NOTES ON
THE VEGETATION OF BRITISH
AND IRISH MOSES

BY
HUGO OSVALD

UPPSALA 1949

ALMQVIST & WIKSELLS BOKTRYCKERI AB
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FOREWORD

In the present paper a description will be given of the topography (morphology) and vegetation of some peat lands in the British Isles. An attempt is also made to classify these peat lands according to the system previously published by the present writer (Osvald 1925a). As an introduction a short survey will be given of the different types of peat land, their topographical and physiognomical characters. The next chapter is a short description of some of the major plant communities of the British and Irish bogs, founded exclusively on the present author's own notes. Then follow the observations concerning the topography, hydrography, and vegetation of the bogs, arranged geographically in three parts, viz.: 1) England, Wales, and Isle of Man, 2) Scotland, and 3) Ireland. The bogs or mosses of the British Isles are divided into two large groups 1) raised mosses and 2) blanket bogs. Tansley, in his excellent treatise of British vegetation has separated from the raised moss a special type or subtype, the valley bog. This type is conceived as an initial stage of a raised bog type, but since the present author has no observations from bogs of this subtype, he has had to confine himself to the two main types. Finally the Scandinavian and the British bogs are compared, and the endeavour is made to point out the most important differences between the bogs in the two regions concerned.

It is not intended to enter into a discussion of the results of previous and later investigators as compared with the observations reported here. These are, in fact, too limited for such a discussion and the present paper should in the first place be regarded merely as a presentation of data collected during some stimulating excursions in Great Britain and Ireland, as an account of the vegetation of some British and Irish bog areas seen through the eyes of a Swedish botanist.

The field observations were made in 1921, 1931, 1935, and 1937. It is a great pleasure to the author at this occasion to acknowledge the assistance given to him and the valuable discussions on peat and peat vegetation problems which he has had in the field with a number of British and Irish scientists: — Dr. T. W. Woodhead of Huddersfield (The Pennines 1921), Professor W. H. Pearsall of the University of London (The Lonsdale district 1921), Dr. W. G. Ogg (now at Rothamsted) and Mr. I. Robertson (now in Edinburgh) of the Macaulay Institute of Soil Research, and Mr. G. Fraser of the Forest Service in Aberdeen (Scotland 1931), Professor A. G. Tansley of Cambridge and Dr. H. Godwin of the Botany School of the University of Cambridge (Ireland 1935), Professor W. G. Fearnside of the University of Sheffield and his daughter (now) Mrs. Bulman, Cambridge (The Pennines 1937), Mr. G. F. Mitchell of Trinity College, Dublin, and Mrs. Bulman (Ireland 1937), Mr. Howarth and Mrs. Bulman (Isle of Man 1937), Dr. H. Godwin, Miss Verona Conway and several other botanists from Cambridge (Wales 1937).

The mosses and liverworts have been determined by Dr. hon. caus. N. Herman Persson at the National Museum of Natural History at Stockholm, who has examined very thoroughly all the moss samples, thereby adding much value to the field notes. The lichens have been determined by Professor G. E. Du Rietz at the Institute of Plant Ecology of the University at Uppsala.

This paper was written just before the war, but it was not published, because the author
wanted to examine all his *Sphagnum* samples once again. However, time was never found for this reexamination, and, in consequence the publication was postponed. When the present author received the invitation to join the I.P.E. in Ireland he decided to have the paper published although he was fully aware of the fact that the *Sphagnum* lists were not quite complete and in other cases ought to have been checked. The author thought it better to publish his observations in their present incomplete form, than to wait an indefinite number of years. Now or never seemed to be the alternatives. The author is therefore very grateful to the Organizing Committee of the I.P.E. in Ireland 1949 for the impulse their invitation gave to him.

The author is also greatly indebted to Mrs. Bulman for valuable assistance in translating the first two chapters of this paper and to Dr. Godwin, who has read and criticised the paper from a linguistic as well as from a scientific point of view.

The author also wishes to express his gratitude to the director of the Institute of Plant Ecology at Uppsala, Professor G. Einar Du Rietz, and to a great number of other friends working at the institute, who have in many ways assisted him, suggesting improvements, checking plant names and so on.

The Latin nomenclature is in the main in agreement with the nomenclature used by Tansley in his book "The British Islands and their Vegetation".
THE MORPHOLOGICAL OR TOPOGRAPHICAL TYPES OF MIRE

To the ordinary man mires are not only lonely and monotonous but even uninteresting, and when one wanders for mile after mile over the unvarying surface of a bog it may seem difficult to dispel such an impression. But it is nevertheless a mistaken one. One has only to persevere to reveal a whole series of fascinating details, to discover that these mires mirror variations in climate, topography and soil conditions, that in fact the interplay of these factors makes its impress upon the history of the mire.

The peat lands (= mires) may be divided into two large groups, fens, and mosses or bogs.¹

The fens occupy shallow basins up to the high water level, low-lying land along lakes and streams, or areas fed by ground water, percolating to the soil surface. Their development is limited by the level of the water table or the rate of flow of the ground water. The vegetation of the fens is more luxuriant than that of the mosses, and the peat, being formed under the direct influence of water from surrounding mineral soils, is richer in nutrients than the moss peat. The mosses are formed on higher ground and the water reaches their surface only as rain or snow. The vegetation consequently is rather poor, and the peat formation depends entirely upon bad drainage of the soil combined with high rainfall or humidity of the climate. Many mosses, however, have at an earlier period in their development themselves once been fens.

This classification differs essentially from that proposed by Fraser (1933) according to which the mires are divided into ‘basin moors’ and ‘climatic moors.’ ‘Basin moors’ include not only fens of several, but not all types, but also raised bogs formed on a fen surface. ‘Climatic moors’ on the other hand include all types of bog formed on mineral soil. The consequence is that the raised bog comes into both of the main types or groups. Very often, however, quite uniform raised bogs have developed partly on a fen and partly on mineral soil, and in accordance with the definition different parts of such raised bogs belong to different main categories of mire. It does not seem appropriate to employ a system, in which one of the most characteristic bog types has to be split up between the two main divisions of mire. The most important factor determining the morphology and type of vegetation of peat land is whether the surface is fed by water from the ground or by precipitation. The content of nutrients in the soil water varies considerably and there is a gradual transition from very rich fens on basic peat to very poor ones on strongly acid peat, but it is always possible to draw a line between areas fed by soil water, and areas fed only by rainwater. The classification principle employed here therefore seems to be the most appropriate one, i.e. to divide the mires, with the exception mentioned below, into the two large groups fens on the one hand and mosses or bogs on the other.

Many of the mires in the arctic-boreal regions

¹ 'Peat land' or 'mire' corresponds to the Swedish word 'myr', including all kinds of peat areas with their vegetation. The term 'fen' is used for all kinds of basin (and groundwater) peat lands, as long as the surface is fed by water from the ground, and 'moss' or 'bog' for the peat lands on higher grounds, where the surface is fed only by precipitation. 'Fen' corresponds to Swedish 'karr' and to von Post's 'topogenous mire' and to part of his 'soligenous mire', 'moss' to the Swedish 'mosse' and partly to von Post's 'ombrogenous mire' (von Post 1926). In German the nearest equivalents to 'fen' and 'moss' are 'Flachmoor' and 'Hochmoor'. The term 'bog' is used as synonymous to 'moss', although it is a more general term, which is in some districts applied to any kind of wet peat land.
of Europe, *i.e.* the northern parts of Scandinavia, Finland, and Russia, cannot be placed in either of these two main categories. Situated on very gentle slopes, where the ground water, comparatively poor in nutrients, is forced to the surface at the margin of the mire\(^1\), thus providing conditions for peat formation; they often form a kind of mosaic of moss and fen, and on this account they are sometimes referred to as 'mixed mires'.\(^2\)

Within these three main groups different types may be discriminated. We shall very shortly consider the fens first.

**Fens** of various kinds have in most countries of north-western Europe, from earliest times, occupied extensive areas of now fertile plains, filling up low-lying and regularly flooded areas, and fringing shallow lakes. To-day most of the large fens have long been drained and cultivated, but here and there considerable portions remain.

The level of the summer water table limits the extent to which the fen can develop, and the climate has therefore no appreciable direct effect upon the physiognomy or the vegetation of the fen. All the more marked, on the other hand, is the influence upon the vegetation of the chemical properties of the surrounding soils. Whether the flora be rich or poor in species certain attributes common to all fens can be usually made out. As a rule the marginal part is relatively dry, and here moist meadows predominate, often supporting a rich and luxuriant flora with willow thickets and not infrequently, alder copses. The main central part is wet and occupied by communities of tall *Carex*. In the wettest part, *i.e.* when the fen encloses a stretch of open water, we find *Phragmites communis*, *Scirpus lacustris* and, in calcareous districts, sometimes *Cladium mariscus*.

Although the climate generally makes no direct imprint upon the topography of the fen, yet in regions with a mild, wet winter and a dry, warm summer, as for instance on the island of Gotland in the Baltic, a remarkable type of mire is produced. A map of a Gotland mire often shows the peculiarity that the streams do not run through the mire but cease at the margin only to begin again at the other side. In winter, when the streams become swollen, a high water table prevails in the mire, and this is transformed into a shallow lake, whilst during the dry summer the streams are reduced, often enough, to trickles so small that they form no stream-courses through the mire. The central parts of these mires were formerly mostly dominated by *Cladium mariscus* (most of them are now entirely under cultivation), the margins were rather dry meadows, lacking tree vegetation on account of the high water level in winter. Another characteristic feature was the abundance of areas of open water of various types and origin, lakelets and pools.

Common to all the types so far mentioned is a flat or weakly concave surface. They are therefore termed collectively *flat fens*.

From these fens one type should clearly be marked off, *i.e.* the *spring fen*, which slopes in all directions from the point where the spring or ground water bubbles up. The vegetation varies much, depending on the properties of the water. The spring mire is a very unimportant category. On the other hand the *sloping fen*, which occupies large areas in northern Sweden is of considerable importance. The spring fen may be characterized as an extreme type of sloping fen.

**Mosses**, in contrast to fens, are an expression of the climate and particularly of the precipitation. There is not only a rather close relation between the amount of rainfall and the proportion of the countryside covered by moss, as has been shown for the South of Sweden by **VON POST** and **GRANLUND**, but the climate also controls the moss type, the morphology and the vegetation of the mosses. Consequently different climatic regions are characterized by different moss types.

With regard to their morphology and vegeta-

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1 A similar soligenous influence (*i.e.* waterflow at or near the soil surface) is often to be found along the margins of fens and mosses.
2 The 'mixed mires' (*in Swedish 'blandmyr*) correspond to part of von Post's 'soligenous mire'.
Topography and vegetation of the major moss types

In order better to understand the relationships between climate and moss type, we shall first acquaint ourselves with the topography, hydrography and vegetation of the most important moss type: the bare raised moss, as this type is developed in the South of Sweden, where extensive areas of bare raised moss are still to be found, and where this moss type has been studied more closely than in any other country.

If we walk out over, say a Småland raised moss, e.g. the large Komosse (Osvald 1923) at the boundary between Småland and Västergötland, we first get to a usually narrow, wet belt with fen vegetation between the moss and the mineral ground, the lagg. The lagg constitutes the marginal drainage system, characteristic of all raised mosses, and is often the only type of drainage in mosses on horizontal ground. (It should be remarked here that an accurate knowledge of the hydrography of the mosses is necessary to understand the conditions of peat formation and the development of the peat land.) The lagg receives the run off from the moss as well as from the surrounding mineral ground, sloping towards the moss. On the further side of the lagg rises the edge of the moss crowned by a thin, stunted wood of Scots fir (Pinus silvestris). The proximal parts of the lagg is poorly developed, the vegetation consists, for instance, of sedge communities with a bottom layer of Sphagnum cuspidatum or S. apiculatum, and here the moss margin rises only slightly above the lagg. If we follow the lagg down stream (it may sometimes be difficult to see which direction is 'down stream', because the water is moving very slowly) we find the lagg fen becoming more and more luxuriant and the flora ever richer, species with higher mineral requirements, e.g. Drepanocladus spp., appearing instead of Sphagnum cuspidatum on account of the larger quantities of water running through the lower parts of the lagg than through the upper ones. At the same time the moss edge becomes higher and steeper and the marginal border-wood denser and taller.

In the lower, distal part of the lagg an actual stream develops in the middle of the fen, and if the lagg stream receives large quantities of water, it may even come actually to erode the margin of the moss. Even in less extreme cases a ‘mature’ lagg constitutes a major obstacle to the spread of a moss. The less wet and less rich in nutrients are the upper, proximal parts of the lagg, the more readily can the moss, so to speak override the lagg zone out over the mineral ground, always pushing the lagg itself in front of the advancing edge. Accordingly,
the moss extends laterally most effectively in the proximal part, i.e. in the direction away from the lowest point of the lagg or moss margin, and so the moss surfaces become more or less sloping. As the moss along the lower course of the lagg increases in height without being able to spread out laterally, the edge of the moss, sloping abruptly, often shows a considerable difference in level between the crown and the lagg.

Leaving the lagg and the marginal pinewood behind us, we walk out over the surface of the moss; this is an almost horizontal plane with small stunted pines here and there. The marginal zone of the bog centre is very smooth and even. Calluna- Sphagnum magellanicum- (S. fuscum) association and Calluna-Cladonia association are the dominant plant communities. Hollows and hummocks are very scarce and inconspicuous or totally absent. This is the so-called marginal complex. Further out we find a mosaic of Sphagnum hummocks with dwarf shrubs, overgrown in places by Cladonia spp., and shallow, waterlogged hollows or depressions. Here the development proceeds in a continuous cycle from hollow to hummock, and from hummock to hollow. The depressions are filled with water-loving, yellowish or yellow-green Sphagna (S. cuspidatum, S. tenellum etc.) and sometimes liverworts such as Gymnocolea inflata and Cladopodiella fluviatans. Later, these are followed by hummock-forming species, for instance the reddish S. rubellum, and, above all, the metallic-glistening S. magellanicum. In the place of the previous depression there is soon a low hummock. Finally, the hummock, since its moisture content has become comparatively small, is covered with brown Sphagna, S. fuscum and to a less extent S. imbricatum. These grow up to such a height that the dryness permits the ingress of a cover of lichens, Cladonia spp. The progressive development now has come to an end. As the surrounding areas of the moss surface grow up, the relative height of the Cladonia hummock gets lower and lower, and finally the top of the hummock becomes the bottom of a hollow, and the development just described may start again. The course of this cycle is called ‘regeneration’, and the resulting complex community regeneration complex. Very often the Sphagnum rubellum hummocks are dry enough to allow a cover of lichens to develop. In such cases the lichen vegetation often is invaded by Sphagnum fuscum and S. imbricatum forming high secondary hummocks.

On horizontal surfaces, hummocks and hollows are distributed irregularly, but on slopes they are arranged at right angles to the gradient, so that the water of the hollows is dammed up.

Let us also observe the flora as we pass. Among higher plants heather is dominant on the hummocks, but on the highest ones crowberry (Empetrum) replaces it; cranberry (Oxyccocus quadripetalus) twines among these shrubs, and here and there gleam the bright pink bells of Andromeda and bell-heather (Erica tetralix). Cotton-grass (Eriophorum vaginatum) and Scirpus caespitosus are common, the sundew (Drosera rotundifolia) glistens with its red insect-catching leaves, and sometimes the golden fruits of the cloudberry (Rubus chamaemorus) shine bright against the brown or russet moss carpet. A great number of liverworts (Mylia anomala, Odontoschisma sphagni, Lepidozia setacea a.o.) are entangled among the Sphagna. These liverworts may finally cover the Sphagnum surface completely, and together with the interesting lichen Gyalecta gloeocapsa they are responsible for the killing of the Sphagna. The vegetation of the depressions is quite different. Along the margins we find cotton-grass and Scirpus and the narrow-leaved sundew (Drosera anglica) on the Sphagnum carpet, and out of the shallow water or bare mud, generally overgrown by a thin film of purplish algae, 'Zygo­gonium' stand isolated straws and matted tufts of cotton-grass. In some parts of the complex Rhynchospora alba is common, and in

1 These algae are always sterile and cannot be exactly identified; they have for many years been referred to as Zygogonium ericetorum; but they may belong to the genus Zygogonium or the genus Rhizoclonium, or perhaps to other genera.
the wettest hollows Carex limosa and Scheuchzeria grow together with Sphagnum cuspidatum.

The result of the regeneration is that the moss increases in height, and finally a level is reached beyond which no further increase is possible. Heath lichens (Cladonia) spread out over the hummocks, and the peat surface of the hollows, which dry out periodically in the summers, becomes totally covered with a thin, smooth skin of 'Zygogonium'. After dry periods this cover is crumbled, and the bare peat is exposed to weathering. Equilibrium is attained: the growing regeneration complex has become the stagnation complex.

It is in the nature of the phenomenon, that such a condition can only arise and persist, when the surface is very nearly horizontal. On sloping ground, running water soon begins to erode the bare peat where growth has ceased. The water cuts deep channels in the loose peat barriers, which dam up the water in the hollows; the hummocks become much better drained and drier, and so the whole surface of the moss becomes firmer. Probably wind erosion also takes place, but water erosion is the main factor in the retrogressive process on mosses of this type. The erosion complex is thus formed. Here bell-heather flourishes better than on any other part of the moss, and when it is in flower one can make out from a great distance the border-line between different complexes.

In order to give a more adequate conception of the vegetation of the moss the composition of some of the most prominent communities and complexes of Komosse and the succession sequence are given in tables 1 and 2 and the succession scheme on this page.

As we have been walking over the moss plane, we have gradually approached a small group of Scots fir, spruce and birch. They stand bordering a number of pools, which constitute the last relic of a vanished lake. The outlet from the lake is almost entirely obliterated by the moss but for an occasional swallow hole, marking the position of the stream. Further down swallow holes become more frequent and finally unite into a stream, which flows

---

### Table 1. The most important plants of the dominant sociations in the regeneration complex on Komosse.

<table>
<thead>
<tr>
<th>Plant</th>
<th>Calluna-Cladonia</th>
<th>Calluna-Sphagnum magellanicum</th>
<th>Empetrum-Cladonia</th>
<th>Calluna-Sphagnum imbricatum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Andromeda polifolia</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Calluna vulgaris</td>
<td>4</td>
<td>4</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Oxycoccus quadridentatus</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Drosera rotundifolia</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Rubus chamaemorus</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Eriophorum vaginatum</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Scirpus caespitosus</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Mylia anomala</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Sphagnum balticum</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>S. fuscum</td>
<td>3</td>
<td>3</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>S. magellanicum</td>
<td>4</td>
<td>4</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>S. rubellum</td>
<td>3</td>
<td>3</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>S. tenellum</td>
<td>2</td>
<td>2</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Cladonia pyzidata</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Carex limosa</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Sphagnum cuspidatum</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>S. balticum</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
</tbody>
</table>

1 The figures indicate the frequency of the plants according to the Hult-Sernander scheme: 5 = dominant, 4 = abundant, 3 = frequent, 2 = occasional, 1 = rare.

---

Simplified succession cycle, illustrating a common type of regeneration on Komosse.
forth in a channel in the moss. Just as from the lagg, the moss rises on both sides steep and wooded from the stream level. The stream itself is usually bordered by Carex fens.

Through another part of the moss plane winds the grey-green ribbon of wet reed and sedge communities. This may be the outlet of a lagg, circling a moss-enclosed island, passing over the moss as a fen soak. The soak does not run in a channel like the stream, but is nearly in level with the moss surface, and it does not form an actual open watercourse. The soak may also be conditioned by other circumstances, and its vegetation may be very variable. It is always of a fen type with Carices, Molinia and other grasses. Here and there are groups of trees, usually birch. Certain soaks may in early summer appear white with cotton-grass (Ericophorum angustifolium) and later gold with bog asphodel (Narthecium ossifragum). Both of these drainage systems are primary as compared with the secondary erosion drains.

In all types of primary drainage systems there is always a soligenous influence due to water coming from the surface of the mineral ground or layers near to it.

As the moss grows, the upper part of the streams are often more or less overgrown. The drainage of the moss surface then takes place through swallow holes, which persist for a long time. These swallow holes are very narrow and have steep walls, and in these holes, where the drainage is exceptionally good, the vegetation is quite different. When the soaks are overgrown there are usually no swallow holes, but a number of pools develop.

As we proceed to the other side of the moss, we may come again upon a lagg, but if the mineral ground slopes away from the moss, this passes gradually into a swampy wood.

The bare raised moss, the classical moss type, is very widely distributed throughout north-western Europe. The type is not exactly the same over the whole area. In the East of Sweden the lagg is well developed and the sloping margin is rather well drained and has a rather dense and high pine-wood with Ledum palustre and Sphagnum magellanicum. Further west the lags are less marked, the moss margins flatter and less drained; the marginal pine-wood is thinner and poorer, and in the West of Sweden it is totally lacking. In the East the plane of the moss is practically horizontal, and, consequently, streams, soaks and erosion complexes are absent; on the hummocks in the regeneration complex Sphagnum fuscum is the dominant species. The difference between east and west with regard to the vegetation of the moss plane can be exemplified by the following regeneration schemes, where only the most prominent plant communities are included (see next page):

If we move from the bare raised moss region to the East, we very often find another moss type, the wooded raised moss. It occurs for instance in places in the East of Sweden

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**Table 2. The composition of some of the most important complexes on Komosse.**

<table>
<thead>
<tr>
<th>Sociation</th>
<th>Marginal complex</th>
<th>Marginal complex</th>
<th>Regeneration complex</th>
<th>Stagnation complex</th>
<th>Erosion complex</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>wetter type</td>
<td>drier type</td>
<td></td>
<td></td>
<td></td>
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1 The figures indicate the percentage of the area covered by the sociations.
and is common in eastern Europe. In Sweden mosses of this type have a rather close stand of common pine (Scots fir), generally with a dense undergrowth of Ledum palustre, the ground being covered with Sphagnum magellanicum and S. angustifolium. The lagg is usually rather well developed and has a rich fen vegetation, but the margin of the moss does not rise very high.

In the western part of the raised moss region, say, the south-west parts of the uplands of southern Sweden, the lags practically disappear in the proximal parts because the water flowing in from adjacent areas, which are leached by the heavy precipitation, is not sufficiently rich in nutrients to produce a lagg. The moss surface is approximately level when it abuts upon the mineral ground. This type of moss is the flat moss. The margin, however, is often wetter than the rest of the moss plane. With regard to internal drainage system, streams and soaks, vegetation, etc., the flat moss conforms to the western facies of the raised moss. If for any reason, however, an effective obstacle to the lateral extension of the moss occurs, even these mosses have a well developed steep but generally treeless margin.

In yet more maritime conditions, the mosses are able to creep over sloping ground more rapidly, and the moss surface becomes concave. The water draining from the surroundings is not collected in lags but continues right through the moss as soaks. The surface of the moss is usually more smooth than that of the raised moss, and Sphagna play a lesser part in its peat formation. Sphagnum fuscom is often entirely absent. Eriophorum vaginatum and Scirpus caespitosus often play an important rôle, and sometimes the cotton-grass becomes the sole dominant, and is capable of forming pillar-like tussocks, half a meter high, as though set up at random upon the bare peat. The regeneration is less obvious than in the raised moss.

In the most maritime districts of north-western Europe the mosses may cover not only flat areas and gentle slopes but also comparatively steep hills. This type is the blanket moss. The surface of this moss is generally rather smooth, which means that there is no regular or obvious cycle of regeneration, and covered with rather uniform communities, dominated for instance by cotton-grass and Scirpus caespitosus, except in the retrogressive stages, where the surface is very broken, eroded by water and wind, and supports a dry heath vegetation.

In the blanket moss the drainage is usually much simpler than in the raised moss. On the steep slopes the primary streams are generally not overgrown by the blanket moss, but sometimes the outlets from small ponds are overgrown in essentially the same way as the streams in the raised mosses. Sometimes small secondary streams occur, running through the peat to the primary ones.

If we turn northward from the raised moss region, we find that the raised mosses pete
out gradually. In the whole of northern Sweden for instance they are replaced by other types of mire. The raised moss, as will be easily understood, involves a change of the original hydrography within the area covered by the moss. In the laggs the water is diverted and led partly into new channels and in new directions. The further north one goes, the more unsuitable the climate becomes for this change to occur on account of the spate at the time of snow melting. The water flows towards the central parts of the mirea, which develop into fens, and smaller or larger areas of moss develop on those parts on the marginal areas, which are least subjected to the influence of water draining in from the surroundings. The result is a central, fen-like mire, surrounded by strips, broken here and there, of moss, the so-called marginal moss or marginal bog.

The central portion of this mire is rarely an unbroken fen, but according to the nutrient content of the water, the area is dotted with moss hummocks of varying size to a greater or less degree. On almost flat mires these hummocks are rounded, but on more sloping areas they are orientated at right angles to the gradient, forming long ribbons. According to the morphology of the moss hummocks we may distinguish thus island mires and ribbed mires.

In calcareous districts, as for instance Jämtland, the moss areas may be strongly reduced or totally absent. The whole mire is then a fen. On the other hand in districts with very poor mineral soils the moss areas may cover most of the peat land thus forming a type of mire which is very similar to a raised moss.

The lateral growth of these bogs as of the raised bogs — when the raised bog is pushing the lagg in front of itself —, is due to the waterlogging of the mineral soil along the margin. Because of humus impregnation in the mineral soil by organic matter from marginal peat, the ground water seeping towards the bog (or the lagg) margin along a broader or narrower zone just outside the bog or lagg is forced to the surface, thus creating conditions for peat formation in this zone. Clearly this process can only take place, where the mineral soil slopes gently towards the bog. The process may be described as waterlogging progressing upwards. The result is that the bogs grow upwards, not downwards.

Regardless of the great variation between fen and moss within this type of mire there are, between these northern types of mire and the typical raised bog, a number of exceedingly interesting transitional types which may be characterized as combinations of raised bog and mixed mires. Some of these bog types have been described by Sjörs (1948).

Furthest north we have finally the so-called palsa mires 1 with their high hummocks or peat hillocks, produced by frost action. These mires are confined to regions where frozen subsoil remains for the whole year round, but without frost penetrating so deeply that the mire becomes bottom-frozen.

The large differences in the vegetation of mosses in different regions is reflected in the type of peat formed. On one side we have the practically pure Sphagnum peat (Sphagnum fuscum peat of the eastern raised moss usually being the purest), and on the other side the sedge peat of the blanket mosses with hardly any traces of Sphagnum and with large quantities of much-decayed material in it.

Concluding this attempt to designate the major mire types of north-western Europe, the main characteristics of the types from the east to the west, which will be dealt with more closely on the following pages, may be summarized as follows: the raised moss is characterized by the raised margin and the lagg running between the moss and the mineral ground; the flat moss usually has a wet margin, but it does not rise conspicuously above the mineral ground; the concave moss has no wet margin, its surface being lower than the margin; finally, the blanket moss covers flat land, gentle slopes, and hills.

The relationships between climate and moss type may be conceived in the following way.

1 Derived from 'palsa', a Finnish word meaning peat hill or a dome.
In a region with a rather continental climate bog formation can take place only on horizontal or nearly horizontal ground, in regions with a more oceanic (humid) climate moss formation can take place on more sloping areas, and in the most extreme oceanic regions, e.g. the Highlands of Scotland and the West of Ireland, even fairly steep slopes may be kept waterlogged during very long periods, thus providing the conditions for moss formation. The morphological classification of the types is, however, independent of this conception. This is a great advantage as compared with many other more or less 'genetic' systems.

**SOME COMMON PLANT COMMUNITIES OF BRITISH AND IRISH BOGS**

Calluna and Calluna-moss sociations (Table 3)

*Calluna* communities, either without a bottom-layer or with such a layer of *Pleurozium schreberi* or *Hypnum cupressiforme* are rather common on bogs of all types. They occupy dry hummocks or well drained, sloping margins of the bogs. Owing to the wide ecological amplitude of *Calluna* there is only moderate uniformity in the vegetational composition. In addition to *Calluna*, only *Eriophorum angustifolium* has been observed in each of the areas represented in the table. Although these *Calluna*-dominated communities are frequently met with, the area covered by them is usually small, and the rôle they play in the physiognomy and development of the bogs is rather unimportant.

**Erica tetralix** sociation (Table 4)

The *Erica tetralix* community, without or with a very thin bottom layer, often develops on dry hummocks of raised bogs. In addition, it sometimes occurs on high hummocks on

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Table 3. Calluna and Calluna-moss sociations.

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1. Deer Dike Moss, middle part, 1921.
2. Edenderry bog, east of Ballykilleen, sloping moss margin, 1935.
3. Foulshaw moss, eastern part, 1921.
4. Foulshaw moss, eastern part, 1921.

No. 1, 3, and 4 have been published previously in "Komosse" (Osvald 1923).
Map showing the location of places mentioned in the text.
bogs of other types. On raised bogs this community usually contains (besides Erica): Andromeda polifolia, Calluna vulgaris, Oxycoccus quadripetalus, Narthecium ossifragum (in rather high frequency), and Eriophorum vaginatum (in great quantities), and Myrica gale may play a dominant rôle, and on hummocks on blanket bogs Molinia coerulea reaches very high frequency. Sphagnum are very scarce, the most common one being S. tenellum. Among the lichens Cladonia coccifera is rather common.

Sometimes a transition to the Sphagnum sociations is met with as for instance the following community from Foulshaw moss (previously published; Osvald 1923):

| Andromeda polifolia | 1 |
| Calluna vulgaris | 2 |
| Erica tetralix | 5- |
| Oxycoccus quadripetalus | 1+ |
| Narthecium ossifragum | 1 |
| Eriophorum angustifolium | 1 |
| » vaginatum | 3 |
| Aulacomnium palustre | 1 |
| Campylopus flexuosus | 1 |
| Hypnum cupressiforme | 1 |
| Lepidozia setacea | 1 |
| Mylia anomala | 1 |
| Odontoschisma sphagni | 1 |
| Pellia epiphylla | 1 |
| Sphagnum papillosum | 2 |
| » tenellum | 3 |
| Cladonia coccifera | 1 |
| » pyxidata | 1 |
| » silvatica | 1 |
| » squamosa | 1 |
| » uncialis | 1 |

### Table 4. Erica tetralix sociation.

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On Scandinavian bogs, the Calluna-Cladonia and Erica-Cladonia sociations are well defined communities. The latter, however, does not seem to play any considerable rôle on British bogs and since Erica is dominant only in one of the areas listed, both communities are treated together. Calluna vulgaris is decidedly dominant (except in no. 8) and Erica tetralix occurs practically everywhere (dominant in no. 8). Eriophorum vaginatum is constant, often in large quantities, and E. angustifolium is usually present. Andromeda and Oxycoccus, both constant in the Calluna-Cladonia sociation of Komose, seem to be decidedly less common on British bogs. Scirpus caespitosus occurs in fairly large frequency in most of the areas from Ireland, and in both of the lists from the west coast of Ireland Molinia is rather prominent. It is remarkable that Narthecium, present in all the lists from the Erica tetralix sociation, is of minor importance in this community. The commonest mosses are Rhacomitrium (in most of the notes from Ire-
Table 5. Calluna- and Erica tetralix-Cladonia associations.

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1. Foulsaw moss, south-west part, 1921.
2. Tregaron bog, north-west part, 1931.
5. Wicklow mountain, 1935.
9. Lewis, south-west of Barabhas, erosion complex, 1931.

On dry hummocks of British as well as of west Scandinavian raised bogs, Rhacomitrium occurs in small patches, but in Great Britain well defined communities with a bottom layer of Rhacomitrium have not been observed, except on blanket bogs, but on these the Calluna-Rhacomitrium association plays a very important rôle. In this community Calluna is always associated with Scirpus caespitosus, which sometimes becomes dominant. Besides Calluna and Scirpus, Eriophorum angustifolium and E. vaginatum are always (or nearly always) present, the latter sometimes in greater quantity than Scirpus. In the thick cover of Rhacomitrium, Sphagna as well as other mosses are rare, but the lichens Cladonia silvatica and C. uncialis, or one of them, are always present.

This community is characteristic of the driest and most exposed hummocks of the wind- (and water-) eroded complex of the blanket bogs (if not grazed as in some parts of the island of Lewis) and of the bog margins around the large retrogressive areas in the blanket bogs. In addition, it occupies the summits of isolated high hummocks on growing blanket bogs and sometimes also other dry areas of these bogs.

Calluna-Sphagnum associations (Table 7)

In table 7 three well defined Calluna-Sphagnum communities are represented, i.e. the Calluna-Sphagnum magellanicum association (3—5), the Calluna-Sphagnum rubellum association (6—8) and a Calluna-Sphagnum association (9—12) with four Sphagnum species together dominating the cycle of the regeneration complex. From the hummocks in this complex to the hummocks in the erosion complex there is, at least on Swedish bogs, a marked increase of Erica, and very often Erica replaces Calluna.

Calluna- Scirpus caespitosus-Rhacomitrium associations (Table 6)

The Empetrum-Rhacomitrium association common on north-west Scandinavian bogs as for instance on the island Andøya (OsvAlD 1925 b) has not been observed.
Some common plant communities of British and Irish bogs

Table 6. Calluna - Scirpus caespitosus - Rhacomitrium sociations.

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All the notes have been obtained from blanket bogs.
1. Wales, north-east of Ffestiniog, 1931.
2. Lewis, Loch Vatandiep, west of Stornoway, hummock, 1931.
3. Lewis, south-west of Barabhas, hummock, 1931.
4. Lewis, north of South Dell, 1931.
7. Lewis, Loch Vatandiep, flat bog surface, 1931.
8. Lewis, south-west of Barabhas, hummock, 1931.

bottom layer. The two former communities are typical of the distinctly raised bogs, where they form one of the major constituents of the regeneration complex, and besides, they occur on scattered hummocks on bogs of other types; the latter community forms the major part of the vegetation of the flat or slightly raised bogs of western Ireland. In all of them Calluna is dominant, and Erica is always present, sometimes in great quantities. In the field layer, also Drosera rotundifolia and Eriophorum vaginatum are constant. Andromeda and Oxycoccus, both constant in the Calluna-Sphagnum magellanicum sociation of Scandinavian raised mosses, are inconsiderable (cf. the Calluna-Cladonia sociation). The main differences are found in the bottom layer, where Sphagnum magellanicum, S. rubellum and a mixture of S. magellanicum, S. papillosum, S. plumulosum, and S. rubellum are dominant respectively. Except for the difference in the bottom layer the two former sociations are very similar, but the western Calluna-Sphagnum sociation differs from the other two not only in the composition of the bottom layer but also in that of the field layer: Narthecium ossifragum, Eriophorum angustifolium and Scirpus caespitosus are always present, and Rhynchospora alba is rather frequent. In addition to the four dominant Sphagnum species in the bottom layer, Campylopus atrovirens, Sphagnum tenellum and Cladonia silvatica are always found, and S. subsecundum, which very seldom occurs in Sphagnum hummocks, very often is fairly frequent in the smooth Sphagnum cover of this sociation. These sociations are not identical with the Sphagnetum described by TANSLEY (1939), but they constitute the most important part of this association on the raised bogs.

The community represented in no. 1 and 2, Calluna- Sphagnum nemoreum sociation is rather inconsiderable as compared with the other Calluna-Sphagnum communities.

Scirpus caespitosus - Eriophorum vaginatum sociations (Table 8)

The communities dominated by Scirpus caespitosus or Eriophorum vaginatum in the field layer and more or less Sphagnum in the bottom layer, undoubtedly are the most important ones on the blanket bogs of Great Britain and Ire-
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Some common plant communities of British and Irish bogs

Table 7 continued

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1. Lon moor, Fort Augustus, 1931.
2. Isle of Skye, Glen Sligachan, 1931.
3. Deer Dike moss, middle part, 1921.
4. Isle of Skye, Glen Sligachan, 1931.

land. They determine the character of extensive areas. *Scirpus* is usually dominant, but sometimes *Eriophorum vaginatum* is equally abundant or dominant. Although there is much difference between such extremes as for instance the *Scirpus* communities of the Isle of Man and the *Eriophorum* communities of the Pennines, it seems difficult to split up these communities into two sociations with regard to the field layer. In the bottom layer the variation is larger. In some cases there are hardly any *Sphagna*, in others the *Sphagna* form a thick cover. It might be possible to distinguish several sociations with regard to the composition of the bottom layer, but my experience is that there is a rather continuous transition from one type to another, and my own observations are by no means sufficient to allow a splitting up of these communities in different sociations; therefore I prefer to describe them here as a more or less complex or heterogenous community.

The field layer has a number of rather regular components: *Calluna vulgaris*, *Erica tetralix* and *Narthecium ossifragum* may be mentioned in the first place, and next *Drosera rotundifolia*, *Eriophorum angustifolium* and *Molinia coerulea*. It is of interest to observe, that two of the three sites, where *Narthecium* has not been found are located on fairly high altitudes, *i.e.* on Slieveanrea on Ireland, 1,800 feet O. D., and at the head of Afon Brefi in Wales. Is there perhaps in the British Islands a height limit for *Narthecium*? *Bryales* and *Hepaticales* are generally inconconsiderable. In some cases also the *Sphagna* are very scarce, but as a rule there is a good *Sphagnum* cover. The most common species is *S. papillosum*, but sometimes the bottom layer is dominated by *S. magellanicum*, *S. plumulosum*, *S. rubellum*, *S. subsecundum* or *S. tenellum*. *Cladonia silvatica* and *C. uncialis* are frequently observed. This community (or communities), being the most prominent of British and Irish bogs, has been described by a number of investigators (W. G. Smith, Moss, Adamson, Watson, Lewis, Fraser a. o.). A comprehensive account of the results of these scientists is given by Tansley, from whom I may quote the following paragraph: —“*Scirpetum* and *Eriophoretum* are in a sense alternative communities for they occupy quite similar physiographical habitats and they are rarely both developed extensively in the same region.” Broadly speaking, the *Eriophoretum* is typical of the Pennine chain, and *Scirpetum* (with more or less *Eriophorum*) of blanket bogs in all other regions. It seems to me rather difficult to explain why these two similar communities are distributed in such a way, cf. p. 58.

The peat formed by these communities is a rather fibrous *Scirpus-Eriophorum* peat, in which the *Sphagnum* debris is fairly well decayed. Exposed to weathering it breaks down to a
## Table 8. Scirpus caespitosus - Eriophorum vaginatum sociations.

| Andromeda polifolia | Calluna vulgaris | Empetrum nigrum | Erica macaggi | Tetralix | Oxyccocus quadripetalus | Myrica gale | Vaccinium myrtillus | Drosera anglica | rotundifolia | Galium hercynicum | Menyanthes trifoliata | Narthecium ossifragum | Orchis maculata | Pedicularis sylvatica | Pinguicula vulgaris | Polygala vulgaris | Polygonyum persicaria | Potentilla erecta | Succisa pratensis | Carex humata | panicea | Deschampsia flexuosa | Eriophorum angustifolium | vaginatum | Juncus squarrosum | Luzula congeta | silvestra | Molinia caerulea | Rhynchospora alba | Schoenus nigricans | Scirpus caespitosus | Aulacomnium palustre | Breutelchrysocoma | Calliergon sermentosum | Calypogeia trichomanis | Campyliopus atrovirens | flexuosus | Cephalozia bicuspidata | connivens | leucanthera | macrostachya | Cladophialla fluitans | Dicranum scoparium | Diplolophyllum albicans | Hylomichum proliferum | Hypnum cupressiforme | Lepidozia sedacea | Leucobryum glaucum | Lophozia incisa | porphyroleuca | Mnium hornum | Mylia anomala | tayloreni | Novelia curvifolia | Odontochroma ephagni | Pellia epiphylla | Plagiothecium undulatum | Pleurozia purpurea | Pleurozium schreberi | Polytrichum formosum | Riccardia latifrons | pinguis | Rhacomitrium lanuginosum | Rhitydadelphus lutescens |
|---------------------|------------------|-----------------|--------------|---------|------------------------|-------------|--------------------|----------------|---------------|------------------|-----------------|------------------|-----------------|--------------------------|----------------|-----------------|----------------|----------------|----------------|----------------|------------------------|-----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|
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|                     |                  |                 |              |         |                        |             |                    |                |            |                  |                 |                   |                 |                           |               |                |                |                |                  |                  |                        |                 |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |
|                     |                  |                 |              |         |                        |             |                    |                |            |                  |                 |                   |                 |                           |               |                |                |                |                  |                  |                        |                 |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |
I. Sphagnum auriculatum .. .............. .... .
remains being the rootlets of Cladonia alpestris ... .................. ... .
coarse powder and attains very much the appearance of a sedge peat, the most conspicuous

Cium
Ireland; here, however, these sociations play communities in other parts of Great Britain and
Ireland. As in these communities, a number of sociations might be distinguished with regard
to the dominant plants in the different layers, but it would be very hard to overcome the
difficulties caused by the gradual transition from dominant Schoenus in list no. 1 to dominant
Eriophorum in no. 9.

Sphagnum auriculatum

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</tbody>
</table>

Table 8 continued

2. Penniforth, Isle of Man, slope c:a 12°, facing north, 1937.
3. Isle of Skye, near Kyleakin, 1931.
5. At the head of Afon Brefi, east of Llanddewi Brefi, 1937.
7. Slieveanea, 1937.
8. Lon moor, Fort Augustus, 1931.
10. Tregaron bog, 1931.
11. Isle of Skye, Glen Sligachan, 1931.
12. Lewis, west of Vatandiep, 1931.
15. Lon moor, 1931.
17. Isle of Sky, Glen Sligachan, 1931.
18. Wicklow mountains, at the sources of Liffey, 1935.

Schoenus nigricans - Eriophorum vaginatum sociations (Table 9)

This type of community is very uniform, which is due to the fact that it is restricted to a comparatively small area, i.e. the West of Ireland; here, however, these sociations play the same rôle as the Scirpus-Eriophorum communities in other parts of Great Britain and Ireland. As in these communities, a number of sociations might be distinguished with regard to the dominant plants in the different layers, but it would be very hard to overcome the difficulties caused by the gradual transition from dominant Schoenus in list no. 1 to dominant Eriophorum in no. 9.

In addition to the two dominant plants a great number of species occur in all or nearly all the areas listed. These are: Calluna vulgaris, Drosera anglica, D. rotundifolia, Narthecium ossifragum, Eriophorum vaginatum, Molinia coerulea, Rhynchospora alba, in the field layer; and Campylopus atrovires, Sphagnum cuspidatum (sometimes dominant), S. subsecundum (the most typical Sphagnum species) and Cladonia uncialis in the bottom layer. Rather frequent are also Erica tetralix, Scirpus caespitosus (this species has a tendency to increase with increasing dominance of E. vaginatum), Pleurozia purpurea and Cladonia silvatica. In one case the bottom layer was dominated by Dicranum scoparium.

In western Ireland (Connemara and Mayo) this community occupies practically the whole blanket bog area.

The rather remarkable fact that Schoenus nigricans, which in other parts of Europe is characteristic of calcareous fens, grows to-
together with and replaces such plants as *Eriophorum vaginatum* and *Scirpus caespitosus* will be discussed later, cf. p. 58.

Table 9. Schoenus nigricans - *Eriophorum vaginatum* sociations.

<table>
<thead>
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<th>Calluna vulgaris</th>
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Table 10. *Rhynchospora alba - Sphagnum sociations.*

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2. Two miles west of Screel, 1937.
Rhynchospora alba -Sphagnum sociations (Table 10)

These communities correspond to the Rhynchosporetum of Tansley (1939). They form a rather conspicuous part of the vegetation on different kinds of bog although they seldom cover large unbroken areas. The features common to all communities belonging here are the dominance of Rhynchospora and the relatively high water requirements of the Sphagna in the bottom layer. Sometimes, as in typical raised bogs not too far west, the community is poor in species and contains hardly anything but Sphagnum tenellum in the bottom layer. Further west a richer type of the community is often met with (no. 3). A still richer type, in a wetter locality, has been listed by Tansley (1939, p. 700). The Rhynchospora- Sphagnum tenellum sociation often occupies the hollows of the regeneration complex approaching the stagnation stage.

* * *

In addition to the communities now described a fairly large number of other sociations were listed during the field work. But since there is only one list of each of these sociations it seems more convenient to insert these lists in the description of the bogs.

MOSSES IN ENGLAND, WALES AND ISLE OF MAN

Raised mosses

The wooded raised moss seems to be absent from the British Isles. The treeless raised moss is less common in England than in Scandinavia and northwestern Germany and is confined to low or rather low altitudes. Typical examples are the Foulshaw moss and the Deer Dike moss in the Lonsdale district. In both of them the lagg is a Carex-Molinia fen, the marginal slope is a Myrica gale-Molinia community, with some birch, and the undisturbed areas1 of the moss are very similar to the corresponding parts of for instance Komoosse. Among the Sphagnum communities the Calluna- Sphagnum magellanicum sociation (Table 7: 3) is dominant, and the hummocks are occupied by Calluna and Erica communities, either with a bottom layer composed of lichens or mosses (Table 3: 1, 3: 3, 3: 4, 5: 1) or without any (Table 4: 1—5). A very extensive raised moss once covered the low land south of Hatfield (Yorkshire). Although the main part of the moss has been cut away, and all natural vegetation is dead, it can easily be deduced from the regeneration structure of the peat, that the bog has been a raised moss. Also in other regions, where most of the peat has been cut away, for instance in the heath districts at the east coast of England, between Scarborough and Whitby, the remaining peat layers with still living Sphagnum cespitatum, S. compactum, S. tenellum and S. inundatum in a field layer of Calluna, dominant, and some Erica tetralix, Carex panicea, Eriophorum angustifolium, Juncus squarrosus and Scirpus caespitosus, seem to indicate that the bogs have been mainly of the raised type, although some small areas seem to belong to the concave type of mire.

In Wales raised mosses are found from sea-level up to relatively high altitudes. The Tregaron bog for instance occupies a valley about 600 feet above sea-level on both sides of the river Afon Teifi just north of the village of Tregaron, about 13 miles south-east of Aberystwyth. The whole bog area is about 2 1/2 miles long and 1 1/2 miles broad. The tributaries to the river divide this area in three mosses separated by broad fens. The margins of the raised mosses are to a large extent cut for peat, but at some places the

1 The surface of Foulshaw moss is very strongly influenced by the seagulls, which live on the moss in enormous numbers.
original topography can still be observed. In the north-west there is for some distance a typical lagg with birches, *Betula pubescens*, and sallows, *Salix cinerea*, in a field layer of *Carex* spp., *Molinia*, *Potentilla palustris* and other plants, and a bottom layer of *Drepanocladus fluitans* var. *falcatum*, *Sphagnum auriculatum*, *S. cuspidatum*, *S. papillosum*, *S. plumulosum*, *S. pulchrum*, and *S. rubellum*. From the lagg level the moss margin rises only very slowly.

The marginal parts of the moss areas are smooth and dominated by a *Scirpus caespitosus* community, generally with a bottom layer of *Sphagnum papillosum* or *S. pulchrum*, the central areas by two complexes, one of them a typical regeneration complex, the other one of a stagnation type. The difference between them is, however, small and is mainly due to the relative frequency of *Sphagnum* communities. In both of them *Scirpus caespitosus* - *Sphagnum papillosum* sociations (Table 8: 10) covers the main part of the area. Over intermediate stages of *Calluna* - *Sphagnum magellanicum* sociations and *Calluna* - *Sphagnum rubellum* sociations this community seems to develop into the *Calluna-Cladonia* sociations (see Table 5: 2). The low hummocks of this sociations are transformed by the growth of *Eriophorum vaginatum* into rather high hummocks, characterized by the projecting, pillar-like tussocks of the cotton grass. On the top of the pillars these tussocks have a bottom layer of *Cladonia silvatica* and *Pleurozium schreberi*. On the marginal, lower ones *Empetrum* is growing, on the higher ones in the centre, *Vaccinium myrtillus*. On the ground between the tussocks *Aulacomnium palustre*, *Pleurozium schreberi*, *Rhytidiodedphus loreus* and *Sphagna*, and in the highest and driest also *Polytrichum strictum* are found. Very often *Molinia* grows in great quantities, and sometimes small hummocks of *Rhacomitrium* and *Leucobryum* occur. Frequently one or two birches are found in the centre of these large hummocks. In the stagnant parts of the moss all the hollows belong to the "*Zygononum*" type, but in the growing parts as well as "*Zygogonium" hollows, *Sphagnum pulchrum* and *Rhynchospora* hollows (Table 10: 2) occur. In some parts the first signs of erosion in the hollows were observed.

The large hummocks seem to be rather long-lasting. Although they grow slowly it probably takes a long time until they are overgrown, as the surrounding surface doesn't grow very fast either. Since the hummock has been invaded by *Molinia*, or a birch (*Betula pubescens*) has grown up in the center of it, a definite limit for its growth seems to have been reached. In the latter case this might be due to the weight of the birch or perhaps to more rapid decay of peat under the tree. The result would be a depression, gradually filling with water, and causing the death of the birch. According to this conception the succession would be the following:

A more detailed description of this interesting bog is given by Godwin and Conway (1939).

**Blanket mosses**

The blanket moss — including the concave moss type — is typical of extensive areas in England, where the rainfall is high. The largest areas of this type are found in the Pennines. Since the Pennine mosses are well known through
Mosses in England, Wales and Isle of Man

In Wales blanket mosses are also common, although they do not cover areas as extensive as in the Pennines. At high altitudes north-east of Ffestiniog a very common plant community of the blanket mosses, forming a rather smooth surface, is the Eriophorum vaginatum - Sphagnum papillosum sociation (Table 8: 16). In areas where the peat is shallow Calluna becomes dominant. The small hummocks, rising over the smooth surface, are mostly built up of Rhacomitrium, with some Pleurozium schreberi, Cladonia silvatica and C. uncialis. Other more extensive but low hummocks support a Calluna-Pleurozium schreberi sociation. Some small and rather infrequent hollows are occupied by the Eriophorum angustifolium - Sphagnum cusupeatum sociation. A sample of the bottom layer from one of these hollows contained i. a. Cladopodiella fluitans, Sphagnum aqutile(?), S. auriculatum, S. cuspidatum and S. tenellum.

Other hollows are larger and filled with water. These hollows are usually arranged at right angles to the gradient. If so there is as a rule a narrow belt with Juncus squarrosus - Sphagnum papillosum sociation at the upper margin of the hollow and at the lower one a hummock, often eroded by water, with Calluna-Pleurozium sociation (see Fig. 1). Within large areas the erosion, apparently in the first place by water, has resulted in an erosion complex, in which the dry hummocks are covered with Calluna-Rhacomitrium sociation (Table 6: 1) and to a less extent with Erica-Cladonia silvatica sociation. Lower parts between the high hummocks are occupied by a dense cover of Juncus squarrosus with Aulacomnium palustre and by Sphagnum papillosum sociation. The eroded areas sometimes regenerate with Eriophorum angustifolium - Sphagnum papillosum sociation. The brown or greyish-brown landscape is traversed by green strips, i. e. the drainage system with Juncus effusus - Sphagnum aqutile sociation, the composition of which was as follows:

Fig. 1. Schematic drawing showing arrangement of plant communities at a hollow in a blanket bog north-east of Ffestiniog, Wales.
Another type of blanket moss is represented by the large bog at the head of Afon Brefi east of Llanaddewi Brefi in central Wales. The bog occupies a broad valley 1,400 feet above sea-level. At the south side some of the flat areas of the hills are occupied by a Molinia-Polytrichum-Sphagnum apiculatum community, then follows a slope with Molinia-Sphagnum apiculatum community, in which Juncus effusus is abundant at the lower part. The main, central part of the bog is an extensive erosion complex with Calluna-Rhacomitrium siciation as the dominant plant community of the large hummocks, which are separated by large areas of bare, water- and wind-eroded peat, cut by winding erosion channels. On the north side of the valley a smooth area slopes gently up along the hillside. The dominant plant community of this part is the Scirpus caespitosus - Eriophorum vaginatum - Sphagnum plumulosum siciation (Table 8:5), in which Sphagnum plumulosum is forming small hummocks 1½-1 foot high. Some very scarce higher hummocks are covered with Calluna-Hypnum cupressiforme siciation.

The area with this Scirpus community is intersected by some wetter strips, in which the water from the hillsides soaks through this belt to the central part of the bog.

In the Isle of Man peatlands do not play any prominent rôle, probably for the most part because of peat cutting. The Curragh, for instance, on the northern lowland has perhaps been a bog but is now only an irregular complex of shallow pools (peat cuttings?) with Potamogeton natans, Equisetum fluviatile, Menyanthes, Potentilla palustris, Hippuris vulgaris, and other plants, Carex rostrata - Calliergon giganteum fens, Molinia meadows, Juncus gerardi meadows and many other types of marshes and wet meadows with a rather rich flora.

At higher altitudes the vegetation consists mostly of Calluna, Erica, or grass heaths with small patches of boggy ground in some places. At Aerie, Foxdale, for instance, the shallow peat supported an Erica-Narthecium heath, bordering a Molinia fen near a small pool. Here Platanthera bifolia and a large Orchis maculata were growing in abundance. The bottom layer consisted of mainly Sphagnum compactum and S. tenellum, and further Calliergon stramineum, Campylopus atrovirens, Drepanocladius fluitans, Plectocolea crenulata, Sphagnum plumulosum, and S. subsecundum. At the Granite Mountain, south of Foxdale, a hillside facing west and sloping about 10° was covered with a soligenous mire, where the dominant plant community was the Eriophorum angustifolium-Sphagnum papillosum community, in which the following note was taken:

| Calluna vulgaris       | 1 |
| Erica tetralix         | 1+|
| Narthecium ossifragum  | 2+|
| Pedicularis silvatica  | 1 |
| Polygala vulgaris      | 1 |
| Potentilla erecta      | 2 |
| Agrostis canina       | 1 |
| Carex panicea         | 1 |
| Eriophorum angustifolium | 3+ |
| Molinia coerulea      | 1+|
| Blechnum spicant      | 1 |
| Campylopus flexuosus  | 1 |
| Cladopodiella fluitans | 1 |
| Pleurozium schreberi  | 1 |
| Polytrichum strictum  | 1 |
| Sphagnum apiculatum   | 2 |
| » cuspidatum          | 1 |
| » cymbifolium         | 1 |
| » papillosum          | 4 |
| » subsecundum         | 1 |

Small depressions in this type of mire were dominated by a Narthecium ossifragum-Sphagnum subsecundum community in which the most prominent species were: Drosera rotundifolia,
Polygala serpyllifolia, Juncus effusus, Carex vulpina, and Luzula campestris.

The most extensive areas of apparently natural mossaes of the blanket type were found at the Crammey valley head. The peat seems to be very shallow all over. The dominant plant community is a Scirpus caespitosus sociation with a rather tussocky surface. The area is rather broken, because a large number of erosion drains intersect the bog. On Penniforth, on a slope facing north c. 12°, where the peat layer was about one meter thick, the list given in Table 8: 2 was made. Along the drains and on high tussocks Vaccinium myrtillus is dominant, often associated with Pleurozium schreberi. The bottoms of the drains are either bare or covered with a vegetation, composed of Galium hircynicum, Potentilla erecta, Agrostis canina, Anthoxanthum odoratum, Carex echinata, C. fusca, Festuca ovina, Luzula congesta, Nardus stricta, Polytrichum commune, Rhytidiadelphus loreus, Sphagnum apiculatum a.o. Flushes in the drains are occupied by Eriophorum angustifolium either on bare peat or in a bottom layer of Sphagnum apiculatum.

Mosses in Scotland

Raised mossaes

In the Scottish lowlands the mossaes seem to belong to the same type as in the English lowlands. As an example the Red Moss at Parkhill near Aberdeen may be mentioned. Through peat cutting most of the original surface has been spoiled, but in a few places, where the margin was still left, there was a conspicuous rise above the mineral ground, and in one locality a narrow Molinia lagg with Sphagnum apiculatum, S. papillosum and S. plumulosum was observed. The margin of the moss plane was Calluna-Pleurozium heath, Calluna-Sphagnum nemoreum sociation and Scirpus caespitosus - Eriophorum vaginatum - Sphagnum papillosum sociation; the centre was occupied by Calluna-Pleurozium sociation, Calluna-Sphagnum nemoreum sociation and Calluna-Cladonia sociation, all of them with much Erica, Eriophorum vaginatum, E. angustifolium, Scirpus caespitosus and here and there Narthecium. Stunted specimens of Pinus silvestris were scattered over the bog. The bog had of course dried out considerably through the peat cutting. Below the decayed top layer there was 3-4 feet of undecomposed peat of Sphagnum magellanicum, indicating that this species previously had played an important rôle in a regeneration complex preceding the present vegetation. Pl. 3.

Also in the hilly districts of southern Scotland some of the bogs are more or less raised. A few miles south of Crawford, in a region where extensive grass heaths dominate the landscape, a small bog close to the road between Crawford and Little Clyde was studied. The bog was strongly domed, but so, obviously, was also the mineral ground, as could be observed in an eroded profile (old peat cutting?). The nearly horizontal central area of the bog was strongly eroded, probably at first by water but later by wind and water together. In this part the main vegetation was a Scirpus caespitosus community rather tussocky and without Sphagna (Table 8: 1). This community was influenced by grazing; hence the dominance of Scirpus. Calluna was rather low and suppressed. Some small hollows were occupied by Sphagnum cuspidatum and S. tenellum.

The sloping margins of the bog were covered by a smooth Scirpus caespitosus - Eriophorum vaginatum - Sphagnum molle sociation (Table 8: 6). At the bottom of the slope Molinia coerulea was growing on the thin peat, and then followed a grass meadow on the mineral soil sloping away from the bog. From the observations
made it is impossible to tell whether this bog should be classified as a raised bog or not. It might just a well be regarded a blanket bog.

Even at the west coast of Scotland some slightly raised mosses occur. The vegetation of these, however, has very much in common with the blanket bogs in the same district. At Strathcarron for instance near sea level there is a conspicuously raised bog, the vegetation of which is a *Scirpus caespitosus* community with much *Narthecium* and very little *Calluna* and with *Sphagna* in the wettest parts. At Craig lies another slightly raised moss with a typical erosion complex, composed of the following communities: *Calluna-Rhacomitrium* association, *Scirpus caespitosus*- *Sphagnum* association with *Narthecium, Eriophorum angustifolium, Diplophyllum albinum, Pleurozia purpurea, Sphagnum auriculatum, S. compactum, S. tenellum, Scirpus caespitosus*- *Rhacomitrium* association and *Calluna-Cladonia silvatica* association with much *Potentilla erecta*. Wet grooves between the hummocks were occupied by *Eriophorum angustifolium, Juncus squarrosus, Drosera anglica* and *D. rotundifolia* in a bottom layer of *Sphagnum auriculatum*. Pl. 3.

**Flat and slightly concave mosses**

A rather common moss type in the west of Scotland seems to be the flat — slightly concave one, topographically resembling the bogs in southwestern Sweden. In Glen Sligachan on the Isle of Skye most of the mosses belong to this type. A good example is a bog near the hotel. The bog surface is gently sloping, creeping up along the sloping mineral ground and drained in several directions. Part of the bog is an erosion complex, but most of it has a smooth, growing surface with scattered hummocks. This area is occupied by the *Scirpus caespitosus- Eriophorum vaginatum- Sphagnum cymbifolium* association (Table 8: 17). Some small hollows with *Eriophorum vaginatum, E. angustifolium* and *Sphagnum auriculatum* occur in the central part of the bog, where most of the water seems to run through. These hollows give the impression of being the last remains of a previously more extensive plant community which has been overgrown by the *Sphagnum cymbifolium* community. Through increasing growth of *Calluna* and *Sphagnum nemoreum* and *S. plumulosum* in the smooth *Scirpus-Eriophorum-Sphagnum* community the first stage of the hummocks is formed (Table 7: 2). Later *Rhacomitrium* becomes more frequent, and finally the central part of the hummock develops into a *Rhacomitrium* community, sometimes with a field layer of *Calluna*. The erosion complex is cut by several deep channels branching irregularly and going right through to the mineral ground. Here the bog surface is covered with *Calluna-Rhacomitrium* association with much *Molinia* and further *Erica, Myrica, Narthecium, Potentilla erecta, Eriophorum vaginatum* and *Scirpus caespitosus*. See Fig. 2.

Not far from this bog was another one, which apparently was influenced by flush water. The surface was dotted with a number of low hummocks and shallow depressions, arranged at right angles to the gradient. The smooth surface was occupied by *Scirpus caespitosus- Eriophorum vaginatum- Sphagnum cymbifolium* association (Table 8: 11), the hummocks usually by *Calluna- Sphagnum cymbifolium (magellanicum)* association (Table 7: 4) gradually developing into *Rhacomitrium* association. The depressions were filled with a loose cover of floating *Sphagnum auriculatum* with some *Menyanthes*. 
On the whole the Sligachan valley is poor in moss areas. This is partly due to good drainage — the mineral soil is coarse gravel — partly to the great amount of water from the steep hillsides, which prevents moss formation. But in depressions small mires generally occur. *Sphagna* generally play a rather inconsiderable rôle and the peat in the bogs just described is not a *Sphagnum* peat, but mainly a well decomposed *Scirpus* peat with some remains of *Sphagna*.

On the mainland, bogs of the type now under consideration are found in some places. Near Fort Augustus at about 600 feet above sea level large bog areas occupy horizontal or nearly horizontal ground. One of these bogs is Lon moor. Here the dominant plant communities are the *Scirpus caespitosus* - *Eriophorum vaginatum* - *Sphagnum* associations (Table 8: 8 and 15). Sometimes *Calluna* becomes dominant, and the resulting community is the *Calluna- Sphagnum nemoreum* association (Table 7: 1). Drier patches with *Calluna-Cladonia* association were also observed and so were also some wet depressions with *Sphagnum cuspidatum* and *S. auriculatum*.

Although the *Sphagna* are rather common in the vegetation, they do not seem to play an important rôle in the peat. Where peat blocks were exposed to weathering, as along some ditches, the peat had decomposed into a coarse powder. This is probably due mainly to the high frequency of *Narthecium* and *Scirpus* rootlets in the peat.

The high frequency of *Molinia* in some areas of these bogs seems to indicate the influence of water from higher areas soaking over the bog.

In exposed profiles (along the drains) in Lon moor numerous stumps of *Pinus* were found 1—2 feet below the surface.

Blanket mosses

As emphasized above there is a gradual transition from the slightly concave bogs to the typical blanket ones. The Lon moor might just as well have been described as a blanket moss. On the way from Dornie Ferry up through Glen Shiel a number of similar mosses were observed. Usually, however, the bog surface was more or less eroded by water and wind, and in such cases the dominant plant community was the *Calluna-Rhacomitrium* association. Above Cluanie bridge, up to 1,500 feet above sea level, the erosion was very prominent over extensive areas. The same type was common along the road across the waste, desolate area of Rannoch moor. A bog with more dominant *Scirpus caespitosus* which also might be mentioned here is the small bog close to the road a few miles south of Crawford, which has been described previously, see p. 29.

A typical blanket moss area was studied near Kyleakin on the Isle of Skye. As a gently undulating cover this bog extends over low hills and slopes, with a thicker peat on the flat areas and a thinner one on the hill sides. Only some small, steep hills rise above the peat cover. On the flat and slightly sloping parts of the bog which is influenced by grazing the surface is smooth and supports an unbroken and rather uniform plant community of *Scirpus caespitosus* - *Sphagnum* association (Table 8: 3). On the steepest slopes *Calluna* becomes the dominant plant, and many of the species of the flatter areas decrease in frequency or disappear totally.

The most extensive areas of typical blanket mosses occur on Lewis, where most of the northern part of the island is covered with bog. Although much peat is cut, enormous areas are still under quite natural conditions or only slightly influenced by sheep grazing. The moss surface is gently rolling, the peat covers low hills, sloping areas, flat depressions, and valleys. Only comparatively steep hills rise over the peat 'ocean.' On relatively steep slopes, however, the peat is shallower than on more or less horizontal areas. The microtopography of the surface and the vegetation are in the first place determined by the wind. Where the wind action is less prominent, or at least less obvious, the moss surface is smooth and covered with a *Scirpus caespitosus* - *Sphagnum* association (Table 8: 12). Small hummocks of *Sphagnum compactum* and *S. nemoreum* sometimes rise over a surface, or (in patches) *Sphagnum* is replaced by
Fig. 3. Sketch showing successive stages in the development of a wind-eroded complex from a slightly undulating moss surface.

Rhacomitrium. The peat supporting this plant community does not seem to be very deep. An exposed profile not far from the place where the vegetation was noted revealed the following stratification:

a. 100 cm Sphagnum-Scirpus peat, H = 7,

b. 15 cm black, amorphous peat, H = 10,

c. 10 cm podsolized sand and boulder gravel.

Scirpus caespitosus and Sphagnum species (mostly S. cymbifolium and S. plumulosum) usually form the bulk of the peat. It seems, therefore, justifiable to conclude that a plant community of a similar type has been prevalent for a long time. The humification and the Sphagnum content may change, sometimes the top layer is a more fibrous Scirpus peat, which may indicate that Sphagna now are less prominent than previously, but Scirpus and Sphagna are always the main components.

In places where the wind for some reason or other begins to erode the surface, a complex vegetation, dominated by the Scirpus caespitosus - Rhacomitrium sociation develops (Table 6: 7). This community is not only poorer in species than the previous one, but also drier. It is difficult to discern whether the dryness is the cause of, or caused by the erosion. Anyway, through the erosion small hollows are cut in the surface, and the hollows become ever larger. The vegetation in these hollows is mainly Eriophorum angustifolium sociations, either bare or with Sphagnum auriculatum and S. cuspidatum forming a bottom layer. The composition of these communities is illustrated by the following notes from the bog near Vatandiep:

<table>
<thead>
<tr>
<th>Eriophorum angustifolium sociation</th>
<th>Eriophorum-Sphagnum auriculatum sociation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Erica tetralix</td>
<td>1</td>
</tr>
<tr>
<td>Carex oederi</td>
<td>1</td>
</tr>
<tr>
<td>&quot; panicea</td>
<td>1</td>
</tr>
<tr>
<td>Eriophorum angustifolium</td>
<td>3</td>
</tr>
<tr>
<td>&quot; vaginatum</td>
<td>1</td>
</tr>
<tr>
<td>Scirpus caespitosus</td>
<td>1</td>
</tr>
<tr>
<td>Sphagnum auriculatum</td>
<td>5</td>
</tr>
<tr>
<td>&quot; cuspidatum</td>
<td>3</td>
</tr>
</tbody>
</table>

Sometimes the Sphagnum hollows may regenerate through the invasion of Sphagnum cymbifolium and S. plumulosum, while the erosion is going on in other parts, but this does not seem to be a normal occurrence. On drier parts of the moss Rhacomitrium increases, and finally high hummocks (up to 60 cm) with Calluna-Rhacomitrium-sociation are found (Table 6: 2).

The start and progress of the erosion may be illustrated by the series of schematic profiles in fig. 3. In the slightly undulating, original ground surface the wind action has started on some small elevations and has cut a shallow depression in one side of each of them. The hollows become wetter and the remaining parts drier, and thus the vegetation begins to differentiate into hollows and hummocks. In this way the unevenness becomes more prominent, the wind gets a better opportunity to erode, and thus the progress continues, until most of the hummocks have been cut away. Probably the erosion is fastest, when the wind has a tool, so to speak, i.e., rain, hail or snow.

Since the eroded areas are generally more or less sloping, erosion by water is added to erosion by wind. This is particularly common along streams. Such a case was observed not far from the area just described. The stream had cut through the whole peat layer right down to


10. Slightly wind-eroded blanket bog area with *Rhacomitrium* hummocks at Loch Vatandiep, west of Stornoway, Lewis. Cf. p. 32.

June 2, 1931. H. O.


June 2, 1931. H. O.


17. Soak coming from a small pond in the blanket bog east South Dell, Lewis. Swallow holes in the wet grass meadow. — Mr. Garst. — Cf. p. 34. June 3, 1931. H. O.
the mineral ground. A large number of erosion channels ran into the stream. The channels had probably been formed by the water uniting the hollows cut by the wind. Many of these channels had attained such a depth that the erosion in the bottom had ceased, and *Eriophorum angustifolium* was now growing on the bare peat; on the sides of the channels, however, wind erosion was still going on. Pl. 6.

On the western side of the island the erosion is much more intense. Near the road some miles south west of Barabhas an area was studied in which the high hummocks or peat hags were separated by broad and deep, winding channels and supported a vegetation of mainly *Calluna-Rhacomitrium* sociation (Table 6: 3) and *Calluna-Cladonia* sociation in which the bottom layer sometimes was rather thin (Table 5: 9), both of them rich in *Juncus squarrosus*. Another community on the hummocks was a very dry facies of *Scirpus-Rhacomitrium* sociation (Table 6: 8).

Occasionally small cushions of *Sphagnum compactum* and *S. nemoreum* occurred on the dry hummocks. Pl. 7.

Nowhere, however, is the physiognomy of the moss surface determined to such a degree by the wind erosion as in the Ness district north of South Dell. Moreover, the slope of the moss areas very often is such that the wind erosion is intensified by the action of water. A stream is running from east to west, and on both sides large moss areas slope down to the stream as shown in the schematic sketch in Fig. 4. On the north side of the stream the peat layer, due to the exposure to the south, is thinner than on the south side. The prevailing wind is from the west, and, consequently, the hollows cut by the wind have been united through water erosion to long channels parallel to the direction of slope, forming a dense system of parallel, slightly winding and branching open drains (see Fig. 5). The side of the hummock facing the wind is very steep, often more than 1 m high, partly overhanging and lacking vegetation. The top is occupied by the *Calluna-Rhacomitrium* sociation (Table 6: 4), on the lee side sloping to the next drain. The top of the hummock, usually
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being more or less uneven, has obvious signs of wind erosion. The vegetation of these well-drained, dry hummocks, being strongly influenced by sheep grazing, is uniform and uninteresting. As long as the drains are conveying water, they are usually without any vegetation. But when the water supply ceases, for instance if the water takes its course through another drain, the bottom becomes covered with grass and sedge communities with a field layer of *Eriophorum angustifolium*, *Nardus stricta*, *Juncus squarrosus*, *Carex panicea*, etc., and a bottom layer of *Sphagna* (e.g., *S. cuspidatum*, and *S. auriculatum*), in which a number of other mosses occur, for instance *Campylopus atrovirens*, *C. brevifilis*, *Cephalozia bicuspidata*, *Gymnocolea inflata*, and *Odontoschisma sphagni*.

There would not be much to add about this strongly eroded moss type, if the monotony were not broken by a number of interesting soaks. At the top of the slope some small lakes or ponds are situated, which drain to the stream. A few notes were made at one of these lakes and its outlet (see Fig. 6). The lake occupies the centre of an irregular, rounded depression. The surrounding moss is cut by a large number of radial erosion drains and covered by the *Calluna-Rhacomitrium* association and *Calluna-Pleurozium* association. The open water is bordered by a wet meadow, characterized mainly by *Nardus* and *Carex panicea*. In the distal part, i.e., near the outlet, this meadow is fairly broad, and here a number of moss hummocks occur, usually with *Calluna-Pleurozium*-association. The distal part of the lake is occupied by an extensive stand of *Carex rostrata*, and between this and the wet meadow is an edging of *Caltha palustris*, *Potamogeton polygonifolius*, *Hydrocotyle vulgaris*, *Ranunculus flammula*, *Carex fusca*, etc., which continue into the outlet. At the outset the stream is running in a deep, narrow channel; further down the channel widens, giving place to a grass meadow, with *Agrostis tenuis*, *Nardus*, *Juncus squarrosus*, *Rhytidiadelphus loreus*, *Aulacomnium palustre* and *Sphagna*, on both sides of the stream. Still further down the stream disappears below the peat, only to appear again as a number of swallow holes in the meadow. Here the meadow is on a level with the moss surface. In some places the meadow is comparatively dry, indicating that the drainage is very effective. The lower course of the stream is marked by a number of narrow, deep swallow holes with a fairly luxuriant vegetation of *Agrostis tenuis*, *Blechnum spicant*, *Viola palustris*, *Cephalozia bicuspidata*, *Pellia epiphylla*, etc. Pl. 7 and 8.

**Other types of mire**

The Scottish bog types above described are all ombrogenous, i.e. the peat formation is due to high rainfall. It is easy enough to distinguish these types from those which are fed by water from mineral soils. The vegetation of the latter type of peat area may show a considerable vari-
For a comparison an example of such a bog may be given here (15° slope facing north, on Marsco on the Isle of Skye):

- *Drosera rotundifolia*
- *Narthecium ossifragum*
- *Orchis maculata*
- *Pedicularis palustris*
- *Polygala vulgaris*
- *Potentilla erecta*
- *Succisa pratensis*
- *Viola epipsila*
- *Anthoxanthum odoratum*
- *Carex fusca*
- *Eriophorum angustifolium*
- *Juncus effusus*
- *Luzula campestris*
- *Molinia coerulescens*
- *Nardus stricta*
- *Aulacomnium palustre*
- *Hylocomium proliferum*
- *Rhytidiadelphus loreus*
- *Sphagnum apiculatum*
  - *cymbifolium*
  - *nemoreum*

In wet “soaks” the following species were observed:

- *Caltha palustris*
- *Cardamine pratensis*
- *Epilobium montanum*
- *Potentilla palustris*
- *Ranunculus acri*
  - *ficaria*
- *Trifolium repens*
- *Carex echinata*
- *Equisetum arvense*
  - *palustre*
- *Nardus compressa*
- *Scapania undulata var. purpurascens*
- *Sphagnum obesum*

A great number of species are common to this type of peat land and those already mentioned, but, in this region, many of the species will never occur on peat areas unless they receive, with running water, a fair supply of nutrients from the surrounding mineral ground.

**MOSSES IN IRELAND**

**Raised mosses**

On the central plain in Ireland raised mosses occupy large areas. The margins of these bogs are generally spoiled through peat cutting and therefore it is very difficult to get an idea of the original topography and vegetation of the marginal parts. In some places, however, the margin and the lagg of proximal parts is still to be seen, and here a conspicuous although not very high raising of the margin can be observed. Along streams running through the moss areas, the rising margins are often very high. On the moss plane marginal complexes, either dry and rich in *Erica* and *Cladonia*, or less dry, with much *Scirpus* and dominant *Sphagnum* communities, are prevalent. Usually the regeneration complex is smoother than on the Swedish and continental raised mosses. There is also a marked difference in vegetation between Swedish and Irish raised mosses, and, going from the East to the West across Ireland, a gradual change in the vegetation of the moss plane can also be observed. We shall, to begin with, examine the vegetation of some of the large moss areas in the East of Ireland.

**Bogs east of Edenderry.**

East of Edenderry raised mosses extend over large areas. One of these areas was examined along the road from Edenderry to Killeen Thomas House. The east side of the bog has a typ-
Fig. 7. Sketch illustrating the vegetation of a soak in the bog between Edenderry and Killeen Thomas House.

Fig. 7 a. Sketch illustrating the vegetation at the first pool of the soak represented in fig. 7. 1 = Menyanthes; 2 = Juncus effusus; 3 = Eriophorum vaginatum; 4 = E. angustifolium; 5 = Osmunda and Pteridium; 6 = Oxycoccus; 7 = Betula; 8 = Salix; 9 = Pinus; 10 = Sphagnum cuspidatum; 11 = S. pulchrum; 12 = S. angustifolium; 13 = S. fuscum, 14 = Polytrichum commune; 15 = Calluna- S. magellanicum hummock.

The lagg, however, has been drained, and the margin of the bog has been partly cut. The rising of the moss is, therefore, probably more pronounced than it was originally. After the Calluna heath follows a marginal complex, rich in Scirpus caespitosus and with small hummocks of Sphagnum tenellum, S. magellanicum and S. imbricatum, and tiny depressions partly with bare peat, partly with Rhynchospora alba - Sphagnum tenellum sociation. The major community of this complex is the Calluna- Erica tetralix - Sphagnum sociation (Table 7: 9). Here and there Sphagnum magellanicum, S. papillosum, and S. cuspidatum form mats within this community. Further out follows the regeneration complex, the vegetation of which will be described later. On the west side the moss is bordered by an esker, from the top of which an excellent view of the bog can be obtained. Here is the proximal part, and the bog rises only slightly over a small lagg. Further down along the esker, however, the width of the lagg and the height of the marginal slope of the moss increase. From the outlook on the esker several strips of birch wood can be seen running into the moss. These indicate the course of streams and soaks, the drainage system of the moss.
One of these streams is crossed by the road. At this place the stream, bordered by Carex rostrata communities, is running in a channel with a rather dense stand of birch on the slopes. According to the map the stream originates at the road. As a matter of fact, it begins, however, as a soak much higher up in the bog; the upper part of the soak is a row of small pools. Apparently the very beginning is a group of pools, a “pool complex,” with a rather confused vegetation. In the centre, the first of these pools has a floating mat of Sphagnum cuspidatum with Menyanthes trifoliata, surrounded by Eriophorum angustifolium - Sphagnum pulchrum association. Then follows an area of Sphagnum apiculatum with scattered tussocks of Juncus effusus and some stands of Carex fusca. The border towards the typical moss vegetation is characterized by large hummocks of Sphagnum fuscum and Polytrichum commune, partly covered with Oxyccoccus quadriripetalus. Near the pool (at the lower side) a pine, some birches and sallows are growing, together with Pteridium aquilinum and Osmunda regalis. The moss vegetation round the pool is dominated by the Calluna-Sphagnum magellanicum association. The next “pool” is a wet depression with Eriophorum angustifolium - Sphagnum cuspidatum association with a few Juncus tussocks in it, and an edging of Sphagnum magellanicum around it. Then follow some similar “pools,” and then there is a larger one, bordered with Juncus effusus and Dryopteris spinulosa and a couple of large birches (Betula pubescens). In the middle of the pool is an island of Juncus effusus, with a small area of Hydrocotyle on one side and connected to the shore of the pool with a dense stand of Carex. Then, again, follow a number of “pools” with Juncus effusus, Eriophorum angustifolium, Menyanthes, Sphagnum cuspidatum, and S. pulchrum. (See Fig. 7 and 7 a.) The bog surface is throughout characterized by hummocks of Sphagnum magellanicum and S. fuscum. On both sides of the soak there are several wet Sphagnum hollows. A little further down Leucobryum glaucum hummocks occur, and at the same time Myrica gale and Molinia appear along the soak; still further down the course of the water is marked by a very thin stand of birch in a Molinia-Sphagnum community with some Eriophorum vaginatum and Orchis maculata. The dominant species in the bottom layer are S. apiculatum and S. pulchrum. Further on the following species were encountered: Calypogeia trichomanis, Hypnum cupressiforme, Odontoschisma sphagni, S. papillosum, S. rubellum, and S. tenellum. Still a bit further down this type of vegetation is replaced by a strip of grass and sedge communities, mainly Carex rostrata, in the bottom of a channel with scattered specimens of Scots fir and numerous birches on the sloping sides. Pl. 10.

Some hundred meters west of the soak and about 300 m south of the road a boring was made in the bog. The profile, which has been published by TANSLEY (1939) in detail, was shortly as follows:

a) 4.60 m alternating layers of Calluna-Sphagnum peat and Sphagnum peat (S. rubellum, cuspidatum, magellanicum, papillosum and imbricatum) of varying humification, H = 1—8 (regeneration cycles).
b) 1.70 m Carex peat, H = 5—6, in the upper part mixed with Sphagnum, in the lower with Drepanocladus and some Equisetum fluviatile and Cladium.
c) 0.50 m Calluna-Sphagnum peat, H = 8.
d) 1.00 m Carex peat, in the upper part containing Myrica, Phragmites, Menyanthes and Cladium, in the lower muddy and clayey, H = 5—8.
e) 0.95 m wood fen peat with birch, alder, and Carex.

Bluish gray clay.

This stratification shows that the bog has developed from a swampy wood, a carr, over a long-lasting sedge fen stage to the present type.

The distal part of the same bog was examined some miles south of Edenderry, east of Ballykilleen. Here the bog is bounded on the west by an high esker; the lagg is well developed, forming a broad fen with a stream in the middle.
The moss rises considerably over the lagg level. The lagg as well as the moss margin is strongly influenced by drainage, reclamation, cultivation, and peat cutting. A stream is running through the bog in a deep and broad valley. Here the natural vegetation of the rising moss margin can be studied. The major plant community of this is the Calluna heath (Table 3:2). The marginal parts of the moss plane are fairly smooth and dominated by a Calluna-Erica-Sphagnum association (Table 7:10), with a loose Sphagnum layer. Towards the centre of the bog the frequency of Sphagnum increases, and gradually the typical regeneration complex develops. Here the Calluna-Erica-Sphagnum association becomes rich in Narthecium, Eriophorum vaginatum and Scirpus cespitosus, and some high hummocks support the Calluna-Cladonia association (Table 5:3). Large areas are also occupied by a Narthecium-Scirpus cespitosus community, and hollows either with Sphagnum cuspidatum or Rhynchospora-Sphagnum tenellum association are common.

The broad valley in which the stream is running is a rich fen. The lower stream course has been cleaned and deepened in order to improve the drainage, and hereby the water level seems to have been lowered about 0.5 m. The major plant community probably was a Carex rostrata association rich in Mentha aquatica. Large areas of this community are still to be found. Wetter areas in the fen are occupied by stands of Phalaris arundinacea, Polygonum persicaria, and Hydrocotyle vulgaris in large quantities. The drier parts, on the other hand, have developed into grass meadows with mainly Agrostis tenuis and Carex panicea; these parts are now strongly influenced by grazing. In the stream itself the following plants were found: Carex rostrata, Equisetum fluviatile, Glyceria fluitans, Mentha aquatica, Myosotis palustris, Nymphaea alba, and Potamogeton natans.

Over wide areas of the steep slopes of the bog the original type of vegetation, the Calluna heath, has been invaded by either Pteridium aquilinum or Ulex europaeus, now forming very dense stands. Only at the south end of the bog where the slope is steepest some small groups of birch and Scots fir were observed. Previously the moss margins may have been more wooded. Nowadays they may remain treeless, because there are no woods in the surroundings from which trees can spread. On one spot in the valley a small specimen of Quercus robur, associated with Ilex, Hedera and Lonicera periclymenum was observed. This seems to indicate that the drier parts of the fens might also have been wooded in earlier times. This hypothesis is supported by the following profile, which was exposed at the lower course of the stream:

a) 20 cm clay,
b) 10 cm wood peat with oak wood, H = 10,  
c) 10 cm heath peat with Sphagna, H = 9,  
d) 10 cm clayey fen peat.

In 1937 another raised bog area east of Edenderry was visited. This bog was reached from the road between Brockagh and Allenwood Cross. Peat is cut along the road: the notes were made north of the peat cuttings. The area examined slopes very gently to the east and to the south, and further north also to the northwest, where a soak is running in a flat valley. The sloping border is characterized by a stagnation complex, lacking hollows, which might be described as a marginal heath complex. Calluna is dominant, and Erica tetralix is also growing abundantly, usually associated with lichens. Sphagna are very scarce, but occasionally hummocks of Sphagnum fuscum and S. imbricatum with Odontoschisma sphagni occur. Carex panicea is locally frequent, Lycopodium selago scattered.

The dome of the bog is occupied by a slowly growing regeneration complex (Scirpus tussocks dense and hard). In some of the smallest depressions evidently generally submerged, the peat is covered with algae, “Zygogonium”, etc. These depressions are invaded by Sphagnum tenellum or S. cuspidatum. The Sphagnum hollows, in which Drosera rotundifolia, liverworts, for instance Calypogeia trichomanis, Gymnocolea inflata, Lepidozia setacea, and Odontoschisma sphagni, and lichens (mainly Cladonia uncialis)
are growing along the margins, are then invaded by *Narthecium*, associated with *Sphagnum subsecundum*, *S. papillosum* and *S. plumulosum*. The result is the *Narthecium-Sphagnum papillosum* community. In such a community, besides *Narthecium*, the following species were noted: *Calluna vulgaris*, *Erica tetralix*, *Drosera rotundifolia*, *Eriophorum angustifolium*, *E. vaginatum*, *Scirpus caespitosus*, *Sphagnum magellanicum*, *S. papillosum*, *S. plumulosum* and *S. tenellum*. The hummock formation begins with *Sphagnum plumulosum*, then follows *S. magellanicum* and at last *S. rubellum*, all of them associated with *Calluna*. *Sphagnum rubellum*, the main hummock builder, is then killed, for instance by *Odontoschisma sphagni* and other liverworts, and the final stage of the progressive hummock development, the *Calluna-Cladonia* heath, is reached. The hummocks rise to a height of about one foot. The low lying parts of the old hummocks are apparently often invaded by *Narthecium*, thus starting new depression communities. The thin bottom layer of such areas contains for instance *Dicranella curviculata*, *Odontoschisma sphagni*, *Pleurozium schreberi*, *Rhacomitrium lanuginosum*, *Sphagnum papillosum*, *S. rubellum*, *S. tenellum*, *Cladonia pyxidata*, *C. silvatica*, and *C. uncialis*. *Erica tetralix* and *Drosera rotundifolia* are, besides *Narthecium*, the most common higher plants on these areas. From this type of vegetation the *Narthecium-Sphagnum papillosum* community gradually develops, sometimes with *Narthecium-Sphagnum tenellum* association as an intermediate stage. From the observations now presented the following scheme of succession may be drawn (see next column):

The *Narthecium* communities seem to cover the main part of the area, amounting to some 50 per cent. In the wettest part of the regeneration complex *Rhynchospora alba* is sometimes growing in the hollows, generally associated with *Sphagnum tenellum*, and some *Sphagnum cespitatum* hollows are occupied by *Rhynchospora fusc a*, here at its eastern limit in Ireland. In the centre of the bog dome occasional hummocks rise two feet above the general level. The higher parts of these hummocks mainly consist of *Leucobryum glaucum*. They are covered with *Calluna-Hyphnum cupressiforme* association (Table 3: 5). The windward sides of these hummocks are rich in lichens, for instance *Cladonia floerkeana*.

**Bog south of Maryborough.**

In 1937 a short visit was made to a large, gently domed, raised bog south of Maryborough. Some soaks, marked by strips of birch wood, start in the middle of the bog and run approximately parallel from west to east. The bog margin rises considerably above the cultivated lagg on the west side. The marginal complex is very rich in *Scirpus caespitosus*. Then follows the regeneration complex, which occupies the main part of the bog. Here the hummocks and hollows are markedly elongated, and orientated at right angles to the slope, except on top of the dome. The long and narrow depressions are usually covered with *Sphagnum cespitatum*, often associated with *Eriophorum angustifolium*, *Drosera anglica*, and *Rhynchospora alba*. A sample from these depressions contained a large number of species, *i.e.* *Campylopus flexuosus*, *Cephalozia connivens*, *Cladopodiella fluitans*, *My-

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**Mosses in Ireland**

<table>
<thead>
<tr>
<th>Secondary hummocks</th>
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<td>Calluna heath communities</td>
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<tr>
<td><em>Calluna-Sphagnum rubellum</em> association</td>
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<tr>
<td><em>Calluna-Sphagnum magellanicum</em> association</td>
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<tr>
<td><em>Calluna-Sphagnum plumulosum</em> association</td>
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<tr>
<td><em>Narthecium-Sphagnum papillosum</em> association</td>
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<tr>
<td><em>Sphagnum papillosum</em> <em>Narthecium</em> association (or</td>
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<td><em>Narthecium-Sphagnum tenellum</em> association)</td>
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<tr>
<td><em>Sph. cespitatum</em> <em>Sph. tenellum</em> *Narthecium with</td>
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<tr>
<td><em>mooses and lichens</em></td>
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<tr>
<td>Submerged peat with algae</td>
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Calluna-Erica heath containing rather much Sphagnum, mainly S. plumulosum, S. magellanicum, S. rubellum, and S. tenellum, accompanied by Lepidozia setacea, Odontoschisma sphagni, and Pleurozia purpurea. The centre of the bog is a regeneration complex. The wettest hollows are occupied by Sphagnum cuspidatum, often with a thin stand of Eriophorum angustifolium and Rhynchospora alba, other wet hollows by Rhynchospora alba-Sphagnum cuspidatum (Table 10:1). These wet communities are invaded by Narthecium and Sphagnum papillosum, forming either the typical Narthecium-Sphagnum papillosum sociation or a Narthecium community with a very thin bottom layer of Sphagna (S. plumulosum and S. tenellum) and a number of liverworts, for instance, Calypogea trichomanis, Cephalozia macrostachya, C. connivens, Lepidozia setacea, Odontoschisma sphagni, and Pleurozia purpurea. Then follows the Calluna-Sphagnum rubellum sociation (Table 7:6) and finally the Calluna-Cladonia silvatica sociation (Table 5:4). In the Narthecium community the following list, rather typical of the Narthecium communities, was made:

\begin{itemize}
  \item Andromeda polifolia \quad 1
  \item Calluna vulgaris \quad 1
  \item Erica tetralix \quad 1
  \item Drosera anglica \quad 1
  \item \quad rotundifolia \quad 1
  \item Narthecium ossifragum \quad 4
  \item Eriophorum vaginatum \quad 1
  \item Rhynchospora alba \quad 1
  \item Scirpus caespitosus \quad 1
  \item Calypogea trichomanis \quad 1
  \item Cephalozia bicuspidata \quad 1
  \item \quad connivens \quad 1
  \item \quad macrostachya \quad 1
  \item Lepidozia setacea \quad 1
  \item Odontoschisma sphagni \quad 1
  \item Riccardia latifrons \quad 1
  \item Sphagnum papillosum \quad 2
  \item \quad rubellum \quad 1
  \item \quad tenellum \quad 1
\end{itemize}

According to these notes and other observations concerning the development of one com-

\begin{itemize}
  \item Athlone Bog, south of Athlone and on the west side of the Shannon. The bog was reached from the north, where the moss rises very high over the extensive marginal fen, which are now cultivated. The margin of the moss has been cut for peat, and after removal of the peat fuel, the underlying fertile fen peat has been drained and cultivated. The influence of drainage is evident in the marginal parts of the untouched moss surface. It is, however, obvious that these parts are an old marginal complex, not a regeneration complex, with

\begin{itemize}
  \item Narthecium-Phleum pratense sociation
  \item Calluna-Cladonia silvatica sociation and Calluna-Erica sociation with a poor bottom layer, largely of lichens, on a dead Sphagnum surface. Thus the succession is very similar to that on Allenwood bog.

Very large tussocks of Scirpus caespitosus are common in most not too wet communities over the whole area, but increase decidedly on the proximal parts of the dome and decrease along the soaks. The frequency of Calluna changes in the opposite way. Also on this bog the Narthecium communities occupy the major part of the area. It seems, however, as though Narthecium, accompanied by Sphagnum magellanicum and S. tenellum, varies in frequency in the same way as Scirpus. Sphagnum imbricatum occasionally forms high “secondary” hummocks, generally on top of Rhacomitrium patches of the low, ordinary hummocks. Other “secondary” hummocks, up to 18 inches high, are built of Leucobryum glaucum; they often support a cover of Pleuroziun schreberi or Hypnum cupressiforme.

The high hummocks are often infested with ants.

**Bogs in the river Shannon valley.**

In some parts of the river Shannon valley raised mosses extend over very large areas. One of these large bogs is the Athlone Bog, south of Athlone and on the west side of the Shannon.

The bog was reached from the north, where the moss rises very high over the extensive marginal fen, which are now cultivated. The margin of the moss has been cut for peat, and after removal of the peat fuel, the underlying fertile fen peat has been drained and cultivated. The influence of drainage is evident in the marginal parts of the untouched moss surface. It is, however, obvious that these parts are an old marginal complex, not a regeneration complex, with

\begin{itemize}
  \item Athlone and on the west side of the Shannon.
  \item Calluna-Erica heath containing rather much Sphagnum, mainly S. plumulosum, S. magellanicum, S. rubellum, and S. tenellum, accompanied by Lepidozia setacea, Odontoschisma sphagni, and Pleurozia purpurea. The centre of the bog is a regeneration complex. The wettest hollows are occupied by Sphagnum cuspidatum, often with a thin stand of Eriophorum angustifolium and Rhynchospora alba, other wet hollows by Rhynchospora alba-Sphagnum cuspidatum (Table 10:1). These wet communities are invaded by Narthecium and Sphagnum papillosum, forming either the typical Narthecium-Sphagnum papillosum sociation or a Narthecium community with a very thin bottom layer of Sphagna (S. plumulosum and S. tenellum) and a number of liverworts, for instance, Calypogea trichomanis, Cephalozia macrostachya, C. connivens, Lepidozia setacea, Odontoschisma sphagni, and Pleurozia purpurea. Then follows the Calluna-Sphagnum rubellum sociation (Table 7:6) and finally the Calluna-Cladonia silvatica sociation (Table 5:4). In the Narthecium community the following list, rather typical of the Narthecium communities, was made:

\begin{itemize}
  \item Andromeda polifolia \quad 1
  \item Calluna vulgaris \quad 1
  \item Erica tetralix \quad 1
  \item Drosera anglica \quad 1
  \item \quad rotundifolia \quad 1
  \item Narthecium ossifragum \quad 4
  \item Eriophorum vaginatum \quad 1
  \item Rhynchospora alba \quad 1
  \item Scirpus caespitosus \quad 1
  \item Calypogea trichomanis \quad 1
  \item Cephalozia bicuspidata \quad 1
  \item \quad connivens \quad 1
  \item \quad macrostachya \quad 1
  \item Lepidozia setacea \quad 1
  \item Odontoschisma sphagni \quad 1
  \item Riccardia latifrons \quad 1
  \item Sphagnum papillosum \quad 2
  \item \quad rubellum \quad 1
  \item \quad tenellum \quad 1
\end{itemize}

According to these notes and other observations concerning the development of one com-
18. Edenderry Bog, eastern margin with a conspicuous rise from the broad lagg left in the near background. Cf. p. 36.
August 17, 1935. H. O.

July 2, 1937. H. O.

20. Swallow hole in Athlone Bog with Crataegus, Osmunda, Pietis etc. Dr. Godwin, standing at the bottom of the hole, is stretching his right arm straight up. His hand can be seen just right of the centre. Cf. p. 41.
August 15, 1935. H. O.
21. *Sphagnum* pool at the beginning of the soak through Edenderry bog.

22. The first big pool with open water in the soak through Edenderry bog.

23. The same pool as in the previous picture (22), showing the large *Juncus* tussocks.

24. Large *Juncus effusus* tussocks in the same pool as in 22 and 23.

25. Rather flat and dry part of the soak through Edenderry bog. In the background the stripe of birch wood along the stream (gallery woods).


27. Blanket bog at the sources of Liffey, Wicklow mountains. Wind-erosion has started just above a hollow in the slope facing prevailing wind direction. Cf. p. 46. August 18, 1935. H. O.

28. Strongly eroded blanket bog at the sources of Liffey, Wicklow mountains, with large hummocks capped with *Rhacomitrium*. Cf. p. 46. August 18, 1935. H. O.
   July 7, 1937. H. O.

   August 10, 1935. H. O.
munity into another the following scheme of succession was drawn:

- Calluna-Cladonia association
- Calluna- Sphagnum rubellum association
- Narthecium- (Sphagnum papillosum) association
- Sphagnum papillosum
- Rhynchospora alba - Sphagnum cuspidatum association
- (Eriophorum angustifolium - Sphagnum cuspidatum association

This succession is similar to that in the Alienwood bog.

From the centre of the bog a drain, marked by a series of swallow holes, mostly overgrown however, runs to the north. The soak is surrounded by a marginal complex richer in Scirpus caespitosus than other parts of the bog. The first sign of the soak is an oblong depression with Carex-Sphagnum communities, some 20 m long and about 5 m broad. The transition from the marginal complex is a zone dominated by Calluna, then follows a Scirpus caespitosus community rich in Molinia. The central area is occupied mainly by a Carex rostrata - Sphagnum papillosum association containing i. a. Cardamine pratensis, Menyanthes trifoliata, Potentilla erecta, and P. palustris, and further by Eriophorum angustifolium and E. vaginatum communities, rich in Sphagna. In the continuation of this depression the course of the water is indicated by Scirpus caespitosus communities rich in Molinia and with a bottom layer of Sphagnum magellanicum, S. imbricatum, S. rubellum, and S. papillosum. Some distance further down is the next depression. Here the vegetation differs much more from the ordinary moss surface than that in the first one. The upper part is a small area with Eriophorum angustifolium - Sphagnum cuspidatum and - S. papillosum communities, with Menyanthes, Molinia and Hydrocotyle vulgaris and further Aulacomnium palustre, Calliergon stramineum, and Sphagnum subsecundum. Then follows a narrow strip dominated by Calluna and then a dense thicket of Ulex europaeus, with an edging of grass communities, dominated by Molinia. Here Orchis traunsteineri was observed. A bit further down is a magnificent swallow hole, at least 3 m deep and marked by a large Crataegus monogyna shrub and a thicket of Rubus fruticosus (agg.). The hole is surrounded by dense stands of Pteridium, Myrica and Molinia, with only the last-named at the lower edge. In the hole itself a splendid, large Osmunda regalis is growing. A layer of Mnium hornum and Eurychnium praelongum covers the peat in the lower part of the hole. Below this swallow hole, which is the largest and richest one, there are at least four similar holes, all of them characterized by luxuriant Osmunda and two of them also by Rubus and Pteridium (see Fig. 8). All these swallow holes are deep, and their walls are nearly perpendicular; the upper edge of the holes as well as the moss surface between them is level with the neighbouring parts of the moss. The lower part of this interesting drainage system was unfortunately destroyed through peat cutting.

In the regeneration complex, 1/4 mile from the edge of the bog a boring was made. The profile, already published in detail by TANSLEY (1939), was shortly as follows:

- a) 4.55 m Sphagnum peat (mainly S. papillosum, S. rubellum and S. cuspidatum) with varying humification, $H = 2-8$ (regeneration cycles), and in some layers mixed with Narthecium (Narthecium-Sphagnum peat) and Eriophorum angustifolium, in others with Calluna and E. vaginatum:
- b) 3.20 m fen peat, mainly Carex peat with Cladium and Phragmites, but also some layers with Cladium peat and Phragmites peat, in the lower part muddy, $H = 5-8$.
- c) 0.05 m yellow fine-detritus nekron-mud with Phragmites and chalk.
- d) 1.80 m cream coloured calcareous mud, in the lower part obviously clayey. Bluish gray clay.
The stratification shows that the moss has been formed on a fen, which probably had a large extension along the river Shannon. The upper part of the profile reveals several regeneration cycles. The *Narthecium-Sphagnum* peat only occurs in the top of the profile and the dominance of *Narthecium* in the vegetation seems to be a comparatively recent phenomenon.

Some miles north of Athlone another large raised moss in the Shannon valley 3 miles n.-w. of Lanesborough was visited in 1937. Because of pouring rain only a list of the most important plants of the dome and a scheme of the succession was made. Special attention was, however, paid to the retrogressive stages in the regeneration. The bog was largely burnt over, and there was some difficulty in finding an unburnt area.

The rather high hummocks and the shallow depressions of the regeneration complex are not evidently orientated. The open "*Zygogonium*" pools are as in the previous bogs invaded by *Sphagnum cuspidatum*, associated with *Eriophorum angustifolium*, *Rhynchospora alba* or *R. fusca*. The sequence of plant communities then follows the same scheme as in the previous bogs. The *Sphagnum rubellum* hummocks attain a height of 1—2 feet. On the highest *Polytrichum strictum* and *Empetrum nigrum* sometimes occur. Some plants more common on the bogs further west were observed here. These are *Sphagnum subsecundum*, *Pleurozia purpurea* and *Campylopus atrovirens*.

Among the plants observed in the regeneration complex the following may be mentioned: *Menyanthes trifoliata* (in pools), *Orchis maculata*, (occasional), *Carex panicea*, *Campylopus flexuosus*, *Cephalozia connivens*, *C. macrostachya*, *Diplophyllum albicans*, *Cornicularia aculeata*, *Cladonia crispa* var. *virgata*, *Cladonia squamosa*, *C. floerkeana*, and *C. pyxidata*.

The following scheme of succession, where only the bottom layer is considered, was drawn from the observations made:

![Succession diagram](image-url)
The succession on the dead heath surface has not been studied in detail earlier. On the Irish excursion Miss Fearnsides (Mrs Bulman) called attention to the rôle of Sphagnum tenellum in the final stages of retrogression.

**Bog west of Castlerae.**

West of the Shannon valley raised or flat mires occur at least to Claremorris. These bogs are obviously domed, but as no undisturbed margin was observed it is impossible to assign the type of bog exactly.

About 3 miles west of Castlerae, Co Roscommon, an extensive bog complex, intersected by soaks, was examined. The surface is smooth and distinct hummocks are very rare, but here and there the surface is broken by small hollows, arranged at right angles to the slope. The vegetation of the smooth surface may be regarded as a uniform plant community, the Calluna-(Narthecium-)Sphagnum sociation (Table 7: 11). There may be a degree of what might be called “micregoreneration” within this community. The Sphagnum species and the other mosses are not irregularly mixed, but in one small patch one species dominates, in others different species. These changes in the bottom layer do not, however, seem to be related to any changes in the field layer. Occasionally large hummocks of Calluna-Rhacomitrium sociation are found.

**Bog 4 miles east of Claremorris.**

This is a slightly raised, evidently convex, bog of much the same type as the last one. The surface is smooth, hummocks and hollows being in the main very indistinct, so that different plant communities can hardly be distinguished. As in the previous bog the surface is dominated by the Calluna-(Narthecium-)Sphagnum sociation (Table 7: 12) with a rather poor bottom layer. Some small, distinct pools with Sphagnum cuspidatum, associated with Menyanthes and Rhynchospora alba, occur here and there, and a few large hummocks are scattered over the surface. These are mostly built of Sphagnum rubellum, S. imbricatum or Leucobryum glaucum. The highest ones are often overgrown by Polytrichum strictum, Hypnum cupressiforme and Pleurozium schreberi.

**Bog west of New Inn.**

Bogs similar to those just described also occur in the region between Athlone and Galway. One of these, a fairly large and obviously domed bog, about 24 miles east of Galway was briefly visited in 1935. Peat has been cut in the northern part along the road. The surface is smooth and the vegetation is a fairly uniform Calluna-(Narthecium-)Sphagnum sociation, very much the same as in the bog east of Claremorris, but with more, often dominant Scirpus caespitosus and in wetter places Rhynchospora alba. In the bottom layer the following species were found: Campylolpus atrovirens, Cephalozia macrostachya, Hypnum cupressiforme v. ericetorum, Lepidozia setacea, Odontoschisma sphagni, Pleurozia purpurea, Pleurozium schreberi, Sphagnum cuspidatum, S. nemoreum, S. papillosum, S. plumulosum, S. rubellum, S. subsecundum, S. tenellum, and on drier places Cladonia rangiformis and C. crispa var. cetrariaeformis. Small hummocks with Calluna- Sphagnum rubellum sociation and some higher ones formed by Leucobryum glaucum were scattered over the bog. Along peat cuttings Blechnum spicant was growing abundantly, and some Osmunda regalis also occurred.

**Bogs along the Owenreagh River near Derrilea.**

On both sides of the river Owenreagh a series of slightly raised bog domes is situated, continuing in the bottom of the glaciated valley the soligenous mires of the valley slopes. The bog area is drained by small streams between the domes. With regard to the vegetation these extremely oceanic raised mires differ considerably from the bogs previously described. The central part of the dome has an uniform vegetation with indistinct hummocks and hollows. The plant community may be referred to as a Myrica-Molinia-Sphagnum sociation, of which the following note was made:
The sloping margins of these bogs are somewhat drier than the centre and poorer in Sphagna. Otherwise the plant community is very much the same. The following species, however, not observed on the central part, were found here: Galium hercynicum, Orchis maculata, Viola palustris, Carex echinata, C. panicea, Deschampsia flexuosa, Holcus lanatus, Juncus articulatus, J. effusus, J. squarrosus, Rhytidiadelphus loreus, Aulacomnium palustre. These marginal parts may to some extent be influenced by the water in the river. It should, however, be emphasized that although the rainfall had been extremely large during the days preceding our visit to this bog — it was for instance impossible to pass the road bridge across the river — the bog-margin rose about 2 m above the river level.

The vegetation in the soaks is dominated either by Carex limosa (in the wetter parts) or Molinia and the bottom layer is composed of Sphagnum cuspidatum, S. papillosum and S. inundatum. In addition the following species occur: Menyanthes trifoliata, Orchis trau石家er, Ranunculus sp., Veronica sp., Carex fusa, C. diandra, Eriophorum angustifolium, Potamogeton polygonifolius, Utricularia intermedia, Campylium stellatum and Sphagnum contortum. At the boundary between soak and moss margin there is usually a strip of pure Sphagnum papillosum.

The vegetation of the soligenous slope above the raised bog consisted of the same higher plants as those in the bog communities, but the bottom layer was different. A sample collected in a rather typical area contained the following species: Breutelia chrysocoma, Calliergon stramineum, Calypogeia trichomanis, Campylium stellatum, Pleurozia purpurea, Scorpidium scorpioides, and Sphagnum subsecundum.

**Blanket mosses**

Blanket mosses occupy large areas in Ireland. In the major part of the country they are confined to the mountains, but in the extreme West they occur also at low altitudes.

**Blanket mosses in the Wicklow mountains.**

In the magnificent unwooded Wicklow mountains the different vegetational regions are clearly demonstrated in a beautiful display of autumn colours: in the bottom of the valley the bright green or yellowish cultivated fields with their white cottages, higher up the dull green of the pastures with large patches of the dark green Ulex gallii, shining with yellow flowers, and smaller patches of the bright
Mosses in Ireland

purplish-red *Erica cinerea*; then follows the softer purple of the *Calluna* heath, here and there broken of the dark green areas of *Pteridium*, which, on the well-drained slopes, is the dominant plant; still higher lie the extensive areas of dull yellow *Scirpus caespitosus* moss and grey *Rhacomitrium* heath, and above all these regions the windblown tops with irregular white stripes of bare mineral soil in the cap of black eroded peat.

The district round the Sources of the Liffey was visited in 1935 and 1937, and here most of the observations from the Wicklow mountains were made. From this district, where the blanket bogs occupy the land above 1,800 feet (600 m) *PETHYBRIDGE* and *PRAEGER* have described large areas of smooth *Scirpus* mosses. As a matter of fact areas where *Scirpus caespitosus* is really dominant do not seem to be very extensive. On the major part *Calluna* seems to be dominant in the field layer. Nevertheless *Scirpus*, being common in all communities, not too wet, and slightly higher than *Calluna*, sets the character of the moss surface, and its dull green colour dominates the landscape.

As a rule the moss areas are smooth on the sloping hillsides, and richer in hollows and hummocks on the more or less horizontal plateaus, which of course are less drained. On the latter areas the vegetation is rather similar to that of the domes of the raised mosses, *i.e.*, a complex of pools, *Sphagnum* hollows, *Scirpus caespitosus* communities (Table 8:18), rich in *Narthecium*, *Calluna-Cladonia* and *Calluna-Sphagnum* communities etc., all of them connected in the following scheme of succession (see next column):

On the steeper slopes, 5°—8°, the surface is smooth, distinct hummocks and hollows being rather scarce; the plant communities are, however, largely the same and usually very rich in *Scirpus*, as will be seen from the notes from the *Calluna-Cladonia* sociation (Table 5:5 and 6). Sometimes one or two communities occupy large parts of the slopes, in other cases they are combined to form a complex. For instance, in the areas of *Calluna-Cladonia* sociation some wetter and lower parts are dominated by *Narthecium* and *Sphagnum plumulosum*, and occasionally high hummocks of *Rhacomitrium* or *Leucobryum* or both of them rise over the smooth surface. These hummocks are often wind-eroded, and in such cases *Rhacomitrium* is growing on the windward side, *Leucobryum* on the lee side. Dry slopes are occupied by a complex of *Calluna-Rhacomitrium* sociation and some *Calluna-Sphagnum rubellum* sociation. Small areas are also occupied by *Scirpus* sociation, *Scirpus-Odontoschisma* sociation with a dense bottom layer of *Odontoschisma sphagni*, and by *Scirpus-Sphagnum tenellum* sociation with some *Campylopus atrovirens*. The pools on the more or less horizontal plateaus are often filled with submerged mosses, *i.e.*, *Drepanocladus fluitans, Cladopodiella fluitans, Cephalozia bicuspidata, Sphagnum cuspidatum, S. inundatum* etc. They are then invaded by *Sphagnum apiculatum, S. papillosum, S. plumulosum, and S. tenellum*, accompanied by *Odontoschisma sphagni* and *Rhacomitrium*, (in such a hollow on the top plateau *Mylia taylorii* and *Calypogeia trichomanis* were collected) and, later, by *S. rubellum*, resulting in the *Calluna-Sphagnum rubellum* sociation. In a sample from

---

Wind erosion

- *Rhacomitrium*
  - *Calluna-Rhacomitrium* sociation
    - *Leucobryum*
  - *Calluna-Cladonia* sociation
    - *Calluna-Sphagnum rubellum* sociation
    - *(Scirpus-Calluna-Sphagnum plumulosum* sociation
    - *(Scirpus-)* *Sphagnum papillosum* sociation
  - *Scirpus-Sphagnum* sociation
    - *Sphagnum cuspidatum, tenellum* sociation
    - *S. inundatum, etc.*
  - *Water*
On the highest peaks of the mountains the wind erosion is apparently very strong. The still remaining hags of black peat on the hilltops indicate that also these tops have once been totally covered with peat.

The retrogressive stages of bog development form a rather striking break in the monotony of the blanket bog. Other breaks are the areas where the soligenous influence produces a different type of vegetation. Such an area, situated on a gentle slope below a steeper hillside, where the peat is cut by an erosion channel, was visited in 1937. Here the dominant plant community is the Carex rostrata - Sphagnum apiculatum association, the composition of which is illustrated by the following note:

<table>
<thead>
<tr>
<th>Species</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Andromeda polifolia</td>
<td>1-</td>
</tr>
<tr>
<td>Empetrum nigrum</td>
<td>1-</td>
</tr>
<tr>
<td>Calluna vulgaris</td>
<td>1-</td>
</tr>
<tr>
<td>Orchis maculata</td>
<td>1</td>
</tr>
<tr>
<td>Potentilla erecta</td>
<td>1</td>
</tr>
<tr>
<td>Carex canescens</td>
<td>1</td>
</tr>
<tr>
<td>» rostrata</td>
<td>4</td>
</tr>
<tr>
<td>Eriophorum angustifolium</td>
<td>1</td>
</tr>
<tr>
<td>» vaginatum</td>
<td>1</td>
</tr>
<tr>
<td>Luzula congesta</td>
<td>1</td>
</tr>
<tr>
<td>Polytrichum commune</td>
<td>1</td>
</tr>
<tr>
<td>Aulacomnium palustre</td>
<td>1</td>
</tr>
<tr>
<td>Sphagnum apiculatum</td>
<td>5</td>
</tr>
</tbody>
</table>

In the upper part of this soligenous fen is a pool with much Juncus effusus, marginally invaded by Sphagnum apiculatum and Carex canescens; here Rumex acetosa and Deschampsia flexuosa were found. The fen is fed by a number of small streams from the hillside; one of these seems to be an erosion channel, which has brought gravel into the peat, another one an overgrown stream, now marked by a number of swallow holes surrounded by heath, rich in Molinia and Vaccinium uliginosum. In the upper margin of the fen, close to the boundary between this and the hillside, are some large swallow holes, at the time for our visit totally dry. A schematic sketch of this soligenous area is drawn in Fig. 10.
Mosses in Ireland

Bogs in the Slievefelim mountains.

The Slievefelim mountains rise to a height of about 1,700 feet. This mountain district was entered from the north, west of Cooneen Hill, and from Curreeny Commons the hillside up to about 1,300 feet was climbed. Most of the region above 1,200 feet is covered with blanket moss. The lower parts of the moss areas are largely cut for peat. The dominant plant community is *Scirpus caespitosus* association, where *Calluna* has been reduced through repeated burning. In the note (Table 8: 13), which was made on a local peak near the summit of Knockfune (1,280 feet), the effect and signs of burning were less obvious than on the rest of the moss area examined. On the top plateau the *Sphagna* look rather poor, but on the gentle, lower slopes they are growing vigorously, *S. papillosum* usually being the dominant and *S. plumulosum* and *S. rubellum* forming low hummocks. Steeper slopes apparently have a rather thin peat layer supporting a wet *Calluna* heath. On the summit plateau is a small pool surrounded by a fairly rich vegetation of *Anthoxanthum odoratum*, *Carex echinata*, *C. juncella* (?), *Molinia coerulea*, *Aulacomnium palustre*, and *Rhytidiadelphus loreus*. To judge from the profiles exposed in peat cuts, the peat is very dense and black and highly decomposed. No wood stools occur in the bottom layer.

From Curreeny Commons we proceeded south and west to Limerick. The valley south of Mauherslieve is covered with large moss areas extending over the gently sloping hillsides and the nearly horizontal bottom of the valley. Occasionally these more or less horizontal areas are dome shaped like raised mosses, but the domes do not seem to be surrounded by laggs.

Bogs on the Slievanea mountain.

One of the highest mountains in the south-west of Ireland and one most exposed to the south-western wind is Slievanea on the Dingle peninsula. It rises to 2,026 feet. Below 1,200—1,400 feet the slopes are too steep to be peat covered, but above this altitude there is a uni-

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**Fig. 10.** Sketch illustrating the vegetation of a soligenous fen in the blanket bog, Wicklow mountains. Legend: 1 = *Carex rostrata- Sphagnum apiculatum* association; 2 = Swallow hole; 3 = *Juncus effusus*, 4 = *Carex canescens*; 5 = *Sphagnum apiculatum*; 6 = Gravel.
reliable evidence of a complete peat cover 1—1.5 m thick over all physiognomic features of lower gradient.

Above 1,600 feet wind erosion, initiated from the western side, is serious. Over large areas of the highest parts of the top plateau (e. 2,000 feet) the peat has been almost totally removed. It is no longer an erosion complex with hummocks separated by deep channels, but a bare mineral ground, totally lacking vegetation, dotted with large, scattered peat hags. Along streams on lower parts of the top plateau water erosion is added to the wind erosion. The result is an erosion complex of the ordinary type. Such a complex was examined on the slope facing south. The erosion channels are cut down to the mineral soil, leaving large stack hummocks between them. On these the major plant community is the Calluna-Rhaacomitrium association with Juncus squarrosus invading the highest parts (Table 6: 6). Lower and wetter parts are occupied by Sphagna, for instance S. apiculatum, S. cuspidatum, S. nemoreum, S. papillosum, S. rubellum, and S. tenellum, and further by Carex echinata, Hylocomium proliferum, Metzgeria furcata, and Pleurozium schreberi. The secondary retrogression flushes are mainly occupied by the Eriophorum angustifolium - Sphagnum papillosum association. On the mineral ground of the erosion channels Sphagnum subsecundum and a greenish variety of S. plumulosum seem to be common.

In a slightly eroded area at about 1,800 feet was a pool with a quite different type of vegetation. The following species were noted: Viola palustris, Carex fusca, Luzula silvatica, Festuca rubra, Rhytidiadephus loreus, Sphagnum imundatum, and S. subsecundum.

**Bogs in Connemara and Mayo.**

In Connemara and some parts of Mayo the peat mosses are more prevalent than in any other part of Ireland. The peat appears to grow everywhere, usually however, at low altitudes, as the higher parts of the mountains generally are too steep and rough to allow any peat formation. But at low altitudes flat areas and gently sloping hillsides [up to 8°] are covered with peat, which on steeper slopes gradually changes into a thick humus layer on the mineral soil. This west Irish blanket moss type differs from all other blanket mosses in Ireland through the general occurrence of Schoenus nigricans.

On nearly horizontal ground these blanket mosses often have ombrogenous domes. Such a bog was examined in 1937 two miles west of Screeb near sea level. Here the dome, slightly inclined to the south-east and eroded by the sea is pierced by two islands of moraine (granite blocks). The whole bog is covered with a fairly uniform Schoenus community (Table 9: 2). The slight unevenness in the surface is connected with some differences in the composition of the bottom layer. There may also be a regeneration cycle, connecting the small patches of different mosses, for instance:

```
Sphagnum imbricatum + Leucobryum + Rhaacomitrium + Pleurozium

<table>
<thead>
<tr>
<th>Cladonia silvatica + C. uncialis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sphagnum rubellum + Rhaacomitrium</td>
</tr>
<tr>
<td>Sphagnum papillosum + S. magellanicum + S. imbricatum</td>
</tr>
<tr>
<td>Dicranum + Campylopus + Sphagnum plumulosum</td>
</tr>
<tr>
<td>Sphagnum cuspidatum + S. subsecundum + Pleurozia</td>
</tr>
</tbody>
</table>
```

These different bottom layers form, however, a mosaic of very small patches and there are no parallel changes in the field layer, except that Narthecium and Drosera intermedia seem to increase on the wettest spots. Small, conspicuous hummocks formed mainly of Sphagnum imbricatum, but also of S. rubellum are spread over the whole area. The highest hummocks are invaded by Rhaacomitrium, Calluna and Molinia. One very large Sphagnum fuscesc hummock, 18 inches high, was found near the margin of the bog. In the centre there is a
row of inconspicuous pools, perhaps the last remains of an overgrown soak, which contain Menyanthes, Sphagnum crassicladum, S. cuspidatum, and S. subsecundum. Pl. 12.

In the neighbourhood of Roundstone the topography is more broken, and consequently the peat lands less extensive. The area about 5 km north of Roundstone, however, is occupied by the large Craiga More Lough moss. This is a typical blanket moss without any signs of lags, although some horizontal areas have a low dome, like the raised mosses. The major plant community might be called Eriophorum vaginatum - Schoenus nigricans (- Sphagnum subsecundum) association. (Table 9: 7). Very often Campylopus atrovirens and Dicranum scoparium, or one of these, are dominant in the bottom layer, (Table 9: 9). Here and there Rhynchospora alba is dominant in the field layer forming a Rhynchospora-Sphagnum association. (Table 10: 3.) Over the smooth surface of these communities some low Sphagnum hummocks rise. They are usually covered with Calluna-Sphagnum (rubellum-)magellanicum association. (Table 7: 5.) Other, still smaller hummocks are formed by Molinia and Schoenus, associated with Sphagnum plumulosum. As a characteristic feature the low frequency of Sphagnum may be emphasized. A fairly large percentage of the area, is covered only by a thin film of algae. Scattered over the surface are very shallow depressions, usually covered with a coating of algae, and sometimes filled with Sphagnum cuspidatum and S. subsecundum; some of them have a thin stand of Carex limosa, and others, on the wettest part of the moss, are occupied by Utricularia intermedia and Potamogeton polygonifolius.

On dry slopes Molinia becomes fairly frequent, and then the moss changes without any sharp boundary line into Molinia heath on thick humus or grass peat.

On slopes, where there is a soligenous influence, the Scirpus caespitosus -Molinia- Sphagnum papillosum sociation develops (Table 8: 14) on a thin layer of well decomposed peat. Cladium, Phragmites, and Carex lasiocarpa sometimes occur in places where they cannot be relicts from overgrown lakes. As they are usually growing below steep slopes their presence may be explained as due to soligenous influence.

On a relatively high part of the moss a small pool with water lilies occurs; here a soak originates, the course of which is indicated by a number of shallow pools and a few swallow holes. The first pool has a thin stand of Menyanthes and Eriocaulon septangular. In addition to these two species, Nymphaea alba and Carex limosa grow in the other pools. In the swallow holes Molinia is abundant. The same grass covers the slopes along the lowest part of the soak, and at the place where the soak flows into the lake there is a thin stand of Cladium mariscus. Along the lower shore of the pools there is always a high hummock of Sphagnum rubellum or S. imbricatum. Close to one of the pools the moss area had become well drained and the hummock supported a dry Erica tetralix - Cladonia silvatica heath (Table 5: 8). See Fig. 11.

North of the area now referred to, a small lake, totally enclosed by the bog, was examined. Here the vegetation of the moss is more variable, thick mats of Rhynchospora-Sphagnum papillosum sociation and distinct hummocks of Calluna-Sphagnum magellanicum sociation being spread over the smooth surface of Eriophorum vaginatum - Schoenus nigricans - Sphagnum subsecundum sociation.

The bottom layer of the Rhynchospora community was rather rich, and a sample contained the following species: Calygogeta trichomanis, Campylopus atrovirens, Cephalozia bicuspilata, C. connivens, C. macrostachya, Cladopodiella fluittans, Hypnum cupressiforme v. ericetorum, Lepidozia setacea, Odontoschisma sphagni, Riccardia latifrons, Sphagnum cuspidatum, S. magellanicum, S. papillosum, S. plumulosum, S. rubellum, S. subsecundum, and S. tenellum.

At the shore there is an edging of Scorpidium scorpioides (in the transition between the Sphagnum mat and Scorpidium, Aulacomnium palustre and Stigonema ocellatum occurred), then follows a zone with Phragmites, in the outer part mixed with and then replaced by Scirpus lacustris, which in its turn is followed by Nymphaea alba.
31. The blanket bog at Sheskin Lodge. — Prof. A. G. Tansley and Dr. H. Godwin.

32. Winding hollows in the blanket bog at Sheskin Lodge.

33. High *Rhacomitrium* hummocks on the blanket bog north of Sheskin Lodge. The hummock to the right wind-eroded. — Prof. A. G. Tansley.

34. The first stage of wind erosion in a *Culnuma-Cladonia silvatia* hummock rich in *Carex paniculata*.

36. Blanket bog south-west of Glencullin Upper. The dark area in the middle of the background (a slope facing the camera) is the bogburst. Cf. p. 55.
August 13, 1935. H. O.

37. The bottom of the drained Lough Boleynagee south-west of Glencullin Upper. The white spots are pine stumps on wood peat upon lake mud. In the far end a small area with open water. Cf. p. 55.
August 13, 1935. H. O.

38. The bog-burst in the blanket bog south-west of Glencullin Upper, looking uphill. Crescentic crevasses with sheets (or blocks) of lowered peat fallen c. 5 ft. Cf. p. 55.
August 13, 1935. HARRY GODWIN.
August 10, 1935. H. O.

August 13, 1935. HARRY GODWIN.
41. One of the nice places where we (A. G. Tansley, Harry Godwin and the author) had our picnic lunch during the excursion in 1935. A few miles north of Clifden, Connemara. The steep slope of the hill is covered with a dense copse of oak and in the foreground the beautiful *Phormium tenax* is growing on boggy ground.

August 12, 1935. H. O.
row of inconspicuous pools, perhaps the last remains of an overgrown soak, which contain Menyanthes, Sphagnum crassiscadum, S. cuspidatum, and S. subsecundum. Pl 12.

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Lobelia, Eriocaulon, and in some places Schoenus are growing below Phragmites.

In the numerous small lakes, totally surrounded by bog, a unique society of species occurs, i.e. Lobelia dortmanna, Nymphaea alba, Eriocaulon septangulare, Cladium mariscus, Phragmites communis, and Schoenus nigricans. Along the shores of some of the lakes Erica mackayi is abundant.

The stratification of the peat was studied in a bog immediately north of Roundstone, where the peat is being eroded by the sea; the surface vegetation is a grass meadow, and Fucus vesiculosus is growing on the eroded peat. The boring was made by Prof. JESSEN, of Copenhagen, in company with Dr. JONASSEN, of Copenhagen, and Mr. MITCHELL, of Dublin. The top layer to about one m depth is an Eriophorum-Molinia peat, in the upper part black, in the lower part brown, apparently compressed because of good drainage. Then follows two or three dm wood peat with stools of Pinus in the upper part and shrubs and birch further down: the lower part of this layer contains charcoal. Then follows black Phragmites peat, and then a thick layer of lake mud down to 5 m below low tide. The pine stools, forming a distinct stool layer 0,5 m below high tide, indicate a subsidence of the land. On the other hand it is not unlikely that the sudden change from Phragmites to wood peat is the result of a land elevation possibly contemporaneous with a change of climate.

Stumps of pine can be observed practically everywhere in the vicinity of Roundstone near the bottom of the peat, and according to JESSEN they are usually of subboreal age. If this be the case, the major part of the extensive moss areas must, I think, have been formed during the subatlantic period. This would be in coincidence with recent views on the general increase of peat growth in subatlantic times throughout Britain.

Some miles north of Clifden at Streamstown, a bog, covering a rather steep slope from the top to the bottom, was examined. The upper part of the bog is fairly dry and covered with an Erica heath, very rich in Molinia (Table 4:6). The lower part is considerably wetter, the vege-
tation being an *Eriophorum vaginatum* - *Schoenus* association (Table 9:8). At the bottom *Schoenus* becomes more vigorous and dominant. Here *Phragmites* also appears. Some low hummocks (*Sphagnum magellanicum, S. plumulosum, and S. imbricatum*) rise above the smooth surface; they support a vegetation similar to that of the top. Larger hummocks, built of *Rhacomitrium* or of *Sphagnum imbricatum* with *Rhacomitrium* on the top, attain a height of $1\frac{1}{2}$—2 feet. Hollows, at right angles to the slope and dammed by dry hummocks, occur in the lower part. They are occupied by the *Eriophorum angustifolium - Sphagnum apiculatum* community, bordered by *Sphagnum compactum* and *S. subsecundum*.

In the district north of Palmore the bogs are characterized by high *Rhacomitrium* hummocks scattered over the surface. Eroded peat is to be found on gentle slopes up to an altitude of about 1,000 feet.

In the vicinity of Westport bogs are rare, but northwest of this place bogs extend over immense areas. They cover the plains as well as gentle slopes (up to $10^\circ$) and the tops of the low hills, forming a continuous cover or blanket over the rolling mineral ground. The lower mountain slopes are covered with peat, which on high altitudes is continued by grass heaths.

In the district of Bangor very large bogs cover the plains and hillsides with slopes of less than $5^\circ$. The *Sphagnum* layer is usually best developed on fairly horizontal areas, while it is often totally lacking on the slopes. Regeneration, in the original sense of this word is lacking, but hummocks of varying size are scattered over the bog. The vegetation in this region was studied in detail on both sides of a small stream, south west of Glencullin Upper.

Somewhat below Lough Boileynagee the smooth bog surface slopes at about $5^\circ$; the vegetation is dominated by the *Schoenus nigricans* association (Table 9:1); some wet parts are occupied by the *Schoenus-Eriophorum vaginatum - Sphagnum cuspidatum* association (Table 9:6). The dominant community of the high hummocks, usually about two feet high, is the *Calluna vulgaris - Sphagnum rubellum* association (Table 7:7). On some hummocks this association is followed by the *Calluna-Cladonia silvatica* association; other hummocks are totally overgrown by *Rhacomitrium*.

In another part of this bog district some notes were made on the nearly flat top plateau as well as on the slope. In both cases the vegetation could be characterized as a *Schoenus* association (Table 9:3 and 5). On this fairly smooth surface the following species seem to be the most important hummock-builders: *Sphagnum imbricatum, S. plumulosum* and *S. rubellum*. The hummocks are of varying size and support different types of vegetation. Relatively low ones are covered with the *Calluna-Sphagnum rubellum* association (Table 7:8). Ordinarily the hummock formation seems to start about small tussocks of some of the sedges, usually *Schoenus. Sphagnum papillosum* and *S. plumulosum* generally form the first stage, *S. rubellum* and *Rhacomitrium* the next. Thus tiny cushions of *Calluna-Sphagnum rubellum* association are formed. When these hummocks are only some inches high the wind action begins. On the windward side all vegetation except *Rhacomitrium*...
Vegetation of British and Irish mosses

trium is killed off, but on the lee side the Calluna-
Sphagnum rubellum sociation is still growing,
with the eventual result that many hummocks
reach a height of more than one meter. One such high hummock is demonstrated in
Fig. 12. It measured 6 m in length and 5 m in
width; the top reached about 1.5 m above the
lower edge and 0.75 m above the higher edge;
the slope from the top to the lower edge was
about 20°. The top was covered with the Cal-
luna-Cladonia silvatica sociation (Table 5: 7),
which, on the windward side, was replaced by
Rhacomitrium or by Erica cinerea-Rhamomiti-
trium sociation projecting as tongues between
eroded parts of the hummock. On the lee side,
below the lichen community of the top was a
zone with Sphagnum rubellum, further down
was another zone with Calluna-Cladonia silv-
atica sociation, and, finally, the border to the
Schoenus surface was Sphagnum plumulosum
with some Leucobryum glaucum. A rather con-
spicuous feature of the bog vegetation in this
district is the dominance of Schoenus and the
scarcity of mosses on the slopes. On flat areas,
particularly the lower ones, Scirpus caespitosus
and Eriophorum vaginatum are more frequent,
the moss layer better developed than on the
slopes. The lower parts of the slopes, (i. e. the
bog margins near streams etc.) are generally
drained by small soaks along the gradient.
The tiny channels of these soaks, in which
i. a. Carex panicea and Potamogeton polygoni-
folius were observed, are very often eroded on
the windward side and to the action of wind
frequently that of running water is added.

Typical bogs develop in this district on all
slopes not steeper than 5°, and sometimes bogs
occur on much steeper slopes. North of Bangor
the steepest slope with peat attained 15°. Here,
however, the peat was shallow and in the upper
part strongly eroded. On still steeper slopes
no peat is formed, but the soil is very rich in
humus. East of Bangor the following plants
were listed on a 27° slope to the north:

Calluna vulgaris Erica tetralix
Erica cinerea Myrica gale

Salix aurita Molinia coerulea
Vaccinium myrtillus Nardus stricta
Anagallis tenella Scirpus caespitosus
Hypericum pulchrum Blechnum spicant
Osmunda regalis Dicranum scoparium
Polygala vulgaris Leucobryum glaucum
Succisa pratensis Pleurozia purpurea
Agrostis canina Pleurozium schreberi
> tenuis
Carex panicea Rhacomitrium lanuginosum
Cynosurus cristatus Thuidium tamariscinum
Deschampsia flexuosa Sphagnum rubellum
Juncus squarrosus Cladonia silvatica

Generally, Molinia is dominant, but on
ridges formed by the tread of grazing cattle
Calluna is the most prominent plant. The
slope is traversed by some wet drains, in which
the following plants were noted:

Anagallis tenella Carex panicea
Cirsium sp. Juncus bulbosus
Drosera rotundifolia Nardus stricta
Pedicularis palustris Narthecium ossifragum
Polygala vulgaris Scirpus caespitosus
Potentilla erecta Campylopus atrovirens
Ranunculus flammula Sphagnum apiculatum
Viola palustris plumulosum
Carex oederi subsecundum

The stratification of the bogs just described,
is rather simple. At a small stream the margin
of the bog was eroded in some places, revealing
the following strata:

1) At the bottom a layer of well decomposed
wood peat about 45 cm thick, the upper part
of which was obviously burnt,
2) A layer of birch peat, 15 cm thick, and
3) A well decomposed Molinia peat.

In the wood peat a very large pine stump was
found.

Between Belmullet and Bangor, peat profiles
were studied at three places. One mile S.S.E.
of Glencastle Hill, south of the road, in a
bog area sloping north the following profile
was observed in a peat cutting (Pl. 15):
a) 95 cm *Molinia- Eriophorum vaginatum* - (*Sphagnum*) peat, in the upper part $H = 3$, gradually increasing to $H = 6$ in the lower part.
b) 20 cm Carex peat with *Myrica*, $H = 8$.
c) 30 cm Carex peat with *Phragmites*, slightly muddy.

The mineral ground was sand.

The layer with *Myrica* seems to correspond to a layer of wood remains (i. a. oak (?), *Betula* and *Calluna*) 10 m further down the slope. Similar wood remains also occurred at other places in the peat cutting and always at the same level.

Somewhat east along the slope, the following profile was noted:

a) 150 cm *Eriophorum-Molinia* peat  
b) 25 cm *Molinia* peat  
c) 25 cm wood peat, $H = 10$, in the lower part obviously burnt.

A little further east a cut along a small stream revealed as similar profile with a large pine stump resting on the bottom layer of well decomposed wood-peat and covered with *Eriophorum-Molinia* peat. Still further east, along the same stream, the following profile was noted:

a) 150 cm *Eriophorum-Molinia* peat  
b) 25 cm yellow substance in the middle with a thin black layer, perhaps a burnt layer.  
c) 25 cm wood peat, in the lower part with charcoal.

At practically all places, where the stratification could be studied, on sloping hillsides as well as on flat areas, pinestools, birch and oak wood were found 1—2 m below the surface, usually near the mineral ground, indicating that this part of Ireland was once covered with woods consisting mainly of pine with some birch and oak, probably giving place later to pure birch wood. It may be supposed that this forest stage corresponds to the Bronze Age. The first bog stage seems to have been characterized by *Molinia*, and the present type of vegetation has developed gradually.

The bogs at Sheskin Lodge.

In the district of Sheskin Lodge (Co Mayo) bogs occupy the major part of the gently rolling plain. Generally *Schoenus* is dominant on the fairly horizontal areas (Table 9: 4), while *Scirpus* seems to be more important on the slopes (Table 8: 4). The lower parts of the slopes are often drained by tiny, shallow soaks in which *Narthecium* and *Carex panicea* are dominant, sometimes forming a *Narthecium-Sphagnum* sociation. The bulk of the bottom layer in this community is composed of *Sphagnum cuspidatum*, *S. papillosum*, and *S. subsecundum*, and among these *Odontoschisma sphagni* and *Diplophyllum albicans* occur. On a relatively low part of the bog the surface is broken by a number of pools of varying size. Here the *Sphagna*, mainly *S. cuspidatum* and *S. subsecundum*, are more frequent and the *Scirpus-Sphagnum subsecundum* sociation (Table 8: 9) is the major plant community. Pl. 13.

The bog areas in the vicinity of Sheskin Lodge are characterized by a richness of *Rhacomitrium* hummocks, often with *Empetrum* on the top, usually wind-eroded, and in some cases nearly broken down. The wind, however, seems unable to form hollows as in the Lewis bogs. According to Professor Morrison, tenant of Sheskin Lodge, frost in the winter is more common in this part of Ireland than in Connemara and this difference in climate may be sufficient to explain the difference in erosion between the bogs in Connemara and those further north.

The moss flora in the bottom layer of these hummocks is rather rich, and the following species were recorded: *Dicranum scoparium*, *Frullania tamarisci*, *Hypnum cupressiforme* var. *ericetorum*, *Pleurozium schreberi*, and *Scapania gracilis*. *Cladonia silvatica* also occurred on the hummocks.

The bogs, to some extent at least, are drained by subterranean streams, the course of which can be followed through a series of swallow holes. A very beautiful drainage system of this kind was examined in the bog south of the lodge.
The vegetation of these swallow holes differs distinctly from the surrounding bog. In the shallow holes, which apparently do not collect much water, the *Sphagnum* species *magellanicum*, *apiculatum*, *papillosum* and *cuspidatum* form thick and soft carpets, and together with the *Sphagna*, *Aulacomnium palustre*, *Calliergon stramineum* and *Polytrichum commune* occur. In the deep and narrow swallow holes on the other hand the moss vegetation of the steep walls is very rich, and among the *Sphagna*, *S*. *palustre* is dominant. In one of the holes the following mosses were collected: *Brachythecium rutabulum*, *Cephalozia macrostachya*, *Diplophyllum albicans*, *Eurynchium praelongum*, *Hypnum cupressiforme*, *Lepidozia trichoclados*, *Mnium hornum*, *Mylia taylorii*, *Odontoschisma sphagni*, *Pellia epiphylla*, *Plagiothecium undulatum*, *Thuidium tamariscinum*. In the same hole the following higher plants were encountered: *Lonicera periclymenum*, *Senecio aquaticus*, *Juncus effusus*, *Eriophorum angustifolium*, *Molinia*, *Blechnum spicant*, and *Dryopteris spinulosa*.

**DISCUSSION**

The retrogressive processes

In most bog types, perhaps all of them, a retrogressive stage can be distinguished. Even during constant climatic conditions it would be impossible for the bogs to grow indefinitely. The wooded raised moss will become drier and drier, but so far a retrogressive stage is not known. The same is true of the raised, treeless mosses which are formed on practically horizontal areas. But all bogs which are more or less sloping develop further. The first stage is the stagnation complex, then follows the erosion complex.

In many of the blanket mosses retrogression is rather important and mainly due to wind erosion or to the combined action of water and wind. In Lewis, for instance, hollows are formed through the wind action, and the hollows are connected through water erosion, until a system of channels has been formed. The type of this channel system depends upon the direction of the slope in relation to the direction of the prevailing eroding wind. When the drainage system has been established, the erosion appears to go on until the whole area has been broken down. This ultimate result can be studied in many places, in The Pennines, in The Wicklow mountains and on high altitudes in the south-west of Ireland. In many places extensive areas of bare mineral ground have been exposed and hardly anything remains of the peat except scattered peat hags. Wind erosion or combined wind and water erosion is common in the districts just mentioned. It also occurs on low altitudes in the north-western part of Ireland, but here it does not seem to play any important rôle. The wind erodes the hummocks to some extent, but the erosion does not seem to interfere with the growth of the smooth moss surface. In Connemara no signs of wind or water erosion could be seen — except on rather high *Rhacomitrium* hummocks — and, according to Praeger, there is no sign of such erosion on low altitudes in the west and south-west of Ireland. It seems probable, therefore, that the wind erosion requires temperatures below 0° C in order to break up the peat. No doubt the wind action is more severe when the peat is frozen, or when the wind has a “tool”, i.e. hail or snow to work with. In continental regions, the peat can be subjected to wind erosion after a long period of drought, but in the oceanic regions the peat is rarely dry enough to be eroded by the wind at temperatures above zero. Consequently rather small differences in the winter tempera-
ture may account for the differences between different districts with regard to bog retrogression.

Then the question arises, whether there is any retrogressive process in the mosses of western Ireland, and in other regions where the location is sheltered so as to prevent wind erosion. I think there is a very conspicuous retrogression, i.e. the bog burst. By means of this process large areas are suddenly removed and a more stable equilibrium reached. A few words about the bogburst, mainly according to my own observations may be added here.

The first bogburst, or rather result of a bogburst, I have seen was that of Glencullin near Bangor. This one happened about 1930 on a hillside sloping slightly more than 5° just below Lough Boyleynagee, a small lake included in the bog at the top of the slope. Because of very heavy rainfall the lake had been filled to overflowing. The result was that the peat layers in the slope were soaked with water and at last the fibrous peat could not resist the pressure but yielded, and the whole peat mass below the lake slid down in the little valley where the peat “porridge” reached an height of 5 meter above the bottom of the valley. The great disaster, that followed this bog flow, has been described by Delap, Farrington, Praeger and Smyth (1932). The original burst took place in the lower part of the slope, probably at a point where the slope changed suddenly (cf. Mitchell 1935 and 1938, Delap and Mitchell 1939), and the sliding down of large peat blocks has then proceeded upwards. In the upper part of the flow, near the lake, which is now nearly drained, where large blocks remain on a short distance from their original place, the blocks are 2—3 meter broad and 10—20 meter long (see Fig. 13). In the central and lower part the peat blocks are thrown pell-mell. On those blocks, which have the original surface upwards, Molinia has, due to the good drainage, become dominant. Juncus supinus and J. effusus seem to be the first invaders on the bare peat, the first one covers large areas. In the small stream in the middle of the broken area the following species were observed: Hydrocotyle vulgaris, Menyanthes trifoliata, Ranunculus flammula, and Carex rostrata. Pl. 14.

Another more recent bogburst, in the Wicklow Mountains, which has been described by Mitchell (1938), was visited in 1937. In this case the peat below a steep slope had been soaked with water and large peat blocks had slid down over the lower parts of the bog. This part, however, was less steep, and the bog flow never reached the bottom of the valley. The irregular topography of the surrounding parts of this blanket bog seem to indicate that at least one, perhaps several bogflows have occurred previously on this hillside.
Bogbursts and bog flows are very common in Ireland, where bogs develop on rather steep slopes. They may be interpreted as a kind of retrogression, typical of districts where eroding agents are less active. Also in raised mosses where an erosion complex has not developed bog bursts have been observed.

Some characteristic features of the bogs of the British Islands as compared with the Scandinavian

The most striking difference between Scandinavia and the British Islands with regard to the bog type is the great rôle played by the blanket bogs in Great Britain and Ireland. Whilst in south Sweden nearly all bogs belong to the raised type, and in east Sweden a great number to the wooded raised moss, these types are poorly, or not at all, represented in England and Scotland, and only on the Central plain of Ireland the treeless raised moss occupies large areas.

But also within the raised bog type a multitude of differences or changes from East to West can be observed. The general topography of the raised bogs on the British Islands is about the same as that of the bogs in western Sweden, although the rising of the margin in the proximal parts the bogs becomes less marked towards the west. In the distal parts the rising can be very marked and the slope very steep. The topography of the regeneration complex of the English and Scottish raised bogs is very similar to that of Swedish bogs but already in the East of the Irish Central plain the hummocks and depressions become less pronounced — a fact to which Mrs. Bulman first called attention — and further west this complex is replaced by a rather uniform type of vegetation, in which only occasional deep, wet depressions and high, dry hummocks occur. This gradual change from East to West is probably caused by differences in the winter temperature, since the formation of an undulating surface seems to depend mainly upon frost action.

A great change also takes place in the vegetation and flora. In the lagg, for instance, as in the soaks, *Molinia coerulea* in Sweden is of minor importance, while in Great Britain and Ireland it is a typical, often dominant, component in many communities, and, finally, in the West of Ireland, this grass is also prominent on the bog surface itself, together with *Myrica gale* which, on Swedish raised bogs, is restricted to lags and soaks: In Great Britain and Ireland the sloping margins of the mosses are never wooded, but on the other hand they are, in Ireland, largely invaded by *Pteridium* and *Ulex europaeus*. This may, however, be a rather recent occurrence. The dominant plant community generally is *Calluna* heath. The marginal complex of the more or less horizontal bog surface is in Ireland dominated by *Erica-Cladonia* and *Scirpus caespitosus-Sphagnum* communities. Very often *Calluna-Erica-Sphagnum* communities rich in *Scirpus caespitosus* play a prominent rôle.

On English as in West Scandinavian bogs *Sphagnum magellanicum* and *S. rubellum* are the most important *Sphagna* in the regeneration complex, where *Calluna-Sphagnum* communities cover the main part of the area and *S. fuscum* dominant in the east of Sweden, is rare. Further west those two species, *S. magellanicum* and *S. rubellum*, become less prominent, and *S. plumulosum* and *S. papillosum* increase. On the whole, however, the *Sphagnum* carpet in the west is thinner and looser than in the east. The *Narthecium* communities, which are never found on raised bogs in Sweden, except in soaks and along streams in the west of Sweden, are rather inconspicuous on the English and Scottish raised bogs but on the Irish ones they form a characteristic stage in the regeneration cycle and occupy up to 50 per cent of the area. The *Narthecium-Sphagnum papillosum* association is the major one of these communities. To judge from the profile borings the high frequency of *Narthecium* seems to be comparatively recent.

In both regions *Eriophorum angustifolium* grows abundantly in soaks and erosion channels, but in Great Britain and Ireland it is frequent...
also in the hollows of the regeneration complex. Another characteristic feature is the increasing frequency of *Scirpus caespitosus* towards the west.

The wettest parts of the Irish bogs, the hollows, occupying only a small part of the area, are covered with *Sphagnum cuspidatum*, *Rhynehchospora alba* - *Sphagnum cuspidatum* association or *R. alba* - *S. tenellum* association. The low and flat hummocks are dominated by *Calluna* - *Eriophorum vaginatum* - *Sphagnum* communities and *Narthecium* - *Scirpus caespitosus* - (Sphagnum plumulosum) communities; still drier hummocks, as in Scandinavian bogs, by *Calluna-Cladonia* associations. On the hummocks *Rhacomitrium* shows an increasing frequency from the East to the West. This is most obvious in the erosion complex. On Swedish bogs, the hummocks of this complex are characterized by the high frequency of *Erica tetralix*, in *Erica tetralix-Cladonia* association and *Calluna-Cladonia* association rich in *Erica*; on the British bogs these communities are of no or minor importance, although *Erica* is very common in the marginal parts of the bogs, and the hummocks are almost totally occupied by the *Calluna-Rhacomitrium* association. Secondary hummocks occur in both regions now compared. In Sweden these are usually formed of *Sphagnum fuscum* and *S. imbricatum*; on the British bogs *S. fuscum* hummocks are very rare, but on the other hand *Leucobryum glaucum* hummocks are much more frequent than in Sweden. In both regions these secondary hummocks often support dense carpets of *Hypnum cupressiforme* and *Pleurozium schreberi*.

Since most of the British and Irish raised bogs occur on the plains, the higher more or less sloping grounds being occupied by blanket mosses, soaks and streams are not so common as on many bogs in the west of Sweden. Many of the Irish bogs are, however, traversed by great streams and soaks with a characteristic vegetation. Here *Juncus effusus*, which is never found in soaks of Swedish bogs is one of the most conspicuous constituents. On the Irish bogs, the swallow holes, which are the remains of overgrown streams have a much richer flora than in the Swedish bogs including, for instance, *Crataegus monogyna*, *Lonicera periclymenum*, *Rubus fruticosus* (agg.), and *Osmunda regalis*.

On the British and Irish raised bogs a number of species occur which are never found on Swedish bogs except in soaks and along streams, although they occur or even are common in Sweden: *Narthecium ossifragum*, *Pedicularis silvatica*, *Pinguicula vulgaris*, *Carex panicea*, *Rhynehchospora fusca*, *Lycopodium selago*, *Campylopus atrovirens*, *Pleurozia purpurea*, *Sphagnum subsecundum*.

In some districts of the British Isles there is a gradual transition from the raised to the blanket bog, and flat areas of the latter type often have a more or less obvious dome. On these flat areas the vegetation is very similar to that of the raised bogs, but on the more sloping parts the vegetation is usually more uniform, *Scirpus caespitosus*, *Eriophorum vaginatum* and *Narthecium* being the main components of the field layer, *Sphagnum papillosum* and *S. plumulosum*, and in the extreme west *S. subsecundum* and *Campylopus atrovirens* in the bottom layer which is usually rather loose or open. In all parts of Great Britain and Ireland, but particularly in the west of Ireland these blanket bogs support a flora which differs not only from that of the raised bogs of Sweden but also from that of raised bogs in the same district. To the list of species given for the raised bogs, the following species may be added: *Anagallis tenella*, *Orchis maculata*, *Pedicularis palustris*, *Polygala vulgaris*, *Potentilla erecta*, *Deschampsia flexuosa*, *Luzula congesta*, *L. silvatica* and *Schoenus nigricans*.

These differences between the continental and oceanic bog types raise a very interesting problem: what is the main factor responsible for these differences? Since an influence from the underlying mineral ground is eliminated the determining factor must be climatic. *Von Post* and others have tried to explain the blanket bogs as the result of "soligenous" influence, but anyone who has seen extensive areas of blanket bogs covering hills and valleys
will admit that there cannot be any soligenous influence in the sense of von Post, where there is no mineral ground rising above the peat land. It cannot be denied that there is, in many cases, a soligenous influence in the blanket bogs, but areas so affected are relatively small and characterized by a different type of vegetation, mainly Eriophorum angustifolium and Juncus effusus in the field layer, Sphagnum angustifolium, S. apiculatum and S. plumulosum in the bottom layer. In the introductory part of this paper I have tried to prove that the occurrence of blanket bogs can easily be explained as a result of the moist climate. The best evidence I have seen for this conception is perhaps the peat cap on the hill saddle of Slievanea with thick peat on a 20° slope. The differences in the type of climate are also responsible for the differences in the floristic composition of the bog vegetation.

But how can the dominance of Schoenus nigricans in the Connemara bogs, which has caused some authors, who have never seen the bogs themselves but only plant lists, to classify these bogs as fens, be explained, and why is Schoenus characteristic of the Connemara bogs, Eriophorum vaginatum of the Pennine bogs and Scirpus caespitosus of blanket mosses of other regions?

According to Verona Conway (1947) the change in the vegetation of the bogs on the Pennines at Ringinglow bog took place from the beginning of the twelfth century as a result of human influence (wood cutting, burning and grazing), which was probably more pronounced here than in other, more thinly populated districts. Another factor which might be responsible for the present composition of the vegetation, for instance the dominance of Eriophorum vaginatum, dated by Conway to about 1850, is the pollution from the surrounding industrial areas. It is a fact that can easily be observed that the vegetation often is very sooty. The pollution may kill off some species, including liverworts, mosses and perhaps even phanerogams. According to this view, it may be concluded that Eriophorum vaginatum has become dominant in the Pennines because of a higher degree of resistance to the pollution factor.

Concerning Schoenus nigricans, which in England (and other countries) is mainly characteristic of calcareous swamps and fens, the right explanation has already been suggested by Tansley (1939): “— — — the abundance or dominance of Schoenus in blanket bog near the western coasts may be favoured by the falling of sea spray, driven by inshore gales, on the surface of the bog, thus changing the soil reaction in the direction of its more normal habitat”.

In a recent publication Asprey (1947) has described the vegetation of bogs on the island of Canna south-west of the Isle of Skye. There Schoenus nigricans occurs in drains and wet hollows of Sphagnum bogs evidently in the same way as it does in Connemara, to wit in obviously ombrogenous areas.

The large differences in the vegetation of the bogs in different regions is reflected in the type of peat formed. On one side we have the practically pure Sphagnum peat (Sphagnum fuscum peat usually being the purest) on the other side the Schoenus-Molinia-E. vaginatum-Scirpus-Narthecium peat with hardly any traces of Sphagnum in it. In some western parts of Sweden a rather decomposed Eriophorum vaginatum-Sphagnum peat is found, which might be interpreted as an intermediate type. Another intermediate type of peat is the fairly well decomposed “Sphagnum” peat in the raised bogs in the west of Ireland.

The British raised mosses seem to be built up mainly by Sphagnum papillosum and S. magellanicum, the last one also being the most important peat former in the west of Sweden.

In the raised mosses of the Central Plain of Ireland Sphagnum papillosum and S. imbricatum seem to be the most important species, forming a coarse, poorly decayed peat. On the other hand the pure undecomposed Sphagnum fuscum peat, characteristic of bogs in great parts of Europe, does not seem to occur in the British Isles. S. rubellum and S. plumulosum may also be mentioned as rather important peat formers in raised bogs in the British Isles. In the blanket
bogs, where *Sphagna* grow less vigorously than in the other types, the peat may be characterized as *Scirpus caespitosus -Sphagnum* peat, *E. vaginatum -Sphagnum* peat, *Molinia* peat, *Scirpus* peat, *Schoenus* peat or more frequently as a fibrous peat formed mainly by *Scirpus, Molinia, E. vaginatum, Narthecium, and in Connemara and Mayo also *Schoenus*, with only a small amount of *Sphagna*, mainly *S. papillosum, (S. imbricatum), S. rubellum, S. plumulosum, and S. subsecundum*, and to some extent *S. auriculatum and S. cuspidatum*, all these fibrous kinds of peat being fairly well decomposed.

**PLANT LIST**

In the following list of species mentioned in the paper the names are arranged alphabetically within each of the groups.

**Trees and shrubs**

*Betula pubescens* Ehrh.
*Crataegus monogyna* Jacq.
*Hedera helix* L.
*Ilex aquifolium* L.
*Lonicera periclymenum* L.
*Pinus silvestris* L.
*Quercus robur* L.
*Rubus fruticosus* L.
*Salix aurita* L.
— *cinerea* L.
*Ulex europaeus* L.
— *gallii* Planch.

**Dwarf shrubs**

*Andromeda polifolia* L.
*Calluna vulgaris* (L.) Hull
*Empetrum nigrum* L.
*Erica cinerea* L.
— *mackayi* Hook.
— *tetralix* L.
*Ledum palustre* L. — Mentioned only in the general survey of the moss types.
*Myrica gale* L.
*Oxycoccus quadripetalus* Gil. (= *Vaccinium oxyccos* L. ssp. *vulgare* A. Blytt)
*Vaccinium myrtillus* L.
— *uliginosum* L.

**Herbs**

*Anagallis tenella* L.
*Caltha palustris* L.
*Cardamine pratensis* L.
*Cirsium* sp.
*Drosera anglica* Huds.
— *intermedia* Hayne
— *rotundifolia* L.
*Epilobium montanum* L.
*Galium hercynicum* Weig. (= *G. saxatile* L.)
— *palustre* L.
*Hippuris vulgaris* L.
*Hydrocotyle vulgaris* L.
*Hypericum pulchrum* L.
*Knautia arvensis* (L.) Coult.
*Lobelia dortmanna* L.
*Menyanthes trifoliata* L.
*Mentha aquatica* L.
*Myosotis palustris* L.
*Narthecium ossifragum* (L.) Huds.
*Nuphar luteum* (L.) Sm.
*Nymphaea alba* L.
*Orchis maculata* L.
— *tayrnsteineri* Saut.
*Pedicularis palustris* L.
— *silvatica* L.
*Phormium tenax* Forst. — Mentioned only in the text to Plate 16, not in the description of vegetation.
*Pinguicula grandiflora* Lamk.
— *lusitanica* L.
— *vulgare* L.
OSVALD: Vegetation of British and Irish mosses


Polygala serpyllifolia Hose
— vulgaris L.

Polygonum persicaria L.

Potamogeton natans L.
— polygonifolius Pourr. (= P. oblongus Viv.)

Potentilla erecta (L.) Rausch.
— palustris (L.) Scop.

Ranunculus acris L.
— ficaria L.
— flammula L.

Rubus chamaemorus L. — Mentioned only in the general survey of the moss types.

Rumex acetosa L.

Senecio aquaticus L.

Succisa pratensis Moench

Trifolium repens L.

Utricularia intermedia Hayne

Viola epipsila Led.
— palustris L.
— riviniana Rehb.

Grasses and sedges

Agrostis canina L.
— tenuis Sibth.

Anthoxanthum odoratum L.

Carex canescens L.
— diandra Schrank
— echinata Murr. (= C. stellulata Good.)
— fusca All. (= C. goodenowii Gay)
— juncella Th. Fr.
— lasiocarpa Ehrh.
— limosa L.
— oederi Retz.
— panicola L.
— rostrata Stokes
— vulpina L.

Cladium mariscus (L.) R. Br.

Cynosurus cristatus L.

Deschampsia flexuosa (L.) Trin.

Eriocaulon septanulare With.

Eriophorum angustifolium Honck.
— vaginatum L.

Festuca rubra L.
— ovina L.

Glyceria fluitans (L.) R. Br.

Holleus lanatus L.

Juncus articulatus L.
— bulbosus L.
— effusus L.
— gerardi Lois.
— squarrosus L.

Luzula campestris (L.) DC.
— congesta Lej.
— silvatica (Huds.) Gaud.

Molinia coerulea L.

Nardus stricta L.

Phalaris arundinacea L.

Phragmites communis Trin.

Rhynchospora alba (L.) Vahl
— fusca (L.) Ait.

Scheuchzeria palustris L. — Mentioned only in the general survey of the moss types.

Schoenus nigricans L.

Scleris caespitosus L.
— lacustris L.
— palustris L.

Vascular cryptogams

Blechnum spicant (L.) Roth

Dryopteris spinulosa (Müll.) O. Ktze

Equisetum arvense L.
— fluviatile L.
— palustre L.

Lycopodium selago L.

Osmunda regalis L.

Pteridium aquilinum (L.) Kuhn

Mosses and liverworts

Aulacomnium palustre (Hedw.) Schwaegr.

Breutelia chrysocoma (Dicks.) Lindb.

Brachythecium rutabulum (L.) Br. eur.

Callicleryon giganteum (Schimp.) Kind.
— armentosum (Wg) Kindb.
— stramineum (Dicks.) Lindb.

Calypogeia trichomanis (L.) Chorda

Campylium stellatum (Schreb.) Bryhn

Campylopus atrovirens DeNot.
— brevipilus Br. eur.
— flexuosus (L.) Brid.
— shawii Wils.
— schwartzii Schimp.
Cephalozia bicuspidata (L.) Dum.
— connivens (Dicks.) Spruce
— leucantha Spruce
— macrostachya Kaal. — According to Dr. H. Persson this species replaces C. media on oceanic bogs. Sterile specimens are difficult to distinguish from C. media. Only sterile specimens of these two species were encountered in my collections, but, according to Dr. Persson, it is, after some training, possible to distinguish them from each other, through certain differences in leaf form.
— media (Lindb.)
  Cephaloziella rubella (Nees) Wst. var. bifida (Lindb.) Douin
  Cladopodiella fluviatans (Nees) Buch
  Dicranella cerviculata (Hedw.) Schimp.
  Dicranum scoparium (L.) Hedw.
  Diplophyllum alicans (L.) Dum.
  Drepanoclados fluviatans (L.) Warnst. var. falcatus (Br. eur.) Warnst.
  Eurynchium praelongum (L.) Hook.
  Frullania tamarisci (L.) Dum.
  Gymnocoela inflata (Huds.) Dum.
  Hylcomium pyriforme L. var. ericetorum (Br. eur.) Warnst.
  Lepidozia setacea (Web.) Mitt.
— trichoclados K. Müll.
  Lewcobryum glaucum (L.) Schimp.
  Lophocolea cuspidata (Nees) Limpr.
  Lophozia incisa (Schrad.) Dum.
— porphyroleuca (Nees) Schifff.
  Metzgeria furcata (L.) Dum.
  Mnium hornum L.
  Mylia anomala (Hook.) Gray
— taylorii (Hook.) Gray
  Nardia compressa (Hook.) Gray
— hyalina (Lyell) Mitt.
  Novellia curvifolia (Dicks.) Mitt.
  Odontoschisma denudatum (Nees) Dum.
— sphagni (Dicks.) Dum.
  Pellia epiphylla (L.) Lindb.
  Plagiothecium undulatum (L.) Br. eur.
  Plectocolea crenulata (Sm.) Eos.
  Pleurozia purpurea (Lightf.) Lindb.
  Pleurozium schreberi (Willd.) Mitt.
  Polytrichum commune L.
— formosum Hedw. (P. attenuatum Menz.)
— juniperinum Willd.
— strictum Banks.
  Rhamnocomia lanuginosum Hedw.
  Rhytidium dalephtus loreus (L.) Warnst.
— squarrosus (L.) Warnst.
  Riccardia latifrons (Lindb.) Lindb.
— pinguis (L.) Gray
  Saqcoynya sp.
  Scapania gracilis (Lindb.) Kaal.
— undulata L. Dum. var. purpurascens
  Scorpidium scorpoides (L.) Limpr.
  Thuidium tamariscinum (Hedw.) Br. eur.
  Webera nutans Hedw.

Sphagnum mosses

  Sphagnum amblyphyllum Russ.
— angustifolium C. J. — Mentioned only in the general survey of the moss types.
— apiculatum H. Lindb.
— aquatile Warnst.
— auriculatum Schimp.
— balticum Russ. — Mentioned only in the general survey of the moss types.
— compactum D. C.
— contortum Schultz.
— crassicaldum Warnst.
— cuspidatum Ehrh.
— cymbifolium Ehrh.
— fuscum (Schimp.) Klinggr.
— imbricatum (Hornsch.) Russ.
— inundatum Russ.
— magellanicum Brid.
— molle Sull.
— nemoreum Scop.
— obesum (Wils.) Warnst.
— papillosum Lindb.
— plathyphyllum (Sull.) Warnst.
— plumulosum Röll.
— pulchrum (Lindb.) Warnst.
Sphagnum quinquefarium (Lindb.) Warnst.
— rubellum Wils.
— subsecundum (Nees.) Russ.
— subtile Warnst.
— tenellum Pers.
— tenerum Sull & Lesq.

Lichens

Cladonia alpestris (L.) Rabh.
— coccifera (L.) Willd.
— crispata (Ach.) Flot. var. cetrariaeformis (Del.) Vain.
— — var. virgata (Ach.) Vain.
— deformis (L.) Hoffm.
— fimbiata (L.) Fr.
— floerkeana (Fr.) Smrft
— pyxidata (L.) Fr.
— rangiferina (L.) Web.
— rangiformis Hoffm.
— silvatica (L.) Hoffm.
— squamosa (Scop.) Hoffm.

Cladonia uncialis (L.) Web.
Cornicularia aculeata (Schrebl.) Fr.
Gyalecta gloeocapsa (Nitschke) Zahlbr. — This interesting lichen, which has long been overlooked, is mentioned only in the general survey of the moss types. It is, however, probably common also on the bogs of the British Islands. It can easily be detected in the autumn on dying Sphagnum fuscum and S. imbricatum.

Peltigera imbricata (L.) Willd.

Algae

Fucus vesiculosus L. — Encountered on bare peat eroded by sea, near Roundstone.

Rhizoclonium sp. — Mentioned only in the general survey of the moss types. Cf. footnote on p. 10.

Zygogonium ericetorum (Roth) Kütz.

Stigonema ocellatum (Dillw.) Thuret ex Born & Flah.

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