SOME CONSIDERATIONS AFFECTING THE CLASSIFICATION OF THE BOGS OF IRELAND AND THEIR PEATS

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PART I

DESCRIPTION

Climate

THE island of Ireland, a small uplift of the Continental Shelf lying just off the land-mass of Europe, is flanked on the west by the Atlantic Ocean bearing the relatively warm waters of the Gulf Drift—that great ameliorant—past its shores; and has as its prevailing winds the South Westerly Anti-Trades, throughout the year. It has the temperate oceanic climate one would expect in such a situation and conditions.

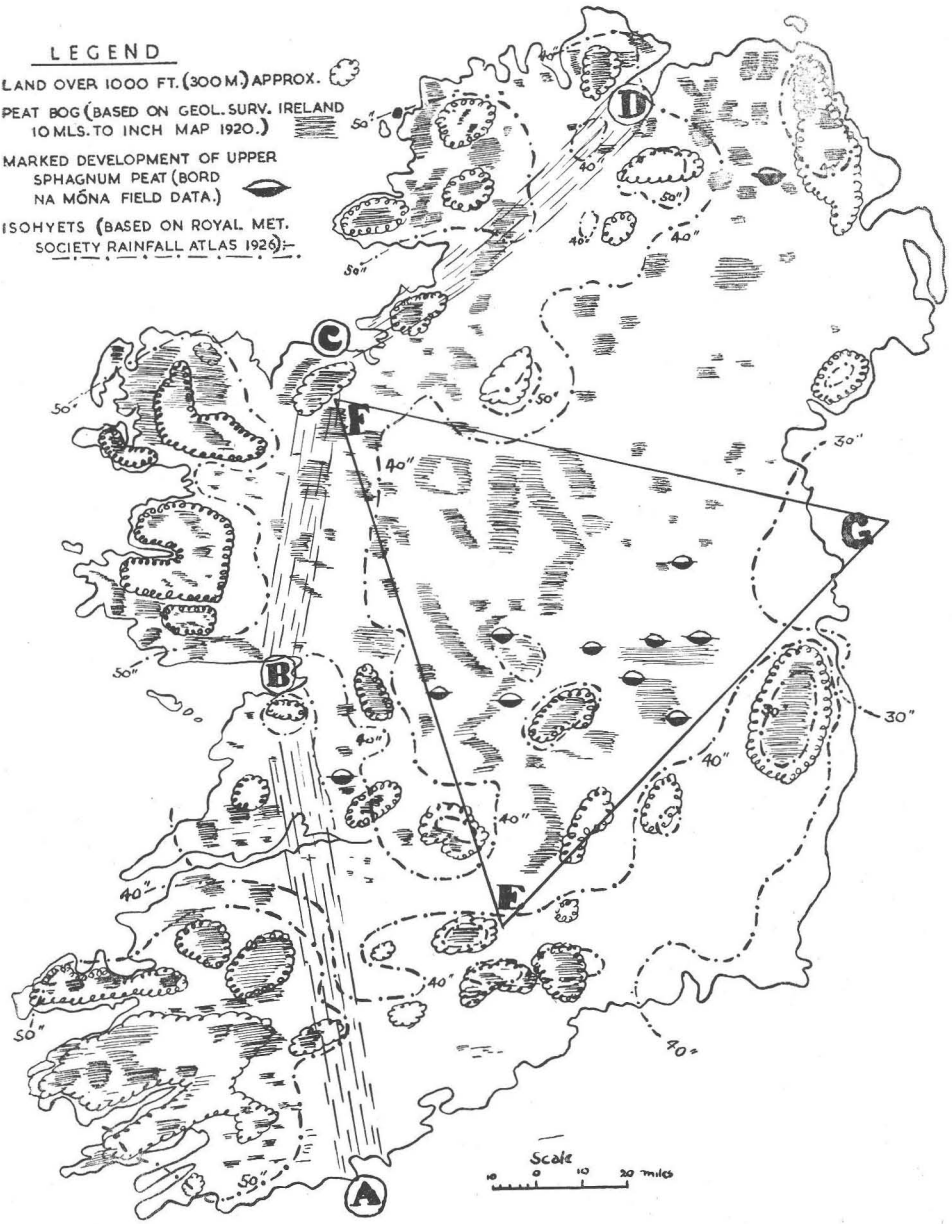
Table 1 shows the limits over Ireland of the means of some of the more important climatic variables.

TABLE 1

Approximate limits to-day over Ireland of some of the more important climatic variables ; data based on the isotherms, etc., shown on the Figures in Tansley (1939)

	Maximum	*Minimum*
Mean annual rainfall ..	150 in. (3,750 mm.)	30 in. (750 mm.)
„ rain-days per annum	250	175
„ duration of sunshine (hours per annum)	1,600	1,200
„ annual temperature	50°F. (10°C.)	42°F. (5·56°C.)
„ Minimal temperatures (Jan.)	41°F. (5 C.)	34°F. (1·1°C.)
„ Maximal temperature (July)	67°F. (19·4°C.)	63°F. (17·2°C.)

Hours of sunshine decrease from south-east to north-west ; total rainfall and rain-days decrease, generally from west to east



IRELAND

Showing high ground, certain isohyets, and the regional distribution of the main bog-types.

KEY TO THE MAIN BOG REGIONS

West of ABCD is the region of the blanket bog. Within the figure EFG are the main aggregates of raised-type bog. On high ground everywhere are the high-level (blanket) bogs.

Rainfall is rather evenly distributed over the whole year with a " peak " in December (early winter) and " valleys " in May and September. Actual mean annual temperatures are remarkably equable over the country as a whole, the annual range of mean temperatures for the warmest and coldest months (July and January, respectively) being only 20° F. (11·1° C.) in the Central Plain, and less than 16° F. (8·9° C.) on parts of the west and south-west littoral.

Thus, within the Atlantic island of Ireland there are, simply, the subregions of most marked and of rather less marked oceanic climate.

Topography. The land-forms are such that the more mountainous parts, reaching their greatest elevation at 3,414 ft. (1,024 m.) in the south-west, lie around the perimeter, that is, in the maritime counties, while the central part is more nearly flat. The Central Plain proper, however, lying at *circa* 200 ft. (60 m.) above sea-level, occupies not more than 10 % of the total area of Ireland. Uplands, often of rather rugged configuration and usually lying between 200 ft. (60 m.) and 800 ft. (240 m.) or more above the sea, cover much of the remainder. They are separated by numerous river-valleys that are seldom deep or narrow; so that the topography, by and large, is undulant rather than sharply outlined.

Rock-types and Drift. The solid geology comprises a great variety of rock-types. The mountains and major uplands present considerable areas of igneous material ranging from acidic granites and felsites to base-rich basalts and diorite. Metamorphic quartzites and mica-schists, Silurian and Cambrian grits and shales, Old Red Sandstone, and carboniferous limestone are common also.

But far more widespread and important is the glacial drift to which all of the foregoing rocks, and others, have contributed, and which covers up to 85 % by area of the whole country as may be estimated from the map in Kilroe (1897).

Climate versus Natural Succession, etc., as factors in bog formation. This, then, is the heterogeneous superstructure upon which the post-glacial peatlands of Ireland have been built; but there is a great body of evidence which appears to show that this is not the climate in which they have grown from the beginning. The common view, supported by data from the Continent of Europe and from other parts of the world, is that there have been a number of climatic changes, hence a succession of rather well-defined climatic phases, since the last retreat of the Ice about ten thousand years ago.

An opinion widely held is that the most recent major change, from a more dry and warm climate (the Sub-Boreal) to about that of to-day (the Sub-Atlantic) occurred *circa* 500 B.C.; but there is evidence that there have been a number of fluctuations of more or less significance since that time. Their relative importance remains to be worked out.

Another school of thought holds that such climatic changes as may have occurred since the retreat of the Ice have not been of

primary importance in fixing the stratigraphy of the peats, but that it was simply a matter of natural vegetational succession until the advent of Man. From which time, say three to four thousand years ago in these Islands, man, acting indirectly through the introduction of grazing animals, and directly through his tree-felling, burning, clearing and cropping operations has, as the principal biotic factor, interacted with the natural environmental factors, bringing about the minor gradations of the " Sub-Atlantic " and producing the bog-surface conditions of to-day.

The Common Factor in our Bog-profiles. Whatever be the true and complete explanation of it, there can be no doubt that the profiles of the bogs of Ireland exhibit a definite and regular sequence of strata. The curious thing is that this " common factor " appears to hold good whether the example chosen be a 5 ft. (1·5 m.) profile from a bog in Wicklow at 2,000 ft. (600 m.) elevation, an 18 ft. (5·5 m.) profile from a bog in the Shannon Basin at only 140 ft. (42 m.) above the sea; or, for that matter, a profile from one of the bogs whose remains now lie between the tide-levels along the West Coast. Highly simplified, the sequence is, from floor to surface, for every bog in Ireland:

(i) A peat or peats often highly humified, composed of the remains of eutrophic/mesotrophic plants and with high ash content. Sometimes with timber in situ.
(ii) A dividing layer of forest peat very frequently containing stumps of *Pinus sylvestris* or *Betula alba*, not uncommonly both together.
(iii) A peat or peats tending to be more fibrous than the peat or peats below the forest layer, usually less humified also, and composed of the remains of oligotrophic-mesotrophic plants. Such peat containing visibly increasing amounts of (*Sphagnum*) moss species near the surface.

While on the one hand it may be contended that this kind of vertical succession in peat-types is primarily the outcome of climatic changes down the centuries, and on the other that it is essentially a natural succession brought about by the " growing away " of surface plants from subsoil nutrients, it seems probable that, for long, all such factors have been inter-active.

It will be interesting to see how far the " common factor " succession of peats suggested above can be traced through the profiles of the general bog-types as given below.

Some Features of the Main Types of Bog in Ireland

The consensus of opinion is that the two great natural types of bog in Ireland are—the *raised-type* bog of the Central Plain and the *blanket-bog* of the West. To the latter may be added its montane sub-type, the *high-level blanket bog* (e.g., in the Wicklow mountains).

The Raised-Type Bog. The depth of the raised-type bog is said to be on average 25 ft. (7·5 m.) but much greater depths occur. For instance in 1949 soundings in a raised bog of 300 acres (120 ha.) commonly showed 40 ft. (12 m.) of peat. Such bogs in Ireland may or may not have basin bottoms (that is, concave floors). Clonsast and other bogs of the size-class 2,000-4,000 acres (800-1,600 ha.), present extent, in the Central Plain, rest partly on basins and partly on morainic sand-gravel ridges that may or may not reach the present-day surfaces. Blue clay, sand and gravel mixtures and (locally) shell marl constitute the subsoils. These are usually calcareous.

From bog-floor to surface the peat types in a Central Plain raised-type bog are commonly about as follows:

(1) 9 ft. (say 2 m.) of reed-swamp-fen peat or peats sometimes with timber on the mineral floor and within the peat. (*Pinus sylvestris*, *Quercus robur*, *Taxus baccata*).

(2) Up to 3 ft. (say 1 m.) of forest peat. A very distinct pine layer (*Pinus sylvestris*) flat-rooted characteristically in the reed peat and accompanied locally by *Quercus* and *Betula*.

(3) (*a*) 6 ft. (say 2 m.) Bog peat of mixed mesotrophic-oligotrophic species; showing a conspicuous content of *Eriophorum* spp., *Trichophorum*, *Narthecium*, *Menyanthes*, *Rhynchospora*, *Vaccinium oxycoccus*, *Sphagnum* and other mosses, with some *Molinia coerulea* and *Myrica gale* locally. The whole usually about H 6—H 8 on the Von Post humification scale.

(*b*) 3 ft. to 6 ft. (say 1-2 m.). Bog peat generally resembling the last but less humified with a marked increase in the amount of *Sphagnum* present.

A thin layer of *calluna* peat, traces of *Betula*, and even a minor growth of *Pinus* may occur between 3*a* and 3*b*. More often than not, in Ireland, within the whole of 3 but especially in 3*b* there is vertically, a marked irregularity or, even, alternation in the degree of humification at any one boring-point.

The surfaces of our raised-type bogs wherever undisturbed by burning, grazing, or drainage, exhibit the typical *regeneration-komplex* or hummock-hollow formation associated with the *höchmoore* but there occur also, crossing these bogs or originating in relict lakes, pool complexes or " springs " within their boundaries, the flushes and paths of soaks of which an example has been so ably described by Osvald (1949).

The Blanket Bog. The depth of the Western blanket bog is on average about 8 ft. (say 2·5 m.) but in flat bog, resting over hollows, depths of 25 ft. (7·5 m.) are not rare. Neither are depths of a mere 2 ft. to 4 ft. (60 cm.—120 cm.) over convex slopes. Blanket bogs,

by definition as it were, cover wide areas rather uniformly and contain known units of up to 15,000 acres (6,000 ha.).

Their top-surface contours and bog-floor contours about coincide. But not entirely so, because it is in the former hollows that the greater depth of peat has been built up and here, below the woody layer, (which does not dip in conformity with the dip of the bog-floor) there may be found an amount of *Phragmites* and other topogenous or topo-soligenous peats reminiscent of those in the lower halves of our raised-bog profiles. On the other hand over the former and present-day ridges and domes of mineral soil or bare rock the peat is thinner and the pine-layer—where the extent of former mineral soil permitted its growth—is rooted wholly or partly in such soil. The sub-strata in question are usually acid, siliceous, and include many drift types—of gneiss, schistose, granitic, metamorphic-quartzite, and other origin. Iron-pan is commonly present, at and just below the junction with the peat.

From bog floor to surface the peat-types in a Western blanket bog (at a non-basin site) are commonly about as follows:

(1) 6 ins. to 3 ft. (15 cm.—90 cm.). Amorphous peat, completely humified or nearly so. Pine at foot, within the layer, or at its junction with (3); which position will depend on the nature of the site—particularly the local topography and gradient of the bog-floor.

(2) 1½ ft. (45 cm.) Pine wood peat and stumps in situ.

(3) 2 ft.—6 ft. (60 cm.—180 cm.) blanket-bog mixed peat, very well humified to moderately humified, say H 9 to H 6; the humification decreasing with approach to top surface. Recognizable plant remains include, most commonly, those of *Eriophorum spp.*, *Molinia caerulea*, *Schoenus nigricans* and *Narthecium*, and the whole, when not more fully humified, constitutes a peat or peats markedly more sedge fibrous or grassy fibrous than are those of the raised type bog peat. In the uppermost 2 ft. or so (0·5 m.) *Sphagnum* spp. and other mosses become conspicuous, but the grassy or sedge fibrous texture of the peat is usually well maintained to the top.

The surfaces of the greater Western blanket-bogs carry on the flat a ramification of pools and lakes belonging, it would seem, to three or four distinct generic types and deserving of special study. Among these bodies of water as well as on the more firm sloping ground *Schoenus* is often very abundant, or in some cases, co-dominant with *Molinia*. There are the usual bog species as well (e.g., *Eriophorum* spp.) and Ericaceae. *Menyanthes trifoliata* occurs in the pools and, in the most swampy areas, on the ground between them. *Molinia* and *Molinia-Juncus* flushes abound and run along or somewhat below the surface—their courses becoming more readily recognizable with increasing unevenness of surface configuration.

The High-level Bog. The average depth and the profiles of the sub-type " high-level blanket bog " everywhere in Ireland so far as seen, appear to compare quite closely with those of the Western blanket bogs proper. But there are fewer places where the maximum depths of the Western bog are reached; and the fibrous bog peat (as distinct from the amorphous lowermost peat) seems to be composed of finer fibres than is the equivalent bog peat in the West. Perhaps it is the sub-recent prevalence of *Molinia* and *Schoenus* in the West, on the one hand, and, on the other, of *Eriophorum vaginatum* and *E. angustifoliam*, *Calluna*|*Erica tetralix*|*E. Cinerea*, and *Rhacomitrium lanuginosum*, at the greater altitudes elsewhere, that accounts for this difference.

Distribution of the Main Bog-types in Ireland. The accompanying map is based on observations from field work carried out to date and is intended as a key to the distribution of the main bog-types, viz., *raised-bog* and *blanket-bog*, and of the latter's sub-type, *high-level bog*, in Ireland.

It affords interesting comparisons with the allocation in his contents and text by Jessen (1949) of the terms " raised-bog " to the sites shown on his key-map (facing p. 110, *op. cit.*): and also with the distribution of " ombrogenous höchmoore " and " soligenous peat " on the map of Ireland's peat bogs which appears as Fig. 36 in Granlund (1932).

On the present map are shown:

(i) The main mountain and hill groups—approximating to all land over 1,000 ft. (300 m.) elevation.
(ii) the location of the main peat bogs based on the Geological Survey (1918).
(iii) the 30 in., 40 in. and 50 in. (750 mm., 1,000 mm. and 1,250 mm.) isohyets of average annual rainfall, 1881-1915, according to the Rainfall Atlas of the British Isles (1926).

The key to the distribution of the bog types is as follows:

Blanket bog. All of Ireland lying west of the transition belt ABCD is the region of known blanket bogs *par excellence*. Where the occurrence of peat bog and elevation greater than 1,000 ft. (300 m.) over sea-level are seen to coincide east of this belt the bog type is high-level (blanket) bog.

Raised-type bog. The triangle EFG encloses the area known to contain the main groups of raised-type bog; and special symbols are used (see " Legend " on the map) to mark the location of particular bogs or bog-groups which have been found to contain noteworthy amounts of younger sphagnum peat (peat-moss material) in upper profile.

These latter would appear to be the nearest equivalent we have in Ireland to the classical " höchmoore " of N.W. Germany and

South Sweden. They appear to reach their best development with us in watershed situations at low elevations in those parts of the country having the least annual rainfall and the greatest degree of difference between mean summer and winter temperatures.

PART 2

DISCUSSION

From the combination on this map of the field evidence for the distribution of our bog types, and of the known distribution of rainfall, it would appear that the 40 in. (1,000 mm.) isohyet is rather decisive in Ireland, marking a convenient boundary as between the region of raised-type bog and the region of blanket-bog. In support of this theory it can be shown that where an abrupt increase in elevation brings about heavier rainfall locally, well within the 40 in. rainfall zone, there the bog type changes locally likewise, and a sub-type of the blanket bog is found. This is probably most strikingly exemplified in the case of the Slieve Bloom Mountains where, standing amid extensive *Eriophorum* bogs at *circa* 1,500 ft. (450 m.) elevation one may look down in every direction upon the raised-type bogs of the surrounding plain.

Conversely, if the theory is correct, bogs in places having less than 40 in. annual rainfall even though in or about the blanket-bog region should be of the raised type. To test this, East Clare was visited and it was found that in the area marked by the most westerly sphagnum moss bog conventional sign on the map in a number of bogs of the size-class 100-200 acres (40-80 ha.), north and south of Tulla on Carboniferous limestone and drift, there were in drained face-banks about 2 ft. (60 cm.) of younger sphagnum peat—peat moss material—then a retardation-layer about 6 in. (15 cm.) thick consisting of non-mossy peat, dark, coarsely-fibrous and containing *Molinia* in one case at least, and then a further 1 ft. to 2 ft. (30-60 cm.) of rather young moss peat. Samples taken in one of these bogs with a Hiller-type borer showed sphagnum moss peat to 1·5 m. then older sphagnum/sedge fibre at between 1·5 and 2 m. depth, then a further occurrence of moss peat (*circa* H 5) to 3 m., which was the limit of sampling.

Table 2 shows the values from pH metre readings of those samples:

TABLE 2—Creevosheedy Bog, Co. Clare

Samples taken 14th November, 1952

	Depth	*pH value* (mean of two readings)
50 m. into the bog from S. edge ..	(1) 0·5-1 m.	5·3
	(2) 1·0-1·5 m.	5·4
	(3) 1·5-2 m.	5·7
200 m. into the bog from S. edge ..	(4) 1·5-2 m.	5·8
	(5) 2-2·5 m.	6·2
	(6) 2·5-3 m.	5·5

The special interest for the bog-investigator of the discovery of a bog type resembling *höchmoor* in East Clare lies in the fact that although having less than 40 in. of annual rain, according to the Rainfall Atlas, the area has more than 225 mean rain-days per annum according to Fig. 24 in Tansley (1939), and is sandwiched between areas of heavier annual rain, on the Atlas.

Tansley's caption clearly links the occurrence of blanket bog *with the greater number of rain-days* rather than with the higher annual rainfall and in his favour we may point to the >40 in. <225 days situation giving raised-bog at Tregaron[1] and to the <40 in./ >225 days situation giving blanket bog in Caithness.[2] It would seem that the position is not the simple one of annual rainfall *versus* number of rain-days but that (e.g.) high latitude in one case (as at Caithness) may turn the scales in favour of blanket-bog formation while in another (say East Clare) the combination of higher mean annual temperatures and of more favourable edaphic conditions may do so in favour of raised-type bog formation.

So far we have adverted to bog-types only (as distinct from peat-types) and among those simply to the two main types in Ireland—the raised-bog and the blanket bog.

A third type of bog which is commonly listed in classifications such as Tansley's is the " Valley Bog." It is not thought necessary to include it here because it does not appear to occur in Ireland except

1. In Cardiganshire, mid-Wales. See Godwin, H. and Mitchell, G. F. (1938), also Godwin, H. and Conway, V. M. (1939).

2. In the extreme north of Scotland. See Crampton, C. B. (1911).

in so far as it underlies present-day raised-type bogs and blanket bogs, or where the removal for fuel of the upper peat from either of those types of bog has exposed it to view.

The field-evidence seems to suggest and logic supports the view that it would be unwise to raise this type of formation to the status of a bog-type in Ireland to-day. This is the more imperative on account of the confusion already existing as between bog-type and peat-type classifications.

Eutrophic fens, usually small or relict, widespread callows, and mesotrophic marshes occur, and complete the picture of the peat lands of Ireland. Certain of the fens present conditions apparently resembling those that obtained in similar habitats before the onset of bog-growth. For example, near Droichead Nua there is a small fen of *Cladium mariscus* with *Phragmites communis*, *Mentha aquatica*, *Juncus effusus*, *Parnassia palustris*, etc.; that probably resembles closely a former fen stage beneath, say, the great Shannon bogs. (It is as well to note perhaps that those are not, to-day, " valley bogs " either. They are raised-type bog over *Cladium* fen/*Phragmites* reedswamp peats).

The practical importance of distinguishing between the blanket-bog and raised-type bog regions in Ireland stems from the fact that, as has become increasingly clear within the past few years, the characteristics of their peats differ fundamentally.

For instance, their drying/rewetting and combustion characteristics, the chemical constituents (e.g., wax content) of their profiles, their responses to drainage and the feasibility of using upon them certain machines and methods, differ greatly.

In short they differ inherently not only in their present constitution (the resultant from their former environmental conditions) but in their present environments—whether as subjects for fuel-utilization or for reclamation, including afforestation. Examples are not wanting where a particular technique proven successful on the one type has failed on the other.

The reality of the distinction made here between those two main bog types in Ireland will not have been in any way vitiated should it prove difficult or impossible to draw a fixed and final line of demarcation between them on the ground, up and down the country. The classification is a natural one, based on genetic, morphological, and physiographical factors and characteristics, and as Tansley says so well in a somewhat similar connection (p. 272, Vol. I, 1939):

> " The difficulties . . . are of the kind which we meet in attempting to classify biological phenomena (everywhere)—they are so complex that while we can recognize well-marked ' types ' representing the prevalent combinations of different factors, we cannot draw sharp boundaries."

It would be quite wrong, however, to suppose that this bilateral division of our bog types is represented on the Continent by the most common division there, viz., into " high bog " and " low bog."

(This point requires special emphasis since it is known that this is precisely what has happened in the past, darkening the understanding of both European and Irish peat-scientists and technicians.)

For long the German school has classified bogs as

(1) *Höchmoore* or " high bog," formed of plants growing in " soft " waters poor in nutrients.

(2) *Neidermoore* or " low bog " of plants growing in " hard " waters rich in nutrients; and

(3) *Uebergangsmoore* or " transition bogs," of vegetation intermediate between the two extremes.

The peats of these " bog types " are therefore, respectively,

(1) Oligotrophic,

(2) Eutrophic, and

(3) Mesotrophic. It is evident that any one or two or all three of them may occur in vertical arrangement, usually in the order (2), (3), and (1) from floor to surface, in any bog anywhere, according to the letter of the classification.

According to its spirit, however, it is evident that the classification was intended to fit the bogs of North-west Germany and the Netherlands primarily; that it applies rather well *to the several peat-layers* of the raised-type bogs of Ireland, at least within the triangle EFG, an our present map, but that it is difficult to see how it can be applied to our western blanket-bog or to its subtype, our high-level bog.

This is a rather serious drawback for students of our bogs and peats and more so for our peat-technicians. The Russian school of peat-investigation based on the methods of the German and Scandinavian schools, similarly recognizes two main types of bog or peat (viz., " high bog " and " low bog "). It states that these two types of bog and their peats differ in their profiles, their degree of physical decomposition, ash content, real density, mechanical strength of their sods and briquettes, and in other significant ways. Different formulæ are used for the prediction of the behaviour following drainage, of " high bog " as distinct from " low bog " peat.

Results which are coming in now from laboratory investigation using the methods just referred to tend to show that the peats—even the upper peat—from our Western blanket-bogs display the characteristics of " low-bog " rather than of " high-bog " peat. Should this suggestion continue to find support from the results of continuing field-work it would be a noteworthy addition to the evidence already available that our blanket bogs differ fundamentally not only from our raised-type bogs, in Ireland, but from the bogs of Europe as a whole, excepting only those of Western Norway.

Here again there is a difficulty because when, in 1952, the blanket-bog of West Norway was visited it was found that, at Hustadmyr north of More og Romsdal at only 100 ft. (30 m.) above sea-level, in a district whose situation, topography and subsoil

resembled closely those of the Gweedore district in Donegal, the surface vegetation and the peat as seen in drainwall profiles resembled not those of our Gweedore blanket-bog but, identically, those of our high-level bogs around Lough Firrib in the Wicklow highlands at around 2,200 ft. (*circa* 660 m.) elevation. The only difference discoverable at Hustadmyr was the occurrence there, in the lower peat or on the mineral soil, of larger pine. Specimens of up to 30 in. (75 cm.) butt diameter were seen. Clearly the difference of 10 degrees of latitude (Hustad 63 N, Lough Firrib 53 N) has approximated to a difference of 2,100 ft. in altitude as between the two places.

We see at once the unwisdom of making direct comparisons between outwardly similar situations. In this case (e.g.), if a particular reclamation technique on Hustadmyr should fail it would not follow that similar efforts on our Western blanket-bog would not prove a complete success.

The Classification of Peats. The situation regarding the classification of bogs and peats—the terms have repeatedly been used as if they were synonymous—has become more and more confused as each classifier has added his particular " stone " to the " cairn." What is wanted now is not a " new " peat-type classification but, rather, a *clarification* of the existing systems.

Von Post, Osvald, Jessen (Europe); the Frazer School (Scotland); Godwin, Pearsall, Tansley (England); Dachnowski-Stokes and Waksman (U.S.A.); and Mitchell (Ireland) are among the leading workers who have contributed in their various ways to our understanding of peat-materials and their classification. The works of over twenty such authorities—their subject-matter having to do directly with, or having relevance to, the bogs and peats of Ireland—have been examined at Droichead Nua and a number of points of interest have emerged rather clearly from this study. Examples are as follows:

(1) At least sixteen different habitat factors and characteristics of the material have been used as distinguishing characters. They range from colour of the peat-ash to local *versus* regional distribution of the (bog) type.

(2) The criteria most commonly employed have been topography, water-relations and climate, and the ways in which these have been interpreted have differed greatly from system to system so that classifications based on identical criteria differ in value.

(3) The most concise statement that can be made about the conditions governing the nature of a particular peat-type is the following: " The nature of the peat depends upon the plant association which has given rise to it and which in turn has been controlled *by the climate, physiography and other locality factors of the district and in particular* by the nature and amount of the mineral nutrients in the waters *of the locality and of the spot* in which the plants were growing."

The passage is taken from Waksman's suggested definition of peat (1942), less the words in italics, which are added here to broaden the scope of the reference at two points, in order to make it clear that factors other than the nature of the water have been operative and that peats other than ground-water fed peats are included.

(4) The classification of the bogs and peats of Scotland by the Frazer School, Frazer, G. K. (1933), Muir, A. and Frazer, G. K. (1940), Frazer, G. K. (1943), etc., into (i) Zonal or Climatic (blanket-bog peats) and (ii) Azonal or Local (raised-bog, basin peats) resembles closely, in effect, the bilateral classification of the bogs of Ireland into (i) Blanket Bog and (ii) Raised-type Bog. But the nomenclature seems unfortunate since it is evident that varying climatic conditions contribute equally (so far as we know) to the build-up of various kinds of bog-peat. For instance the evidence is clear in Ireland that a particular " climate " is associated with the development of sphagnum moss peat on the raised-type bogs of the Central Plain. (Incidentally, if the west coast " climate " favours bog-growth so overwhelmingly it is a fair question why basin situations within the western blanket-bogs do not show as great depths of peat as do similar situations in the (? non-climatic) bogs of the east-centre). As for the distinction " regional " *versus* " local " this will not fit in Ireland because we have in the districts of our " Azonal " raised-bogs a number of aggregates of bogland each exceeding 10,000 acres (4,000 ha.) separated only by adventitious eskers and stream-courses.

The term " climatic bog " if used to denote our Western blanket bog would be additionally unfortunate in that it would lend implicit support to the view that in that region the present " inhospitable " peat-cover is final, something that cannot be improved or eradicated. Happily, however, indications are now becoming available from widely differing sources that this is not the true position.

(5) Von Post's " topogenous peatlands " and his " paludification bogs," the latter subdivided into " ombrogenous " and " soligenous," together with Osvald's " terrestrial " " telmatic," and " limnic " peats have been the terms principally made use of by Jessen (1949).

His classification, thus, of the bog-types and peat-types of Ireland, respectively, is entirely correct and adequate theoretically and is, no doubt, fully in accordance with reality. But, in the field, the *elucidation* of those types, as set up, is another matter. Jessen himself (who regards both raised bog and blanket bog as ombrogenous) prepares us for this by pointing out that " intermediate types between blanket and soligenous bogs are common." Von Post, earlier (1937), expected that Ireland would show " a puzzling intermingling of the two main paludification types "—the ombrogenous, and the soligenous bog—in fact " a multiformity of types."

The rather numerous combinations of plant remains used by Jessen as the framework of his peat-types classification constitute the most lucid statement in existence on the botanical content of our

peats and are, of course, identifiable. But the degree of variation within these (even in peat at identical levels over the same bog) is so great as to render their quantitative assessment impossible. So that in bog-surveys for industrial and land-use purposes one has to be content with a more simple scale, based on the ocular evidence of *principal* botanical content, giving not more than, say, six main peat-types.

PART 3

CONCLUSIONS

To attempt a two-point crystallization, as it were, of the opinions of various eminent workers in the field of bog and peat classification:

The first point is that the nature and relative amounts of the waters feeding a site are of paramount importance in bringing about a particular bog and hence, peat-type. A succession of such types will in time arise from changes in the nature and in the relative amounts of such waters.

The second point is that one of the principal distinguishing characters of any peat-type is its botanical composition and that, so far as our present knowledge goes, it seems probable that the main botanical content may well be, as between peat-types, the differentiating character, i.e., that which has the greatest number of accessory characters.

It would be strange indeed if the origins and relative amounts of the aerial and terrestrial waters feeding a particular bog, or feeding its preceding fen, were not of primary importance considering that our bogs and their peats as they stand consist in greater part, from surface to bog floor, of water (e.g., Experimental Station field-data, 1953-4 show moisture-contents 93 %—96 % for all samples from undrained bogs in various parts of the country).

At the moment we simply do not know to what extent this water is of aerial or terrestrial origin, to what depths rainfall exercises an influence, from what depths ground waters arise, or in what direction or directions (if any) the water, of whatever origin, within and below the peat-strata, is in movement. This great gap in our knowledge applies equally to raised-type bog and blanket-bog. Perhaps scientific bodies and industrial concerns will join forces to close it ? The knowledge in question is essential to our understanding of bog-formation and regression on the one hand and, on the other, to the most effective and economic design of drainage methods, and patterns and of drainage-maintenance plans. Hence it is of fundamental importance to all who are engaged in peat land utilization, whether for fuel production, agriculture or afforestation.

An ancillary problem is that of working out to what relative degree ground-water (percolating via plant-roots or otherwise) and aerial water are influencing the growth or decay of our western

blanket-bogs. European authorities have long been mystified by the prevalence of *Schoenus nigricans* on those bogs, so much so that one investigator termed them fens. The species *Schoenus nigricans* and *S. ferrugineous* are on the mainland of Europe definitely confined to ground-water fed habitats, and in the eastern Mediterranean the former has been recorded in salt-marsh.

Bertsch (1947) gives *Schoenus ferrugineous* (dominant) with *S. nigricans* (locally abundant) as successors to *Cladium mariscus* in the formation of a calcareous fen.

Tansley (1939) mentions the theory that salt spray driven by inshore gales changes the soil reaction of the maritime blanket-bogs in the direction of the more normal habitat of *Schoenus* and this theory finds support in Gorham (1953) who mentions that Webb (1947) has shown that in the West of Ireland where blanket-bogs are prevalent, the chloride content of bog-surface water; is about 0·5 m. mole/1; while in the east, where raised bogs are developed it is only 0·2 m. mole. Gorham mentions also that in Sweden Witting (1948) has observed the concentration of calcium, magnesium, sodium and potassium in bog pools to diminish in passing from west to east.

A contribution of immediate relevance to this whole problem of the influence of atmospheric salts (not merely from salt-spray but from the air and rain), on vegetation is that of Ingham (1950), which seems to have escaped attention up to now. Ingham describes experiments which seem to show that cellulosic and other materials can absorb, *from the air*, nitrogen and other compounds more than sufficient to maintain plant fertility. It would appear from the combined evidence of Webb and Ingham that an unascertained proportion of the plant nutrients in our soils are derived from the sea and are wind-borne; and that differences may well exist, in the respective amounts of such substances contained in the air and rain, and so potentially available for plants, as between the west and the east of Ireland. If this idea could be substantiated it would represent a discovery of the greatest importance from both agronomic and academic view-points, for Ireland and universally.

Assuming that the water-relations problems had been overcome there would remain the problems of present-day climatic trends and their present effects on our bogs in the west and on high ground. As is well known, there has been a marked breakdown of the high-level blanket peats in the present century in Great Britain and Ireland. Crampton and MacGregor (1913) ascribe this, on Ben Armine, Sutherlandshire, to a falling-off in the amount and constancy of precipitation but others think it merely a matter of the equivalent of senile decay having set in on the bogs in question.

My observations in the Wicklow highlands recently, 1949-51, have shown that along the broad Seefingan-Kippure ridge at elevations between 2,056 ft. (617 m.) and 2,473 ft. (742 m.) where *Rhacomitrium* and *calluna* associations were recorded by Pethybridge and

Praeger in 1905 large areas are more or less devoid of vegetation now and the 8 to 12 ft. (2·5—3·5 m.) depth of peat is being washed downhill.

Five stages in this erosion/denudation process are traceable in the Wicklow Highlands, ranging from Stage I (the appearance of surface blow-outs; as on Liffey Head bog at 1,700 ft. (510 m.) to Stage V (recolonization of mineral detritus by plants such as *Rumex acetosella*, as on Kippure summit at 2,473 ft.) (742 m.). At greater elevations, as on Mullaghcleevaun, 2,788 ft. (835 m.), and Lugnaquillia, 3,039 ft. (912 m.) there is now a post-erosion sub-alpine sward, where it would appear there was formerly a cover of blanket-peat. For instance in 1951 north-east of Percy's Table on Lugnaquillia at *circa* 3,000 ft. (900 m.) there was found a vestigial peat " hag " 3 ft. (90 cm.) high. On the same visit, in April, 1951, at 2,300 ft. (690 m.) a fresh deposit of eroded peat was found, up to 1 m. thick and measuring 3 m. by 1 m., resting on frozen snow from previous months. It would appear then that at the greater altitudes erosion is extremely dynamic to-day.

In the western blanket bogs also, down to sea-level, various stages of erosion may be seen, rather localized and somewhat puzzling in their distribution.

Now it seems to be commonly held among physicists, meteorologists, glaciologists and animal-ecologists to-day that there has been an appreciable rise in mean temperatures, at least in N.W. Europe, perhaps up to 2°C., over the past century, with most of the increase accruing in the past half-century. This or its consequences may be responsible for the breakdown of the high-level bogs.

If so and if the change is not merely a temporary oscillation it could mean:

(*a*) that in the long-term view both high-level and western blanket bogs are in the nature of " wasting assets ";

(*b*) That the scales are becoming weighted in favour of tree-growth, hill-pasturage improvement and reclamation generally on our peat-lands.

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