD
CARNAN EOIN
KILORAN BAY
CAILLEACH URAGAIG
CHOILLE BEITHE
LOCH AN SCOLTAIRE
COLONSAY HOUSE
CHOILLE MHOR
LOCH FADA
KILCHATTAN
DÙN EIBHNE
SCALASAIG
RUDH' ÀIRD ALANAIS
DÙN GALLAIN
MACHRINS
BALARUMINDHUB
LOCH CHOLLA
CILL CHOINNICH
ARDSKENISH
TRAIGH NAM BÀRC
CÙIRN MHÒRA
THE STRAND
HANGMAN'S ROCK

MAP II. GEOLOGY.

From Colonsay and Oronsay - John de Vere Loder.



Sketch-map of the stratigraphy of Colonsay and Oronsay.
(Scale : 2 miles = 1 inch.)

STAOSUNAIG DARK PHYLLITES
COLONSAY LIMESTONE
KILORAN FLAGS
MILLBUIE GRITS & PHYLLITES
KILCHATTAN PHYLLITES & SANDSTONES
MACHRINS GRITS & MUDSTONES
DUNGALLAN EPIDOTIC GRITS
ORONSAY MUDSTONES & SANDSTONES
PLUTONIC INTRUSIVE MASSES

K=Kentallenite S=Syenite D=Diorite ↘=Dip of Strata