An ecological study of the vegetation of Claish Moss, Argyll

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AN ECOLOGICAL STUDY OF THE VEGETATION
OF CLAISH MOSS, ARGYLL

by

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SUMMARY

This dissertation deals with the plant ecology of Claish Moss, a series of excentric raised bogs developed on fluvio-glacial sands beside Loch Shiel in Argyll.

An initial study of the series was made using aerial photographs, which revealed the existence of distinct zones of vegetation.

A study of the whole series would have been impractical in the time available for fieldwork, so a representative area containing all the major zones of vegetation was selected after a thorough reconnaissance of the series.

A quantitative description of the vegetation in the study area was made using an adaptation of the 'point-quadrat' method (Levy and Madden 1933). Structured tables were prepared from the floristic data using the Zurich-Montpelier methods of tabulation. This allows comparison with similar sites described by continental workers.

The vegetation was then described in the light of the quantitative analysis and observations made in the field.

An investigation of habitat factors was made which allows correlation between features of presumed ecological importance and position on the mire surface.

The relationship between habitat factors and the vegetation on different parts of the mire was investigated further by studies on the performance of *Molinia caerulea*, *Narthecium ossifragum* and *Eriophorum angustifolium*. In the final Section, the importance of the chemical template and water regime of the mire in determining the make up of the vegetation and performance of plant species on different parts of the mire are discussed.

The problems of development and erosion are discussed and areas of further study suggested.

C O N T E N T S

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SECTION ONE

INTRODUCTION

1. INTRODUCTION

1.1 Location of the Study Area

Claish Moss is situated on the south shore of Loch Shiel in Sunart Argyll (O.S. grid ref. 710677).

1.2 Description of the Site

Claish Moss is composed of a series of strikingly patterned raised mires lying almost at sea level (c 10m.) The site occupies a wide belt of gently sloping ground between Loch Shiel and a ridge of upland separating Loch Shiel and Loch Sunart. Fig. 1.1.

The excentrically domed units of the series are separated by streams which drain northwards from the upland into Loch Shiel. The units vary in width from several hundred yards to over one mile, the total extent of the series being nearly three miles and covering some 1,198 acres.

The series is recognised as being one of the finest and least disturbed examples of excentric domed mire in the British Isles, and is listed as a Grade I site by The Nature Conservancy.

The presence of excentric domed mires like Claish Moss, within the blanket mire systems of Western Scotland is of great interest, because they are lying well outside zone 6 of the distribution of the main types of mire system found in Europe. Bulow (1918). Bellamy (1972). See Appendix. Fig. I. It points to the fact that long cold winters are not an essential template feature for this type of mire to form, Cajander (1913). Tolonen (1967).

Excentric mire complexes have been described by Ruuhijarvi (1960) and Eurola (1962). The main area in which this type of mire complex is found is the North Karelian region of Finland. Claish Moss is closely comparable to the excentric raised mire described by Eurola, which is characterised by a raised peat mass on gently sloping ground, and which possesses alignment of pools and ridges along the contours of its slope. Plate 1.

Despite being climatically less restricted than blanket bog, raised bogs are a decidedly local type in Scotland (Ratcliffe). Most of them occur on more or less flat ground in the lowlands, where rainfall is low (750 mm p.a.); the necessary degree of wetness being maintained by the absence of slope. However this relative dryness of climate is not a necessary requirement as is shown by Claish Moss, under the extremely humid climate of West Argyll. (2120 mm p.a. Inverailort).

It would seem that the scarcity of suitable flat, or gently sloping sites is one of the major factors contributing to the scarcity of raised mire complexes in the mountainous country of the Western Highlands.

1.3. Geology

The solid geology of the area is largely Moinian, a complex of metamorphic rocks; with intrusions of tertiary igneous rocks. See Appendix. Fig. 2.1.

In the upland regions this bedrock often occurs at or near the surface, but in the flatter stream valleys, and on raised lake and marine terraces, the bedrock is covered by layers of drift.

The peats of Claish Moss lie on fluvio glacial sands and gravels, deposited on an old lake terrace. Appendix. Fig. 2.2.

The bedrock pierces the tertiary peat in a number of places where outliers from the upland occur on the plain.

It is interesting to note that in the Bergslagen district of Sweden (Sjors 1948), mire complexes largely consisting of mosses built up eccentrically are mainly distributed on sandy or gravelly, highly permeable glacio fluvio, glacio lacustrine or ablation sediments in broad valleys. Soligenous (rheophilous) mire sites on the other hand, predominate in the mire complexes resting on less permeable till of the slopes of hills and undulating plateaus.

1.4 History

Comparison with basal pollen assemblages with those from other sites in Scotland, permits the estimation that peat began forming at Claish Moss as early as the Flandrian period, perhaps at about 9,000 BP.

At this initial stage in development the peat forming community was a floristically diverse marsh with much Juncus. The ridge hollow system became established approximately 5,000 years ago, the pools forming when less than 2 m of peat had accumulated on the gently-sloping site. P.D. Moore (1977).

1.5 Climate

1. Temperature Conditions

Some data of the temperature conditions experienced at Claish Moss are given in Fig. 1.2.

The averages for air temperature were estimated by the Meteorological Office, and assume a height above mean sea level of 10 metres. In no month of the year does the air temperature fall below 0.6°C. The average monthly temperature is 9.9°C, and the average diurnal range varies from 5°C in January to 8°C in May. Ground frosts may be encountered, with the last frost occuring in mid-April, and the first frost in mid-October.

2. Precipitation Conditions

Claish Moss lies on the very humid coastal belt of Western Scotland which recieves a mean annual number of 200 wet days. British Rainfall 1947-1956. A wet day is defined as a period of 24 hours during which 0.04 inches or more of rain is recorded. See Appendix. Fig 3. Longterm, 1941-1970, monthly averages of rainfall for Inverailort, a Meteorological Office co-operating station lying 12 miles to the north-north east of the site, also at 10 m above mean sea level are given in Fig 1.3.

Daily recordings of precipitation were taken during the period of field work. These can be compared with the 24 hour rainfall amounts for May, June and July 1977 at Inverailort. See Appendix. Fig 4.

Accurate relative humidity figures are difficult to obtain for the site, the nearest station for which averages are available is on Tiree, which is an entirely different environment. However, from maps supplied by the Meteorological Office, the percentage of time with relative humidity equal to or greater than 80%, 90%, 95% and 99% can be given for the area.

Percentage of time with r.h.	⩾ 80%	=	75%
" " " " "	⩾ 90%	=	40%
" " " " "	⩾ 95%	=	25%
" " " " "	⩾ 99%	=	10%

For further details of relative humidity see Appendix Figures 5, 6, 7 and 8.

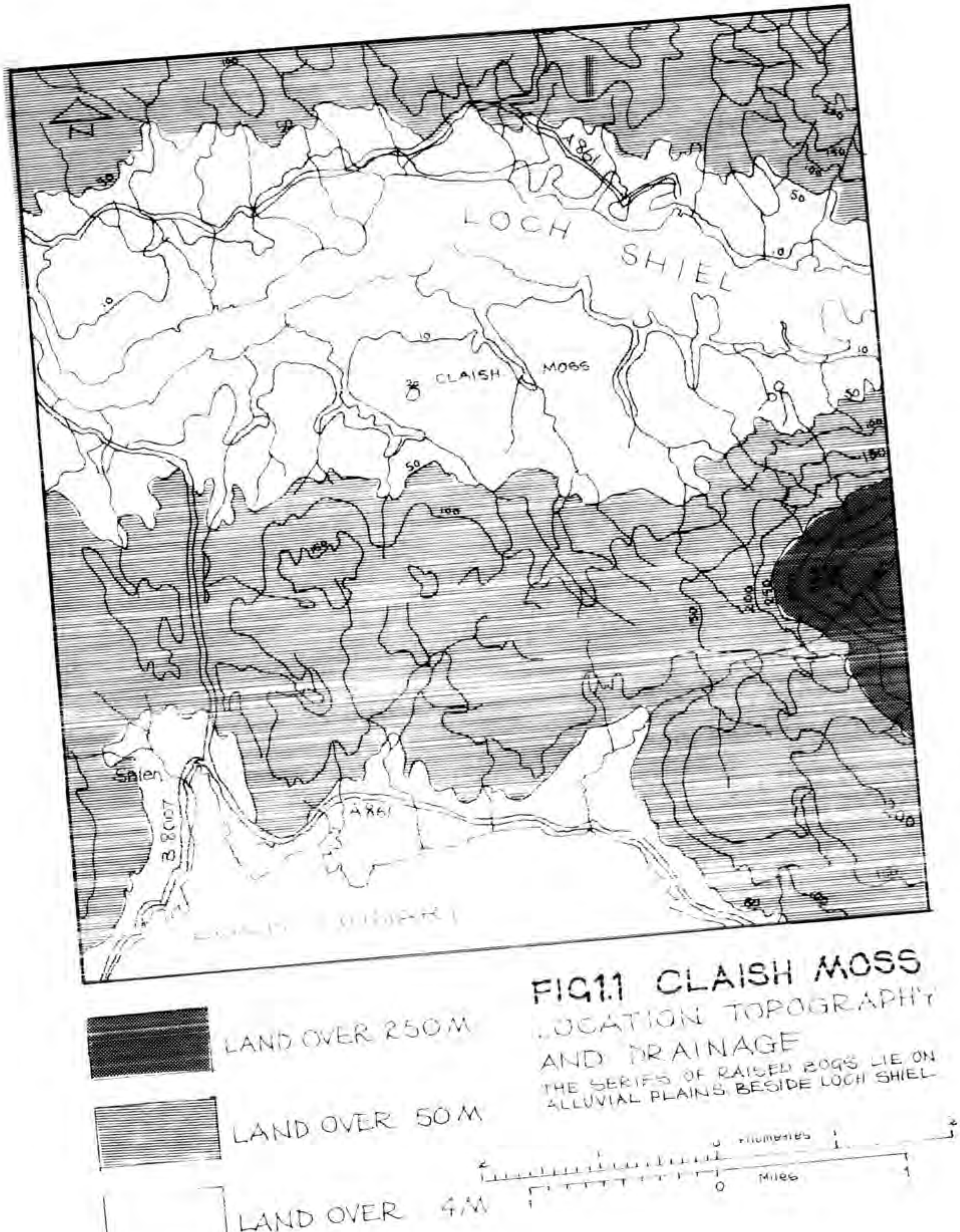


FIG1.1 CLAISH MOSS
LOCATION TOPOGRAPHY AND DRAINAGE
THE SERIES OF RAISED BOGS LIE ON ALLUVIAL PLAINS BESIDE LOCH SHIEL

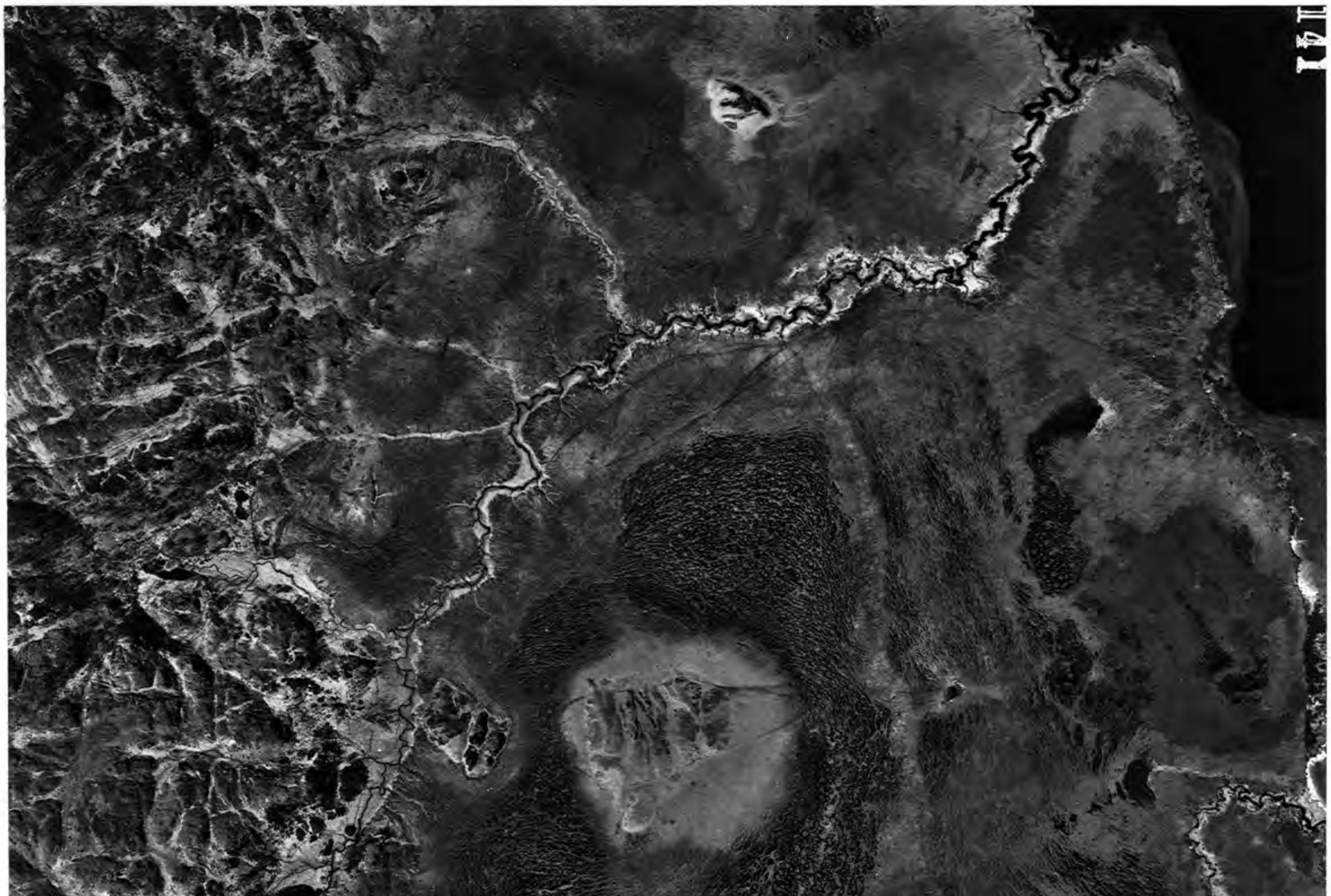


PLATE 1

Aerial View of the Study Area, Claish Moss

The study area is one of a series of raised bogs on alluvial plains beside Loch Shiel. The raised hummock-hollow complexes are separated by lagg streams with Molinietum and transitional rands. Eroded systems are very distinct in aerial view and at first accentuate the concentric pattern of alignment, although a more complete erosion leads to a breakdown of the pattern, and dissection of the surface into an irregular assortment of hags and ridges.

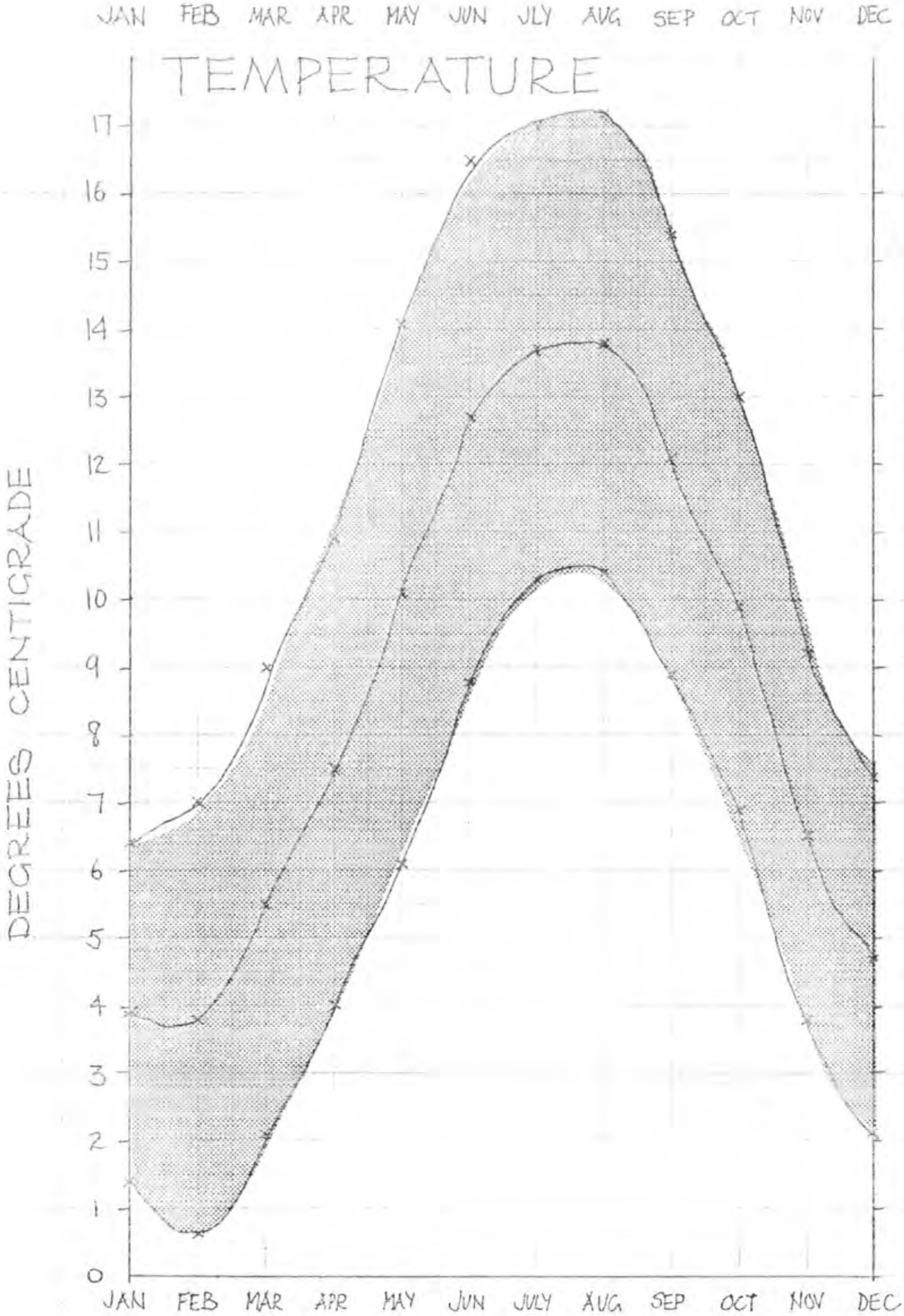


FIG.1.2. Estimated averages of daily maximum, minimum and mean air temperature for the period 1941 to 1970 at Claish Moss assuming a height above mean sea level of ten metres.
Data from Meteorological Office.

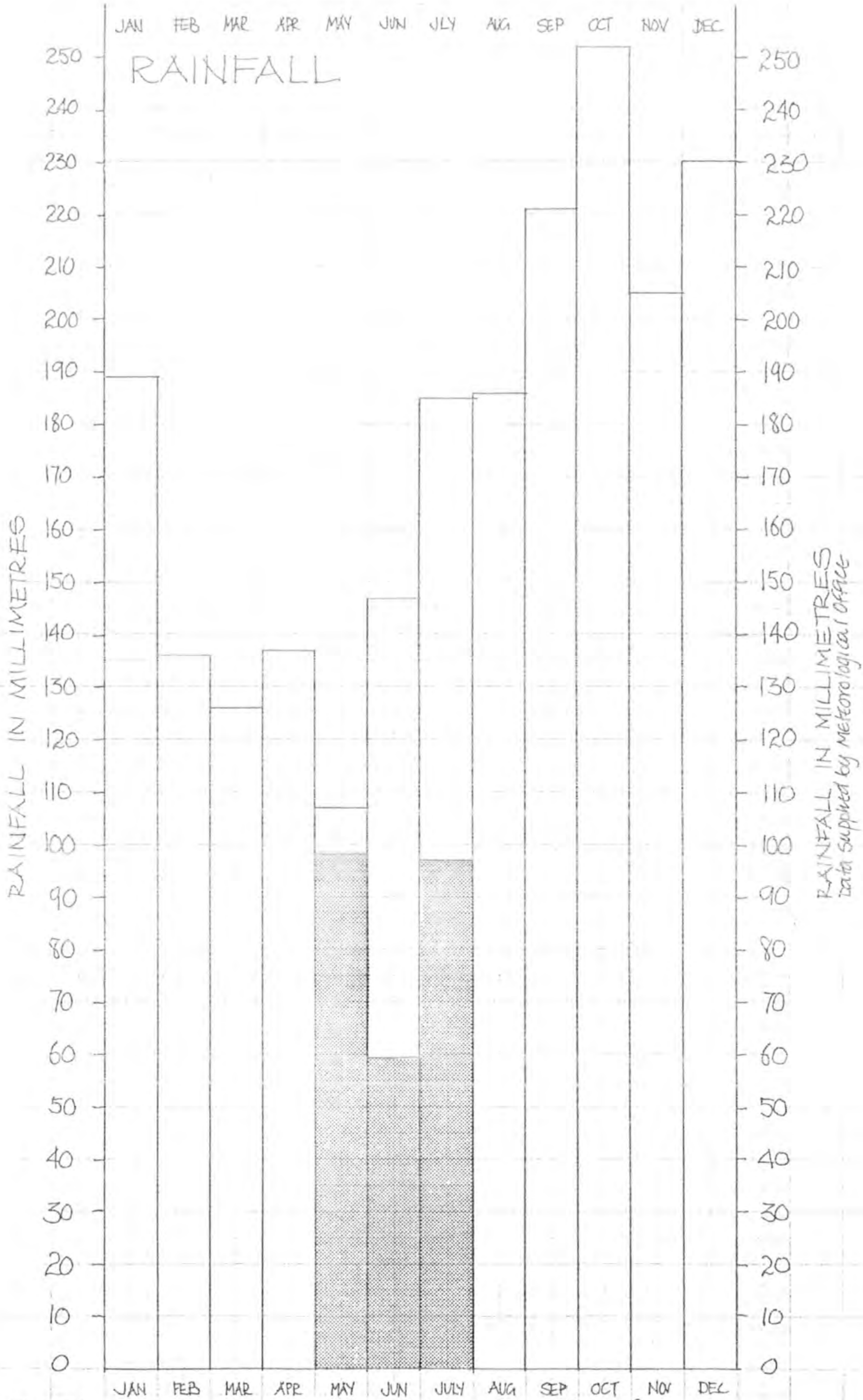


FIG. 1.3. Long-term, 1941-1970 monthly averages of rainfall at Inverailort, 9 miles NNE of Claish Moss. Shaded columns are the monthly totals for May, June and July 1977.

SECTION TWO

DESCRIPTION OF THE VEGETATION

2. DESCRIPTION OF VEGETATION

2.1 Use of Aerial Photographs

Before commencing fieldwork, a careful study of aerial photographs yielded much information about the topography, drainage and major zones of vegetation on the mire units. See Plate I. These are described below.

2.1.1 The Laggs

The word 'lagg' has been adopted as a scientific term to describe wet areas subject to ground water flow, and which separate the mire proper from the mineral edges of the basin.

In the aerial photographs the laggs are seen as light areas associated with stream basins and surrounding outcrops of rock. This light colour can be attributed to Purple Moor Grass, Molinia caerulea, which dominates the vegetation of the laggs.

2.1.2 The Rands

'Rand' is a term applied to the sloping edges of the raised bog, between the patterned mire and the lagg. These are seen as mid-grey areas on the photographs, and can be distinguished from the patterned mire by the absence of developed surface features. A mixed-sward vegetation is characteristic of this zone, darker patches indicating relatively dense stands of Calluna vulgaris.

2.1.3. The Ridge and Hollow Systems

Perhaps the most striking of all the features revealed in the aerial photographs are the areas of patterned mire or 'ridge and hollow' complex. These are characterised by the aligned pools and ridges which lie at right angles to the slope of the ground. Several stages of development can be seen. Around the margins of the cupola, and also beginning to develop on parts of the rand, the hollows are shallow and have a closed cover of vegetation. Where erosion has commenced, the pattern of alignment is first accentuated by open mud-bottomed pools, but where it is advanced the pattern breaks down into an irregular assortment of hags and ridges.

An interpretation of the zones apparent in Plate 1 is shown in Figure 2.1.

2.2. Field Work

2.2.1. Reconnaissance and Site Selection

A reconnaissance of the whole series was made on arrival at Claish Moss, enabling features revealed in the photographs to be experienced on the ground. Having thoroughly explored the site, a representative study area was selected which would embrace the whole range of vegetation types and environmental features characteristic of the site.

The area selected for study corresponds with that shown in Plate I and Fig. 2.1.

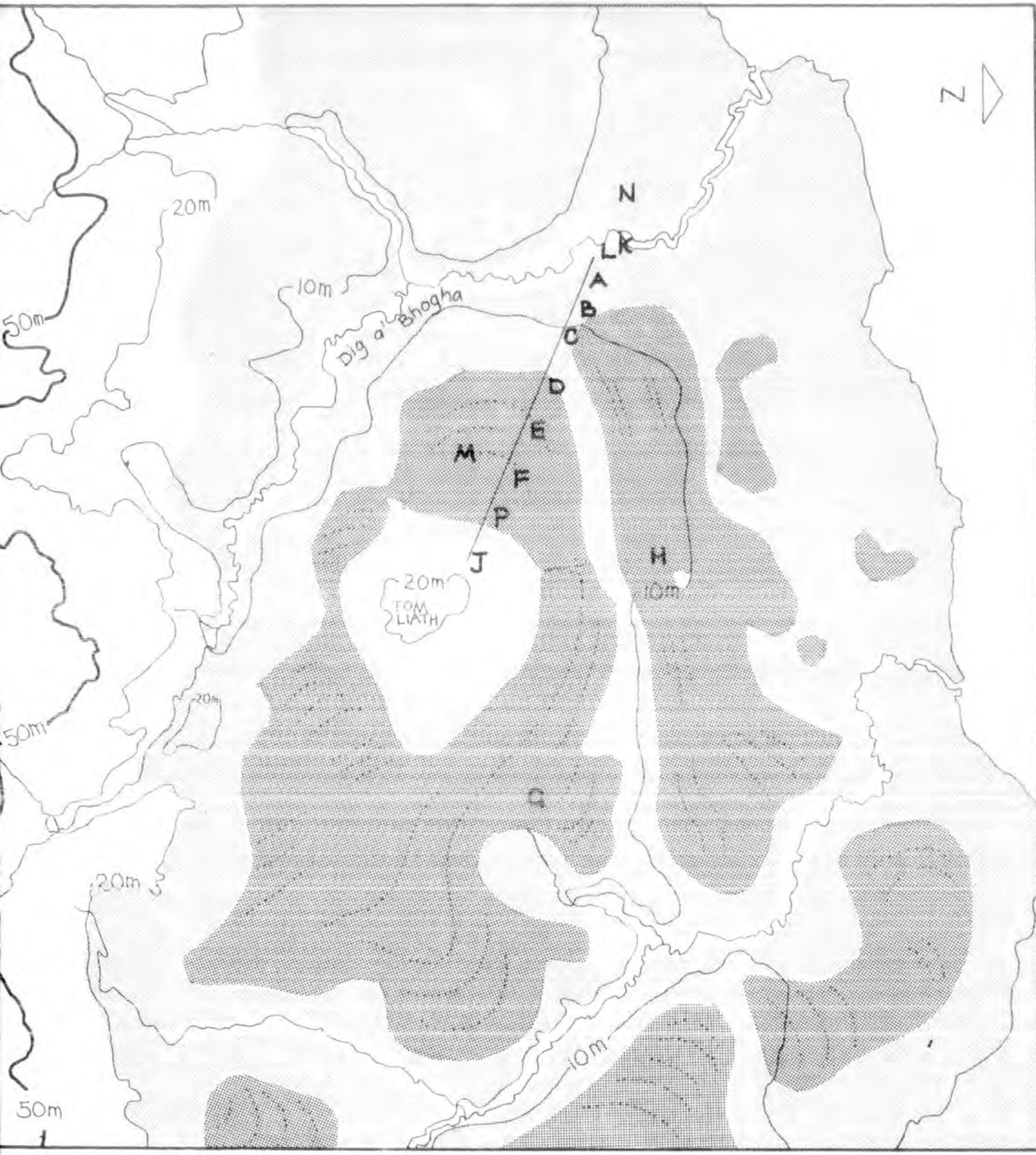
2.2.2. Quantitative Description of the Vegetation

Because of the scale of stands of vegetation found in nature, it is rarely practical to carry out a survey of the whole stand. Instead, representative areas within each stand are selected and the vegetation within them described.

Two problems have to be overcome at the outset: Choice of a practical method of vegetation description, and the siting and size of the representative areas.

There is perhaps no single best method for the quantitative description of plant populations, and the choice will depend on the time available for field work, the type of vegetation encountered, and the method used for the analysis of data collected. J.J. Moore (1970).

At Claish Moss the vegetation was described using an adaptation of the point quadrat method. This convenient way of recording both species presence and percentage cover was probably first introduced by Levy and Madden (1933). The original method employs a frame of



LAGG AREAS WITH MOLINIETUM

TRANSITIONAL RANDS WITH LAWN COMMUNITIES

HUMMOCK-HOLLOW COMPLEX DOTTED LINES SHOW PATTERN OF POOL ARRANGEMENT

FIG 2.1. THE STUDY AREA.

SHOWING MAJOR ZONES OF VEGETATION, AND POSITION OF THE SAMPLE STATIONS

SCALE 1:10 000

METRES

0 100 200 300 400 500 600 700 800

pins which can be adjusted to the height of vegetation. Each pin can be lowered individually and any plant hit by it is recorded. For each species the total number of hits from a series of sample frames is expressed as a percentage of the total number of pins used. Because in most stands of vegetation layering and overlapping of species occurs, the total percentage cover will nearly always exceed one hundred percent.

Exaggerated estimates of percentage cover may well arise if a large diameter pin is used. However, the method is preferred to a visual estimate of cover which is subject to personal bias. In this particular survey the data was collected for the purpose of comparing the different community types within the study area. It was felt that as long as the pin diameter was kept constant throughout the survey, exaggeration of percentage cover would not be too critical.

The point quadrat method was adapted to use a metre length of string with ten randomly placed knots. The string could be adjusted for height and was held taught above the vegetation between two canes. Plant species lying directly beneath each knot were recorded. A pencil was used as the pointer for plants in the shrub and herb layers, whilst a 'standard-pinch' of the moss layer was removed in each case to ensure that small liverwort species were not being overlooked.

In effect a transect was taken in each stand of vegetation, the number of contiguous metre lengths depending on the pattern and diversity of the vegetation.

2.2.3. Transect Siting and Size

The location of sampling sites may be decided by a number of methods. (Shimwell 1972).

a. Subjective assessment of a sample which gives the impression of being fairly representative of the stand or community type.

b. A series of partial random samples.

c. A series of random samples.

d. A series of regular spaced samples.

e. A series of contiguous samples in the form of a belt transect.

The photographic study and reconnaissance of Claish Moss established that there were zones of vegetation which appeared to correlate to the topography and drainage of the bog. A subjective method of site selection within these zones was chosen as it was felt that this was the most appropriate in the circumstances. Finding predetermined random points in the field can be extremely time consuming, particularly where there are few landmarks. (J.J. Moore 1970). It was felt that time could be more profitably employed in becoming familiar with the vegetation. Random sampling may also lead to the omission of obvious vegetation types if these are relatively small. A small area of 'fen-window' (Sensu Sjors) had been discovered in the reconnaissance which could easily have been missed using random sampling techniques.

In addition, on the more degraded areas of the hummock-hollow complex, it would be possible for a large number of randomly selected points to fall on empty mud-bottomed pools, thus giving a misinterpretation of the vegetation of that zone.

Because the zones were arranged around the cupola, each could be encountered by taking a line from the drog stream, Dig a' Bhogha, to the centre of the cupola. Additional sample sites could be set up where it was felt that the vegetation or the ecological features differed from the stations on the main transect line.

Having the majority of sample sites in a line across the bog had the advantage that they could be more easily relocated; each was marked with a tall stake.

See Fig 2.1. for location of the sample plots. Positions L, K, A, B, C, D, E, F, P and J lie on the main transect line. L and K sample the drog stream vicinity and lagg. A, B and C sample the rand. D, E, F, and P sample the major cupola. Station J samples the lagg surrounding the rock outcrop.

Extra sample sites include M, G, H and N. M and G were selected because they represent more advanced stages of erosion than were encountered on the main transect line. H is situated on a lower level than the main cupola, but is in an area where a ridge hollow series is developing. N lies outside the main study area, but was set up to sample a small area of 'fen window'.

The amount of information recorded at each station was determined by consideration of the scale and pattern of the vegetation. The stations were positioned where there appeared to be a reasonable degree of uniformity in the composition of the vegetation. In most cases six contiguous one metre lengths ensured that all characteristic species were being recorded. Any additional species found outside the transect were noted. In the lagg areas where the stands were composed of almost pure populations of Molinia caerulea, only two or three metres were described.

In addition to the quantitative description of vegetation, notes were taken regarding angle and direction of slope, percentage total cover, and height of the stand.

In total, seventy one metre lengths were sampled at thirteen sites on the study area in May. An additional station was set up in June where a further six metres of vegetation were described. Fifty-four plant species were recorded.

To speed up the recording of transects, a coding system was devised in the field using abbreviated forms of the plant names. An example of the field notes are shown in Appendix. Table I. All data was transferred from the field book to a neat copy after each days field work. This was an insurance against loss or water damage to the field book.

Initially difficulty was experienced in identifying some plant species. In these cases a sample of the plant was placed in a bag and coded to the position on the transect. These plants were keyed down after each days field work, and entered into the appropriate point on the transect.

2.3 Tabulation of Data

2.3.1. The Raw Table

When data had been collected from every station it was brought together in a single table. No attempt was made at this stage to sort out groups of recurring species.

This 'raw' table is presented in the Appendix, Table 2, and adopts the form used by the Zurich-Montpelier School of Phytosociology. Each one metre length, or 'relevé' is given a number and assigned a vertical column. The plant species are listed alphabetically under group headings of shrub, herb, moss, liverwort and lichen.

The numbers entered in this table are the actual number of occurences of plant species (each having a possible score of ten in any relevé). The total number of species occuring in each relevé is given at the base of each column. Straightaway it can be seen that there are relevés where certain combinations of species recur.

2.3.2. The Structured Table

The next step is to draw these species groups and relevés together by horizontal and vertical rearrangment of the table. To make the sorting of the table more manageable the data from individual metre lengths for each station are aggregated to give a grand total for each station.

This structured table is shown in Fig. 2.2. Such tables allow direct comparison with description of similar vegetation carried out by continental workers. Information is presented in such a way that the structure of the vegetation can be understood at a glance, which is not possible from simple alphabetical lists of species.

In Table 4 of the Appendix, data is presented in the form of percentage cover. Using scales recognised by continental workers the percentage figure can be converted to cover values which reflect the importance of the component species. Several scales can be applied, all differing slightly in cover class delimitation.

In this study the Domin eleven part scale and the Braun-Blanquet six part scale are compared. The class limits are given in Appendix, Table 5 and these are applied to the Claish Moss data in Appendix, Table 6.

The Braun-Blanquet scale is applied to the structured data in Appendix, Table 7. Here an additional column at the right hand side of the table expresses the degree of presence and constancy of each species using the Braun-Blanquet five part scale, the class limits of which are given in Appendix, Table 8.

Table 2.2. THE STRUCTURED TABLE

Length of transects (m)	6	6	6	6	6	6	6	6	6	6	6	2	6	3
SPECIES	A	N	B	C	H	P	D	E	M	F	G	J	K	L
Molinia caerulea	29	19	50	40	22	21	12	11	13	7	12	20	47	14
Cladonia impexa	1	4		8	1	14	6	34	18	10	1	7	5	
Calluna vulgaris	43	40	7	18	15	19	12	23	24	22	15		8	
Erica tetralix	12	13	23	16	14	18	19	2	11		4		8	
Eriophorum vaginatum	53	31	22	5	9	10	8	5	2	5	1	16		
Hypnum cupressiforme	18	15	7	6	5		3	2	8	2	2	9	13	
Sphagnum rubellum	3	12	20	4	17	13	19	15	2	4		3	21	5
Sphagnum recurvum	17	24	8	12	2	7	8	11	1			1		
Odontochisma sphagni	25	23	31	21	17	21	24	16	5	6		8	15	
Mylia anomola	17	7	12	17	5	8	10			2		3	5	
Calypogeia fissa	10	2	2	1		2		1					6	
Trichophorum caespitosum		1	25	26	4	23	16	10	2	5			1	
Sphagnum magellanicum		7			4	13	3	4	2	2				
Sphagnum palustre			1	3		3		1				1	15	
Eriophorum angustifolium			10	5	13	6	22	16	10	21	9		3	
Sphagnum cuspidatum			6	3	16	2	14	2	3	1				
Plurozea purpurea			1		2	16	3	10	3					
Rhacomitrium lanuginosum				12		3	2	20	17	35	33			
Sphagnum papillosum				1	10	9	3	1	6	3				
Cladonia uncialis				2	4	1		5	4	9				
Narthecium ossifragum		5			1	16			7	3				
Drosera rotundifolia		2				12			1					
Hypnum ericetorum	2	36				1							7	3
Dicranum scoparium	3		4		2								7	
Myrica gale	1										2	5	3	
Rhyncospora alba							4	10	4					
Sphagnum Plumullosum						16							14	
Sphagnum compactum							5				4			
Menyanthes trifoliata									1	1				
Plagiothecium undulatum													10	3
Juncus effusus													3	13
Agrostis tenuis													2	1
Leucobryum glaucum		4												
Phragmites communis		10												
Hylocomium splendens					1									
Sphagnum auriculatum							1							
Campylopus atrovirens									5					
Carex nigra										1				
Campylopus flexuosus											1			
Lephozia bidentata													1	
Thuidium tamariscinum													4	
Festuca ovina													1	
Hypogymnia phaysodes													1	
Ranunculus repens													2	
Rhytidiadelphus squarrosus													3	
Anemone nemorosa														1
Potentilla erecta														1
Veronica officianalis														1
Filipendula ulmaria														1
Ranunculus ficaria														1
Ranunculus acris														2
Ctenidium molluscum														5
Eurynchium praelongum														1
Poa pratensis														1
TOTALS	14	18	16	18	20	22	20	20	22	18	11	10	25	14

SECTION THREE

DESCRIPTION OF THE VEGETATION IN THE LIGHT OF THE STRUCTURED TABLE

3. DESCRIPTION OF THE VEGETATION IN THE LIGHT OF THE STRUCTURED TABLE

The constancy of many plant species across the whole mire surface is immediately apparent from structured data in Table 2.2.

Station L is the only real exception to this pattern, but here vegetation does not strictly form part of the mire proper as it is developed on sand not peat.

The zones described under Section 2.1. are upheld by the floristic analysis, but they are differentiated only by the addition or subtraction of species from the same basic matrix of constants.

The reasons for this uniformity of species will be discussed in Section 6.

The vegetation will be described here under the following headings.

3.1. The Drog Stream

As stated above, the vegetation in the immediate vicinity of the drog stream does not strictly form part of the true mire vegetation. It is characterised by species which only occur on the flood plains of the streams, i.e., Stations K and L in the structured table. Species include: *Juncus effusus*, *Agrostis tenuis*, *Poa pratensis*, *Anenome nemorosa*, *Potentilla erecta*, *Veronica officianalis*, *Filipendula ulmaria*, *Ranunculus ficaria*, *R. acris*, *R. repens*, *Plagiothecium undulatum*, *Ctenidium molluscum* and *Eurynchium praelongum*.

3.2. The Stream Associated Lagg

Large areas of the drog valleys are dominated by almost pure stands of *Molinia caerulea* which form well defined tussocks. Other species are poorly represented, and channels between tussocks are usually occupied by leaf litter. Other species which do occur in the *Molinia* dominated communities are *Juncus effusus*, which may itself form dense clumps, and isolated examples of Anenome nemorosa.

Trees make an appearance in the basins formed by the drog stream. Species include Quercus petrae, Alnus glutinosa, Betula sp. and Salix sp.

3.3. The Rand

There is a marked contrast in the vegetation when moving up from the drog basin onto the rand. Species present on this transition zone are members of the bog community as a whole. Over much of its area the rand is notable for its sward like appearance, interrupted by the presence of Calluna vulgaris and Myrica gale.

Constant species for the zone include Calluna vulgaris, Erica tetralix, Myrica gale, Eriophorum vaginatum, E. angustifolium, Molinia caerulea, Trichophorum caespitosum, Narthecium ossifragum, Drosera rotundifolia, Sphagnum papillosum, S. rubellum and Hypnum cupressiforme.

This corresponds to the Trichophoreto-eriophoretum typicum of the western blanket bog, Sensu McVean. Ratcliffe (1962).

The sphagna are represented here by Sphagnum recurvum, S. rubellum, S. magellanicum, S. palustre and S. cuspidatum; Sphagnum recurvum and Sphagnum rubellum being particularly abundant. Sphagnum cuspidatum appears in samples at stations B and C. At station B it appears where a free water surface has developed in such features as eroded deer tracks. Station C is on the steep slope up from the rand to the cupola, and here some shallow depressions are water filled after prolonged wet periods.

This slope can be seen as the beginning of the transition from rand to ridge hollow system. Pools are extremely shallow and temporary. Three species make an appearnace here which form an important part of the vegetation of the cupola. These are Rhacomitrium lanuginosum, Sphagnum papillosum and Cladonia uncialis.

Liverworts are associated with the hummock building sphagna and include Odontochisma sphagni, Mylia anomola and Calypogeia fissa.

Vascular plants are abundant on the rand, and when seen from a distance give the impression of dominating the vegetation. Eriophorum vaginatum, Molinia caerulea and Trichophorum caespitosum give the rand its characteristic mixed sward appearance, which is relieved only by Calluna vulgaris, Erica tetralix and Myrica gale.

Calluna vulgaris forms quite dense cover in places, particularly where the rand borders the drog streams, and also along the northern edge of the study area bordering Loch Shiel. Here the peat mass ends abruptly in a low cliff which is subject to erosion by the Loch during periods of high water level. The more rapid drainage in these areas is possibly responsible for the more luxuriant growth of Calluna which attains a greater height than in any other zone, except for the eroded and isolated hummocks in the most degenerate parts of the cupola.

One small area within the rand was distinguished by the presence of Phragmites communis, a fen indicator species. In most other respects the vegetation here was indistinguishable from the surrounding Trichophoreto eriophoretum; except for the presence of Leucobryum glaucum and a greater abundance of Narthecium ossifragum.

3.4. The Ridge Hollow Systems

The transition from rand to ridge hollow system is a gradual one. As mentioned in 3.2. the transition commences on the steep slope up from the rand to the cupola. What is apparent from the structured table is the increase in the number of plant species over and above the constant species which constitute the vegetation of the rands. Exactly which species are present, and in what proportion seems to depend very much on the physical conditions prevailing on different parts of the cupola.

However, there is a general trend in the importance of some of the species which were dominant on the rand. In the field layer, there is a decline in the abundance of Molinia caerulea and Eriophorum vaginatum; and a similar decline of Sphagnum recurvum in the moss layer. This is matched by an increase in the importance of Trichophorum caespitosum and Eriophorum angustifolium in the field layer; and Sphagnum magellanicum, S. palustre, S. papilosum, S. cuspidatum, Rhacomitrium lanuginosum, Cladonia uncialis and Plurozea purpurea in the moss layer.

The reasons for the increase in numbers of species is almost undouptably the much modified hydrology of the cupola, which provides additional habitat conditions to those found on the rand. This subject will be discussed in detail in Section 6. Here, the vegetation of the different areas of the cupola will be described.

3.4.1. The Margins - Stations D, P, and H.

Around the margins of the main cupola the pools are shallow and generally have gently sloping margins running into the sward. The vegetation cover is complete, the pools being defined by the presence of Sphagnum cuspidatum or Zygogonium; many of the latter become concealed by leaf litter from Molinia caerulea. The pools may also be fringed with Rhyncospora alba.

3.4.2. The Hummock-Pool Complex - Stations E, F, M, and G.

In the centre of the slope of the cupola, the pools have steeper margins and the dividing ridges are generally higher. The flat ridges still bear the same lawn communities found at the margins, but the striking difference is the development of large hummocks of Rhacomitrium lanuginosum. These may rise as much as a metre above the free water surface of the pools. Plates 2 and 3. There is an interesting zonation of species from the pool to the top of the hummock. The exact composition depends on the degree of erosion, and fluctuation of the water level in the pools.

Where the pool margin is shallow, but maintains a fairly constant level, it may be fringed with Rhyncospora alba, or Sphagnum cuspidatum.

These species give way to Sphagnum papillosum; and sometimes Sphagnum palustre where the bank is shaded for prolonged periods. Campylopus atrovirens may also be present at this level. Higher, on the drier levels these species give way again to Sphagnum rubellum, Sphagnum magellanicum and sometimes S. recurvum. In the summer Drosera rotundifolia and D. anglica were often associated with the Sphagnum and Campylopus hummocks.

The flat ridges carry quite diverse vegetation, including Calluna vulgaris, Erica tetralix, Eriophorum angustifolium, Molinia caerulea, Trichophorum caespitosum, Cladonia impexa, C. uncialis and Plurozea purpurea as well as the hummock forming Sphagna. Narthecium ossifragum was abundant on the ridges, particularly on the shoulders round the ridge margins.

In the centre of most ridges large hummocks of Rhacomitrium lanuginosum have developed.

To begin with other species are able to compete with the Rhacomitrium, but once a certain level has been reached, only Calluna vulgaris, Eriophorum angustifolium, Molinia caerulea and the Cladonia species are able to compete. At its maximum development, the Rhacomitrium achieves true dominance. Compare Fig. 3.1. and Fig. 3.2. Where there are large fluctuations in water table, the lower levels of this zonation are missing and the ridges fringed with bare peat or scattered plants of Eriophorum angustifolium. This is the case in Figs. 3.1. and 3.2. Many of these pools are subject to complete drainage in the summer, and the sphagnum species are replaced by growths of Menyanthes trifoliata and Eriophorum angustifolium. Plates 4 and 5.

In the most advanced stages of erosion the number of species are reduced considerably as can be seen from Station G in the structured table. Here Calluna vulgaris, Molinia caerulea and Rhacomitrium dominate the vegetation. However, many of the Rhacomitrium hummocks are in decline and are badly eroded. Growth of Calluna is comparatively luxurious, particularly on the isolated hummocks in the centre of large pools. Plates 4 and 5.

It is worth noting that Sphagnum species are almost totally absent from this zone, Sphagnum compactum being the only representative. As would be expected, the Sphagnum associated liverwort species are also absent.

3.5. The Outcrop Associated Lagg

In the centre of the main cupola, a large outcrop of bedrock pierces the cupola. Plate 1. This is surrounded by Molinietum (Sensu McVean) and is presumably influenced by run-off from the outcrop. It differs from the drog associated lagg in that it is never likely to be completely inundated by flowing water. (It must be remembered, when examining stations J and L, that reduced numbers of samples were taken).

Molinia caerulea quite definitely dominates the vegetation, having 100% cover. Sphagnum species are reduced in numbers, being replaced in the moss layer by Hypnum cupressiforme. Calluna vulgaris is sparsely represented but was not picked up in the sample. Myrcia gale is present in the lagg, but plants are stunted and well scattered.

SUMMARY

The 'core' vegetation of the mire complex appears to be representative of the Trichophoreto eriophoretum (Sensu McVean and Ratcliffe), typical of ombrophilous blanket mire complexes over large areas of Western Scotland.

The presence of the atlantic indicator species Plurozea purpurea; the absence of Myrcia gale; and the reduced importance of Molinia caerulea in all the Cupola samples is of interest.

The main variation in this 'core' vegetation appears to be in two directions.

1. Impoverishment of the mire flora in eroded areas (Samples M and G).

2. Changes in the flora due to an increase in the abundance of *Molinia caerulea*; or an infiltration of new species in the vicinity of the drog streams.

Having ascertained the composition of the vegetation occuring on all parts of the mire surface, attention can now be focussed on an investigation of habitat conditions relavent to the performance of plant species. These are dealt with in Section 4.

PLATE 2

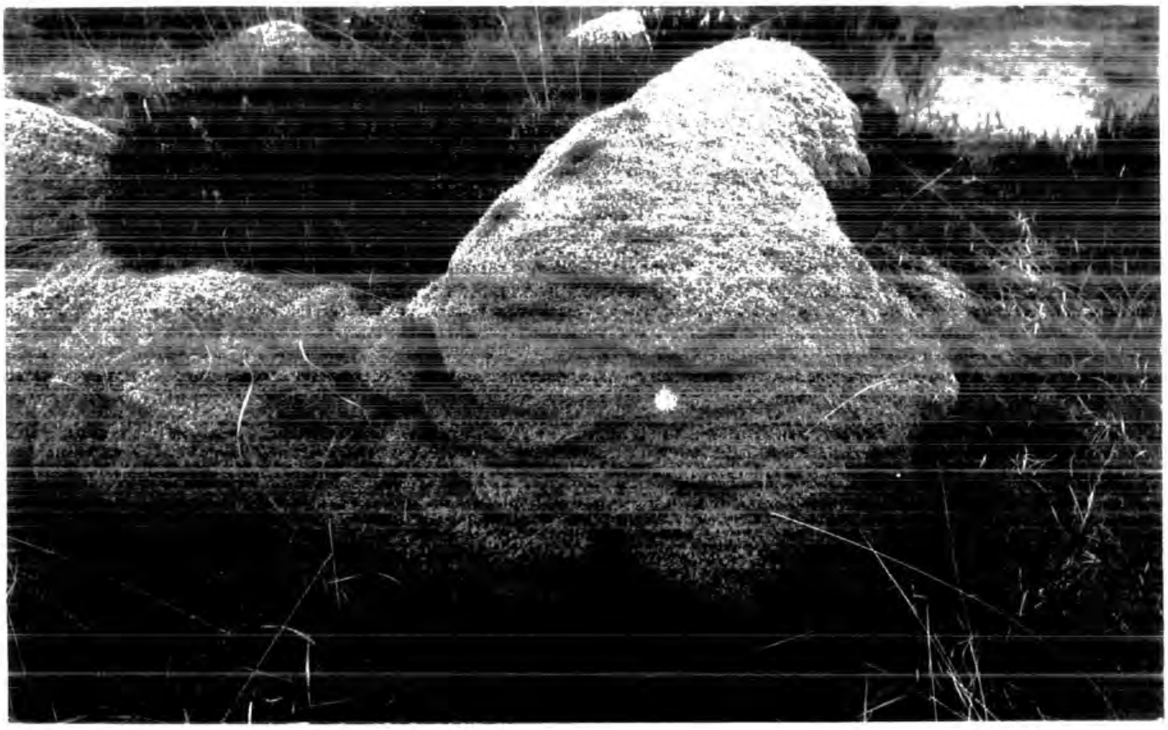


PLATE 3

Rhacomitrium Hummocks   Station F

In the degenerate areas pools are enlarged, often having steep margins. They are sparsely vegetated, whilst the flats and hummocks have largely dried out and numerous mounds of Rhacomitrium lanuginosum takes the place of sphagnum hummocks.

PLATE 4

PLATE 5

Advanced Erosion   Station G

Where erosion is advanced, pools become enlarged and joined, converting many hummocks into islands. Such pools usually have little or no sphagnum, although they may contain more robust growths of Menyanthes trifoliata and Eriophorum angustifolium. Many pools dry out completely in summer.

DETAILED PROFILE OF AN ISLAND HUMMOCK IN THE VICINITY OF STATION 'F' SHOWING A ZONATION OF SPECIES FROM POOL TO HUMMOCK TOP. FLUCTUATING WATER TABLE HAS RESULTED IN A BARE PEAT MARGIN TO THE ISLAND

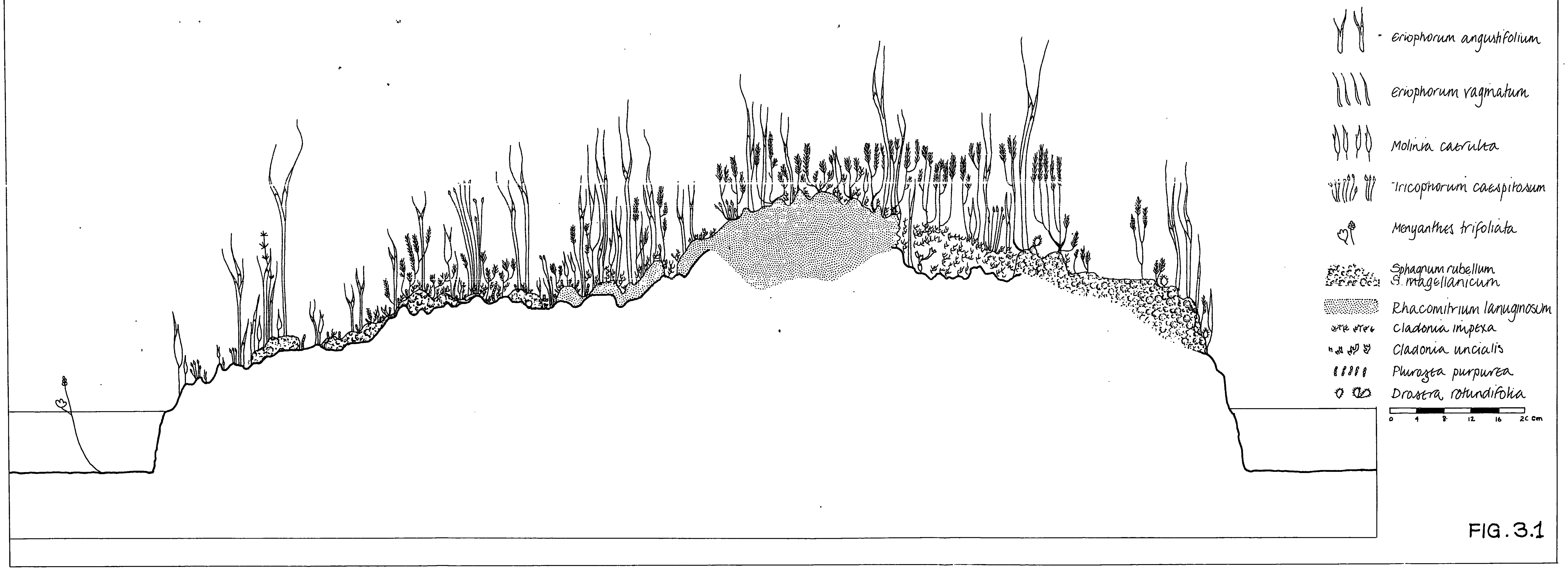


FIG. 3.1

DETAILED PROFILE OF AN ISLAND HUMMOCK
IN THE VICINITY OF STATION 'F', SHOWING ADVANCED
DEVELOPMENT OF RHACOMITRIUM LANUGINOSUM.

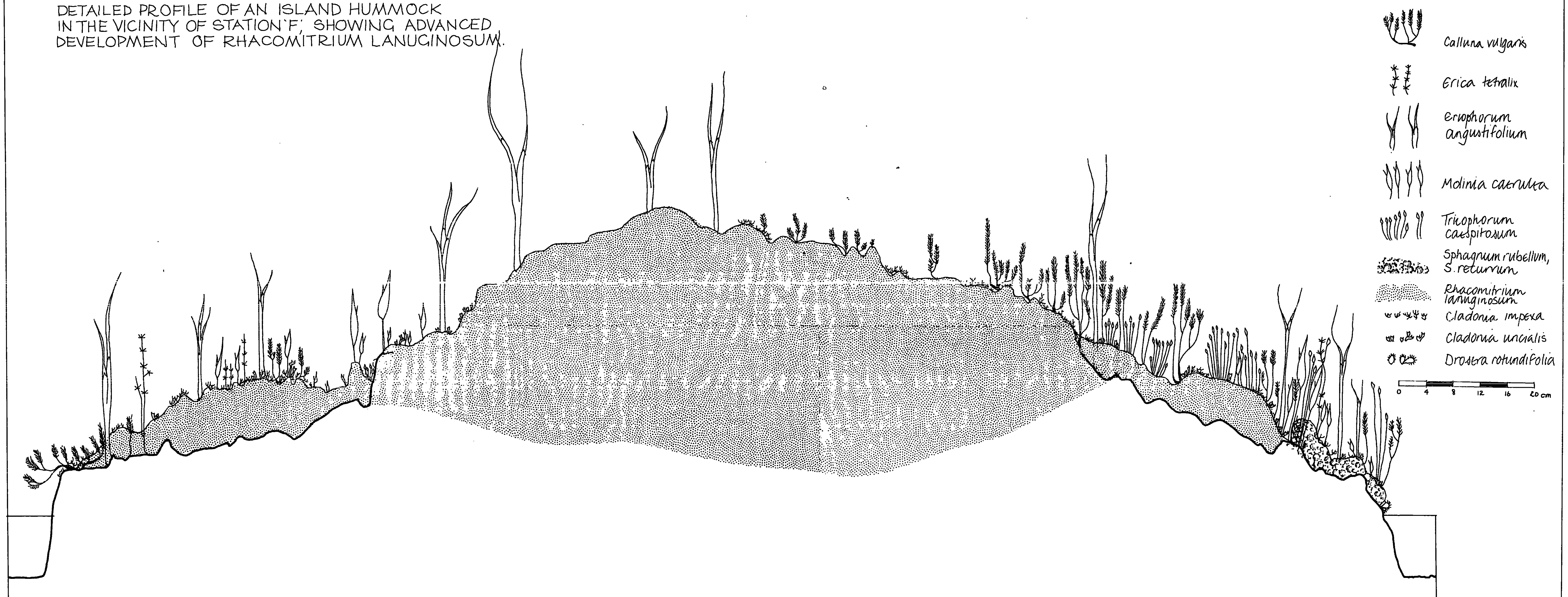


FIG 3.2

SECTION FOUR

HABITAT CONDITIONS

4. HABITAT CONDITIONS

The visual appraisal and floristic analysis of the vegetation reveal variations in its composition which can be attributed to the particular habitat conditions prevailing on different parts of the mire.

By investigating the individual physical factors contributing to the quality of the habitat, it was hoped to shed some light on their relative importance in determining the composition of the vegetation and the performance of the component species.

Peat depth and density, chemistry of the mire water and determination of the subsoil water level are dealt with in this section.

4.1. Peat Depth

Extendable steel sounding rods were used to measure peat depth. Three soundings were taken at each station to ensure that the rods were not being obstructed by subfossil wood in the profile.

The means of the three values are given in Table 4.1. Station L to J (in the table) are on the main transect line and as expected the peat mass increases in depth from the drog stream to the raised cupola. The measurement at L was taken in the stream bed, and was probably piercing wet sand rather than peat. The reduced depth at J is expected because of its proximity to Tom Liath, the outcrop of bedrock remaining above the peat mass.

TABLE 4.1. Mean Values of Peat Depth

STATION	L	K_B	K_T	A	B	C	D	E	F	J	M	G	H	N
PEAT DEPTH CENTIMETRES	199	31	43	118	202	313	454	500	510	210	478	412	244	206

It is interesting to note at this point that P.D. Moore 1977, has found from stratigraphy that the ridge-hollow series of the cupola started forming when less than 2 metres of peat blanketed the site. The peat depth at Station H, where a ridge hollow series is beginning to develop is 2.4 metres.

Station G and M are extra stations set up on the eroded areas of the hummock hollow complex. The depths here closely correspond with others on the centre of the cupola. The depth at station N outside the main study area corresponds with the depths at A and B, which are situated on the rand at the other side of the drog stream.

4.2. Peat Density

Cores of peat were removed at each station to compare peat densities across the site. A 5 cm. diameter corer was employed and the extracted peat samples were cut to 8 cm. lengths and stored in aluminium cans. Cores were removed from both lawns and hollows (or pools).

On return to Durham, the samples were weighed and then air dried in an oven at 100°C. They were reweighed at 24 hour intervals until the weights remained constant. Results are presented in Table 4.2.

As expected, the alluvial soils of the drog banks are heavier than the peats, and remain so after drying. In general, peat cores taken from mud bottomed pools are heavier than those taken from lawns or hummocks. This can be attributed to the high water content of the pool peats. After drying, the weights are much more comparable. The pool peats have much less fibrous material than the lawn and hummock peats and shrink considerably more on drying. This is an important factor in the progress of erosion on the cupola and will be discussed in more detail in Section 6.

4.3. The Mire Water

The origin of the water supply, and the fluctuation in its quantity are important contributors to habitat conditions. The origin of the water will have a bearing on the base status and pH, although these will be modified by the biota in the habitat.

Water level and flow are important in determining the plant species present, as these factors will have an effect on the amount of oxygen available to roots, the distribution of nutrients and the build up or removal of toxins.

4.3.1. Chemistry of the Mire Water

Background

Webster and Potonie (1908) classified mires on the basis of the chemistry and origin of the water. Three types were recognised; from those receiving water from outside the basin to those where the reservoir is fed solely by rain water. The three types correspond to the Rich Fen, Poor Fen and Moss of Sjors (1948).

The groups were defined by Thunmark (1942) and Witting (1948). Rich Fen and Poor Fen are separated by the 'calcareous water limit' at pH 6.8 and dissolved calcium content of 18 mg/litre. Poor Fen and Moss are separated by the 'mineral soil water limit' at pH 4.0 and dissolved calcium content of 1 mg/litre.

Sjors and du Rietz felt that these ecological limits were too strict, and favoured a continuum of variation from rich fen to moss, both in floristic composition of the vegetation, and chemical composition of the ground water.

Later workers in mire ecology, Kulczynski (1949) and Bellamy (1968) propose terminologies which link the hydrological, chemical and floristic data. Bellamy (1972) hypothesises the existence of seven mire types falling into three groups: Rheophilous (rich fen), Transition (poor fen) and Ombrophilous (moss).

Mire Types 1 to 4 are influenced by flowing water derived from outside the immediate catchment and are thus termed RHEOPHILOUS MIRES.

Mire Types 5 and 6 are influenced by ground water derived solely from the immediate catchment and are termed TRANSITION MIRES.

Mire Type 7 is completely isolated from flowing ground water; depending solely upon rainwater falling directly upon it, and are therefore termed OMBROPHILOUS MIRES.

In an effort to position Claish Moss in this classification of mire types, water samples were collected for analysis. To determine whether the floristics of the vegetation could be correlated with chemical conditions, water samples were drawn from Stations A to P inclusive. Samples were taken from the free, superficial water and the capillary water as the pH values and electrical conductance may be quite different. Weather conditions during the period of field work allowed samples to be collected after a period of rainy days, and after a long dry spell. Water was collected in equilibrated polythene bottles and allowed to stand for sediment to settle out.

Acidity of the Mire Water

Measurements of pH were made using a Pye Unican field metre equipped with temperature compensating symmetry control.

Electrical Conductivity

Electrical conductivity was determined using a portable measuring set manufactured by Electronic Instruments Limited, Model MCI MKV.

Ion Concentration

The major cation concentrations were measured using a Perkin Elmer 403 Atomic Absorption Spectrophometer. Chloride concentration was determined by titrating against 0.001 N HCI, the end point being established at pH 4.5 using a pH meter. Sulphate was estimated by balancing cation concentration against anion concentration.

The pH, electrical conductance and ion concentration values for each site are shown in Appendix. Table 10. Mean levels for the dry and wet periods are compared with values determined for Hydrological

Mire Types 6 and 7. (Bellamy 1968). Table 4.3.

Results

With the exception of the drog water (ph 6.4) (which has its origin in the upland south of the moss); the squeezed sample from the drog basin (pH 5.1) (which is subject to inundation by the drog), and the fen window (pH 5.1); the site is characterised by low pH (3.85 to 4.75). There is no appreciable difference between the pH values recorded after periods of wet or dry weather.

The mean pH values would place the site between Hydrological Mire types 6 and 7 (Sensu Bellamy).

The conductivity values for Claish Moss are high when compared with data from other Scottish bog and swamp waters. However, they can be compared with values from Dergoals Flow in Galloway. This is another extensive and low lying ombrogenous bog in a fairly undamaged state, and with similar vegetation to Claish Moss. The pH values for Dergoals Flow range from pH 4.10 to 4.16 and the conductivity values from 67 to 75. (Gorham and Pearsall 1956).

With the exception of the capillary waters from Stations M and G, the values of electrical conductance are fairly constant across the study area at Claish Moss. The capillary water samples have a consistantly higher value than free water from the same position. It is interesting to note the increase in electrical conductance after the dry period. Fig. 4.3. The mean values for the concentration of major ions would place the site in the type 7 mires (Sensu Bellamy). It would seem reasonable to conclude that the exceptionally high rainfall recorded in the area (2121 mm Inverailort); and the close proximity of Claish Moss to the Atlantic coast is an important factor contributing to the values of pH, and the concentration of major ions in the mire water.

Calcium concentrations are extremely low at Claish Moss, whilst

Table 4.3. MEAN VALUES OF pH, ELECTRICAL CONDUCTIVITY AND CONCENTRATION OF MAJOR IONS IN WATERS FROM HYDROLOGICAL MIRE TYPES 6 AND 7 (BELLAMY) AND FROM THE SAMPLE SITES ON CLAISH MOSS, ARGYLL

			TOTAL MAJOR IONS Milli equivalents/litre								
SOURCE	CONDUCTIVITY	pH	HCO_3	Cl	SO_4	Ca	Mg	Na	K	H	TOTAL
HYDROLOGICAL MIRE TYPE 6		4.1	0	0.4	0.4	0.2	0.1	0.3	0.04	0.14	1.58
HYDROLOGICAL MIRE TYPE 7		3.8	0	0.3	0.3	0.1	0.1	0.2	0.04	0.16	1.20
CLAISH MOSS 7.5.77 SAMPLES TAKEN AFTER RAIN. MEAN LEVELS FOR A, B, C, D, E. SUPERFICIAL WATER	69	4.15	0	0.2	0.1	0.028	0.078	0.2	0.01	-	0.65
WATER SQUEEZED FROM PEAT	74	4.30	0	0.3	0.24	0.048	0.094	0.322	0.08	-	1.09
SAMPLES TAKEN AFTER DRY PERIOD 27.5.77. DROG STREAM	90.5	6.4	0.37	-	-	0.206	0.15	0.40	0.036		1.58
MEAN LEVELS D, E, F, M, J, G, H, N. SUPERFICIAL WATER	82.5	4.15	0	0.36	0.10	0.03	0.096	0.32	0.022		0.94
WATER SQUEEZED FROM PEAT	125	4.25	0	0.206	0.20	0.038	0.082	0.236	0.05		0.81
SITE M SQUEEZED } ERODED SYSTEMS	148	4.0	-	0.50	0.07	0.03	0.15	0.386	0.02		1.16
SITE G SQUEEZED } ERODED SYSTEMS	238	4.0	-	0.75	0.65	0.13	0.40	0.813	0.05		2.79

sodium tends to be slightly above the mean values presented by Bellamy for type 7 mires, perhaps indicating the influence of salt spray. Sulphate concentrations are also lower than the mean value given for type 7 mires. Bellamy (1974) has suggested that with increasing 'effect of rainfall' there is a decrease in the importance of sulphate and hydrogen ions in the chemical makeup of the mire water.

Conductivity and ion concentration values are higher in those areas where erosion is advanced (see values for M and G, Table 4.3.) Station G is situated on the edge of a very large pool in the most degraded area of the cupola. When the site was visited in April, prior to the commencement of the field work, this pool constituted a large body of open water. Plate 4. During May and June the water gradually drained out, leaving a large area of bare peat, save for channels of flowing water which linked many of the enlarged pools of the eroded area. It is possible that this large mud bottomed pool is acting as a sink for salts received from a considerable area of the cupola. This combined with increased oxidation of the drained peats would explain the higher values of conductivity and concentration of major ions.

4.3.2. Determination of the Subsoil Water Level

The subsoil water level is defined as the highest level at which free (hydrostatic) water occurs, or would occur if there were sufficiently wide cavities in the soil or peat. All water below this level is termed subsoil water, and should not be confused with the capillary water, which will be considerably higher in a dense peat; or the mineral water. (Sjors 1948).

The height of the subsoil water level is important in that it determines the movements of water in a mire, the angle and direction of slope of the subsoil water surface regulates the velocity and direction of water flow.

This is because, under normal conditions a surface of free water is in equilibrium with water occuring in other states, viz water occluded in small cavities, capillary water, hygroscopical water and hydration water of gels.

Daily measurements of the changes in subsoil water level were performed in the study area at Claish Moss. Pits were excavated at each station, where a free water surface could develop. In an effort to standardise the measurements a piece of wood was laid over the pit, resting on the adjacent ground. The water level was then determined by measuring the distance between the water surface and the lower side of the wooden rod. Care had to be taken not to exert too much pressure on the surrounding peat, as this caused the peat mass to sink, and the water level to rise in the pit.

Results are shown in Fig. 4.1. together with daily rainfall figures from the site, and from Inverailort. No daily measurements of soil water level or rainfall were possible between 27th May and 21st June, but accumulated rainfall in the rainguage on Claish Moss can be compared with the total for the period at Inverailort.

The general trend was for the soil water level to sink over the whole bog surface, as would be expected during a long spell of dry weather. Fluctuations in the decline may be due to the difficulties in standardising daily measurements, or to the delay in rainfall reaching the soil water level. More measurements would be required to shed light on this matter. However, it is known from the literature, that when the water store of the mire is altered, for instance by a shower, the resulting alteration in subsoil water level is very different in different parts of the mire. The following effect has been described for a hummock and hollow complex (Sjors 1948). In the hummock, much water is present above the subsoil water level as capillary water leaving little space for the increase in free water caused by rain. The subsoil water level will therefore rise much more than the quantity of rain fallen.

In the hollow, this is the case only to s slight extent. Thus, the alterations in the water level are greater in those parts of the mire that are rich in hummocks, than those rich in hollows. They are also greater when the level of water is low, than when it is high, and greater in mire parts with little flow, than in those where flow is abundant. Where the damming threshold is low, high water levels are impossible. Fig. 4.2.

Of the stations measured at Claish Moss, the subsoil water level sinks by the greatest amounts at Stations A and B on the rand, and at Station G on the cupola. Here falls of approximately 22 cms are recorded over a period of 35 days.

At the rest of the stations, where measurements were taken for the same length of time, falls of 10 to 15 cms were experienced. These were mainly in the areas of the cupola rich in hummocks and hollows. The pits were situated on the flat parts of the ridges beside hummocks. It is possible that the hummocks are acting as reservoirs of water above the soil water level, whereas in the rand there are no such water stores to replenish the soil water level. Station G is in an area where the damming-threshold is low and the water is draining out of the system.

4.4. Summary of Habitat Conditions

With an understanding of the habitat conditions on the mire, it becomes clear that the major changes in vegetation are correlated with the water regime.

Moving ground water, or a fluctuating water table is indicated by the abundance of Molinia caerulea (Stations L and J). This association of Molinia with moving ground water is well known and the findings at Claish Moss support those of Jeffries (1915) and Rutter (1955).

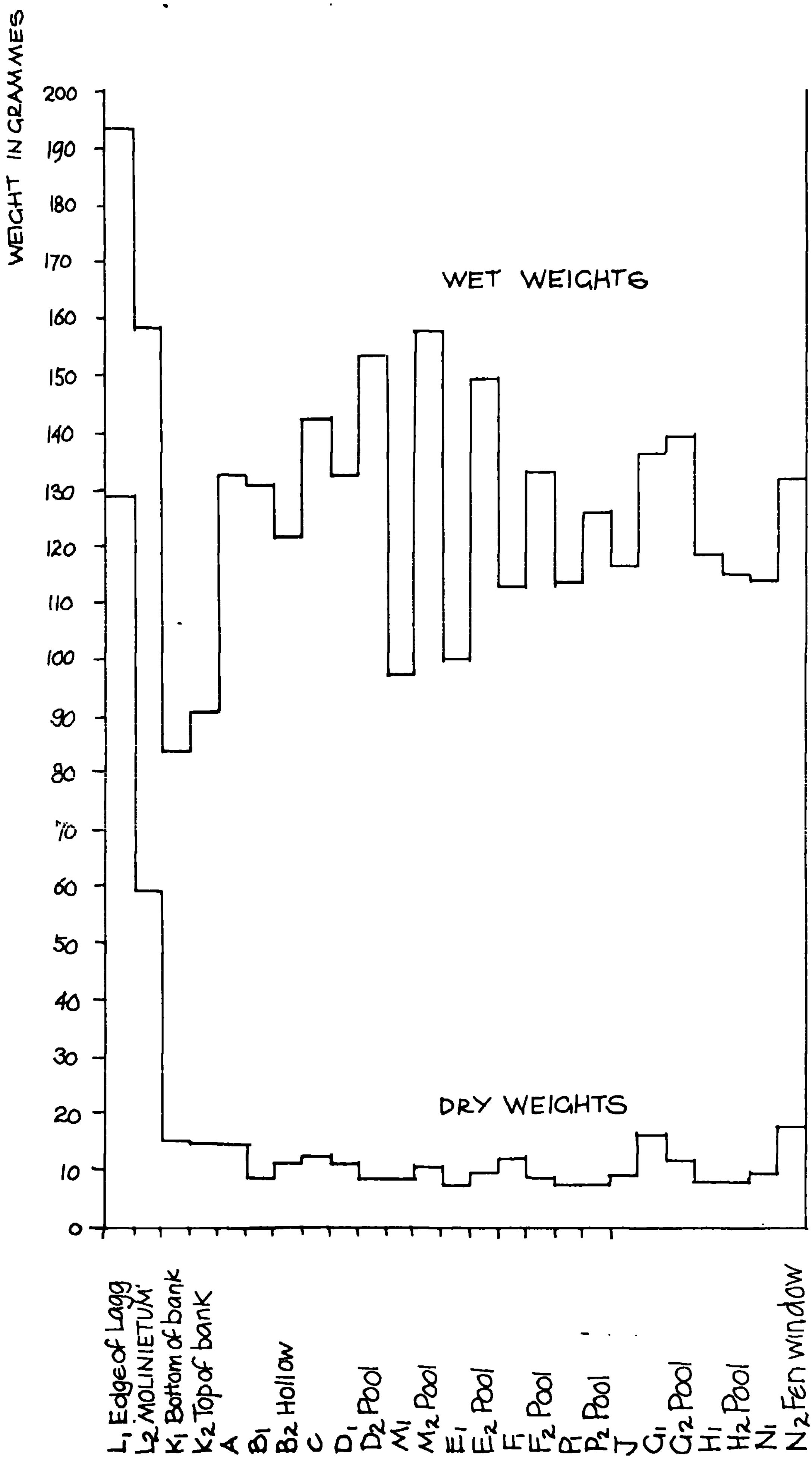
The scattered presence of Myrica gale in the lagg communities is interesting. Myrica is a bog margin species which becomes dominant in ombotrophic conditions where the number of rain days is in excess of 230 p.a. Claish Moss receives approximately 200 rain days p.a. making it a marginal habitat for Myrica except in areas of water flow.

Reduced water flow with increased distance from the drog streams has lead to a development of a hummock-hollow regime. In the early stages of development the hummock-hollow regime is not subject to large fluctuations in water table and the hollows and ridges are rich in Sphagna. As the system ages, the ridges build up and become drier allowing the establishment of Calluna vulgaris and Rhacomitrium lanuginosum. Algal growths in the wetter hollows oxidize the Sphagnum peat, Lundquist (1951) and the pools become progressively devoid of vegetation.

The hummock-hollow regime becomes overemphasised leading to the eventual collapse of the hummocks and further erosion of pools, many of which become joined, leaving isolated hags of peat. The fluctuation in water table is more akin to that of the rand in the more degraded areas and thus is marked by an increase in the abundance of Molinia and Calluna. See Fig. 4.3. for schematic diagram relating zones of vegetation to topography and water regime.

In order to investigate the relationship between habitat conditions and plant performance further, it was decided to compare the performance of three species which are important components of the vegetation throughout the mire.

TABLE 42. PEAT DENSITY.



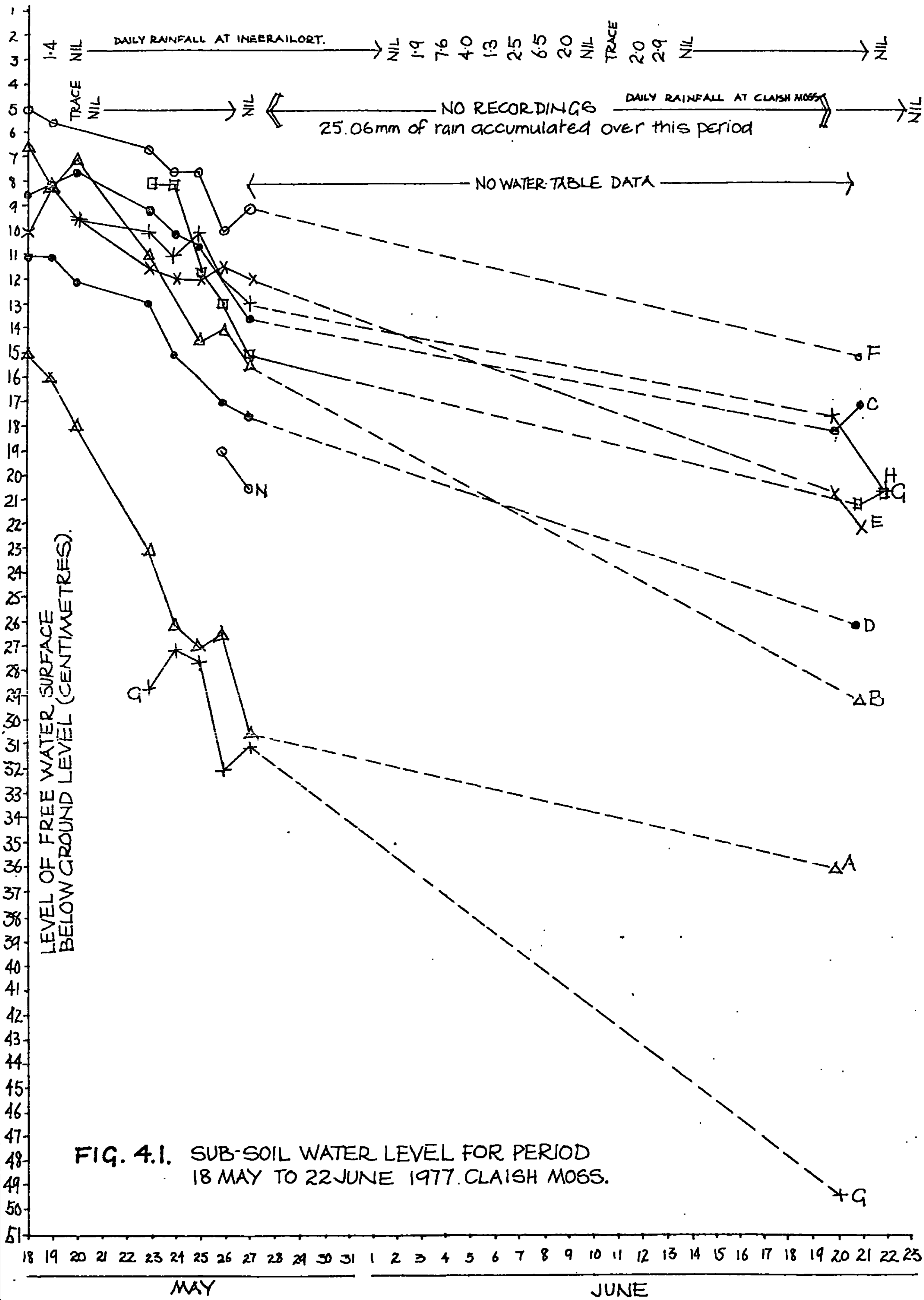


FIG. 4.1. SUB-SOIL WATER LEVEL FOR PERIOD 18 MAY TO 22 JUNE 1977. CLAISH MOSS.

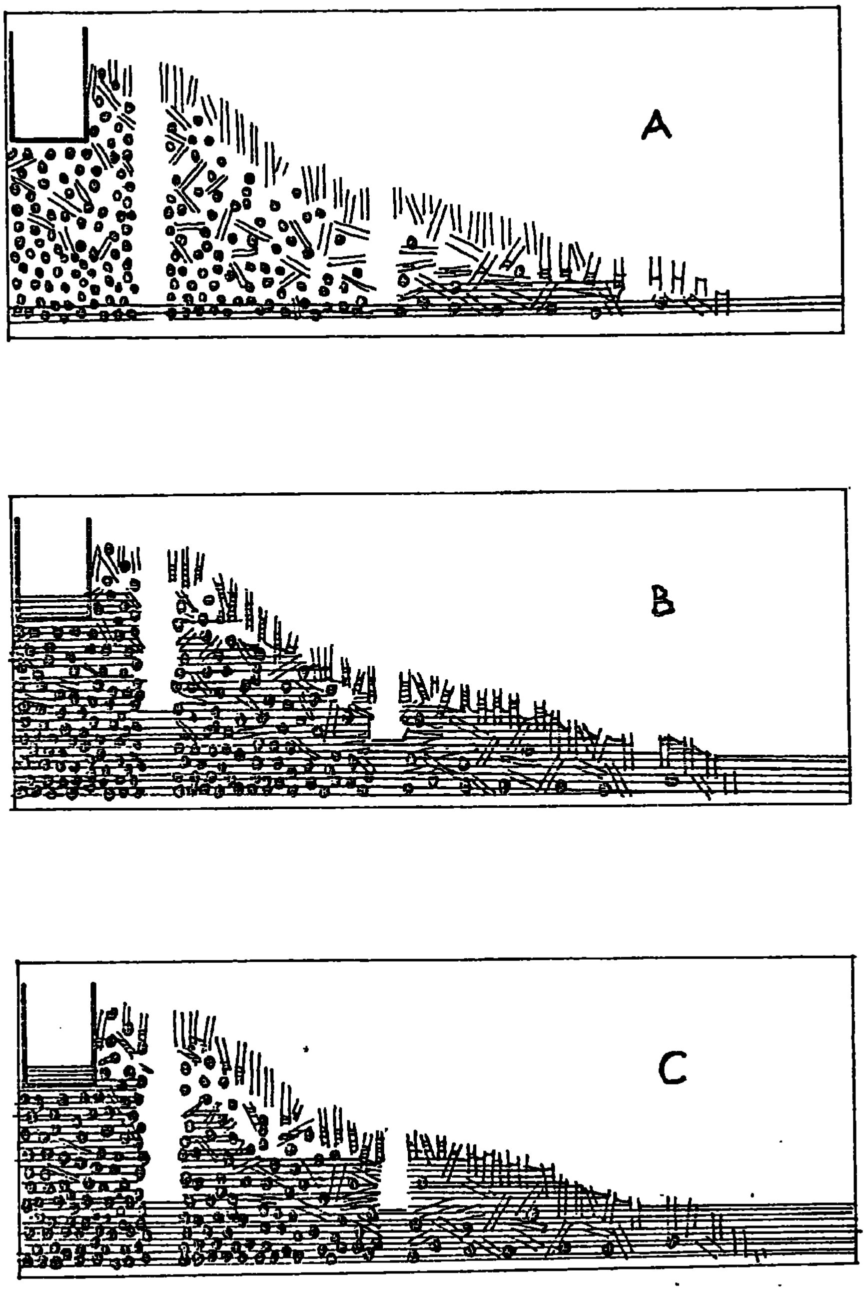
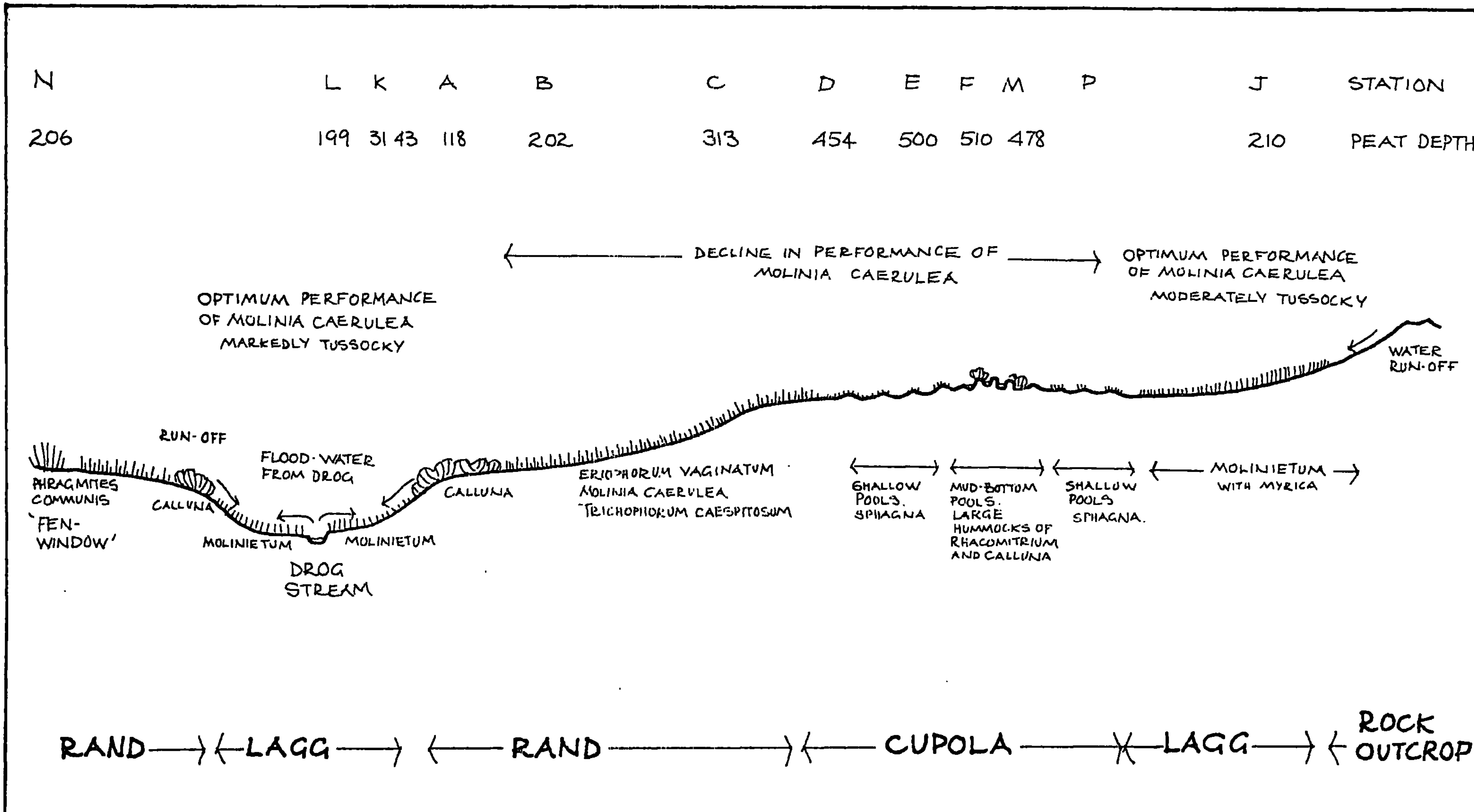


FIG 4.2

SCHEMATIC SKETCH OF CHANGES IN WATER LEVEL IN A HUMMOCK (LEFT) AND A HOLLOW (RIGHT) **A**, BEFORE RAIN. **B**, IMMEDIATELY AFTER RAIN. **C**, AFTER EQUILIBRIUM HAS BEEN RE-ESTABLISHED. (REDRAWN FROM HUGO SJORS 1948).

FIG 4.3 SCHEMATIC DIAGRAM OF THE STUDY AREA



SECTION FIVE

PERFORMANCE TESTS

5. STUDY OF SPECIES PERFORMANCE

It is apparent from the structured table that a number of plant species are constant throughout the study area. Although these companion species can not be used to differentiate exclusive groups of species, they may well be useful indicators of habitat conditions.

During the second period of fieldwork, in mid June, three species; Molinia caerulea, Eriophorum angustifolium and Narthecium ossifragum were selected for a study of performance.

It is accepted that a measure of some suitable character can be made which reflects the vigour or performance of an individual. Photosynthetic area, and reproductive capacity are good indicators of performance, making leaves or reproductive parts of the plant suitable characters for measurement.

In this study, total leaf length was the character chosen for a number of reasons.

i. It is quick.

ii. Flower spikes were not developed on the three species at the time available for study.

iii. All three plants have simple leaves which are easy to measure.

5.1. Method

Samples of the plants were collected at the stations used for the other investigations, thus allowing correlation with physical factors. Fifty samples of each species were collected at each station, unless it was present in limited numbers. In these latter cases a smaller sample had to suffice, but this was taken into account when the data was analysed.

Analysis of variance was carried out to examine the difference between the means of all the samples, using a one-way classification method. The method of working is shown in the Appendix.

In every case, the analysis concludes that samples had been drawn from populations with different means, i.e. that there are significant differences in the performance of the three species in different areas of the study area.

Mean leaf lengths for the three species are given in Table 5.1. and are shown against the number of strikes recorded for these species in the floristic survey. Some interesting points emerge from this study and it is worth looking at each species separately.

5.2. Molinia caerulea

Not unexpectedly, Molinia shows optimum performance for the site in the two lagg communities where it is the dominant species in the vegetation. Table 5.1.

Performance declines steadily from lagg to cupola, showing a positive correlation with the degree of fluctuation in the water table.

It is interesting to compare the performance of Molinia with its habit of growth.

In the lagg communities, the growth is tussocky, with each years growth developing on an accumulation of dead shoot bases. The size of the tussocks appears to increase with increased "wetness" of the soil. In the immediate vicinity of the drog which is subject to complete inundation, the tussocks are very large and the intervening spaces almost totally devoid of other vegetation. In the central lagg, the tussocks are developed to their greatest extent in the zone closest to the rock outcrop, becoming less well developed towards the ridge hollow development on the edge of the cupola. As this lagg receives run off from a limited outcrop of rock, this gradient in tussock size is of great interest. It seems unlikely that such a small outcrop would continue to affect the mineral regime of run-off water, a fact that is supported by the analysis of the mire water. (See Fig. 4.2.) Rutter (1955) has speculated on the importance of fluctuating water table and water flow in removing some factor from the habitat of Molinia, and Kulczynski (1949) emphasised the importance of flow in his concept of Rheophily. It is however difficult to distinguish between removal and supply by mass flow.

On the rand and cupola, the performance of Molinia is reduced as the ground water flow is reduced and the water table becomes more stable. In these situations it is not so aggressive and the tussock habit does not develop.

In general the mean values of performance are lowest on the hummock-hollow complex, but there is a marked increase in these values at Station M and G where erosion is advanced. Here the values are comparable with those on the rand, and it is likely that Molinia is again responding to the effect of water table fluctuation, whatever that may involve.

5.3. Eriophorum angustifolium

Eriophorum angustifolium is a pioneer species which does not compete well once the vegetation has become closed (Armstrong 1964). It is however, able to grow in conditions which many species find unfavourable, and Armstrong found that oxygen diffused rapidly from its roots, thus creating a sulphide free zone in its immediate vicinity.

In the light of this one might expect Eriophorum angustifolium to show better performance in those areas where there was more bare peat to colonise. This is not at first apparent from the mean values obtained, and it may be that this particular method of testing performance is not suitable for Eriophorum angustifolium. This hypothesis is supported by the fact that there were large numbers of young plants in the eroded areas which would tend to lower value for mean leaf length. It is worth noting, however, that the maximum performance in terms of leaf length occured in the fen window (See Table 5.1.), where the abundance of Molinia is reduced.

In retrospect, it may have been better to have used a different performance test for this species. A recognised test for E. angustifolium (Kershaw 1973) measures the ratio of length of triangulate tip of the leaf to the channeled portion of the leaf. This measures the relative growth rates of the shoot apex and leaf primordia, and therefore offers a good measure of performance and general vigour under different environmental conditions.

5.4. Narthecium ossifragum

It was mentioned at the beginning of Section 5 that these tests were carried out in mid-June. It was immediately apparent that Narthecium was more abundant, and more widely distributed throughout the study area than it had been in May. (See Table 5.1.) This is supported by the Nature Conservancy survey of 18th June 1973 when Narthecium is present in 37 out of 40 random quadrats. (Appendix, Table 9).

It also appears that the populations are out of phase in their development on different parts of the mire, making the results of the mean values impossible to interpret.

However, it is worth noting that at the stations where Narthecium made an early appearance, the mean values for leaf length are generally higher, indicating that the species maintained the advantage of a longer growing period.

The species was also very abundant on the shoulders of ridges in the hummock hollow complex, where rhizomes appeared at the surface and many young plants were present. As with Eriophorum angustifolium, the mean values may be biased by the large number of young plants.

Table 5.1.

PERFORMANCE TESTS:

MEAN VALUES OF LEAF LENGTH ARE SHOWN AGAINST SPECIES OCCURENCE

		RAND						RIDGE HOLLOW					DROG AND LAGG		
Length of Transect		6m	6m	6m	6m	6m	6m	6m	6m	6m	6m	6m	2m	6m	3m
STATION		A	N	B	C	H	P	D	E	M	F	G	J	K	L
Molinia caerulea	No. of strikes in releve	29	19	50	40	22	21	12	11	13	7	12	20	47	14
	Mean leaf length	29.7	28.4	29.2	23.7	25.8	24.2	21.9	26.4	28.8	22.4	28.4	35.8	34.6	45.4
Eriophorum angustifolium	No. of strikes in releve	-	-	10	5	13	6	22	16	10	21	9	-	3	-
	Mean leaf length	36.7	52.6	39.9	35.4	32.3	39.9	36.4	30.4	31.7	29.5	25.1	-	26.7	-
Narthecium ossifragum	No. of strikes in releve	-	5	-	-	1	16	-	-	7	3	-	-	-	-
	Mean leaf length	12.72	12.2	6.8	7.1	9.2	8.3	7.8	5.2	8.1	7.3	6.2	-	6.5	-

SECTION SIX

DISCUSSION

6. DISCUSSION

It is apparent from the floristic survey and investigation of habitat conditions, that there is a 'core vegetation' for the mire, which appears to be representative of the *Trichophoreto Eriophoretum Typicum* of McVean and Ratcliffe; and that the main variations within this vegetation appear to be attributed to the fluctuations in the water regime of the mire.

The only area where this pattern does not persist is in the immediate vicinity of the drog stream, where the communities are growing on sand, not peat, and are influenced by the minerotrophic stream water during times of flood.

The drog communities will therefore be considered before the peat forming communities.

6.1. The Drog Basin

Although there were difficulties in measuring the total range of fluctuation of water level in the vicinity of the drog stream, the author has good reason to know that the streams rise quickly and considerably during periods of heavy rain. The basins are inundated with flowing water, some of which must drain from the cupola and rand, but most of it is minerotrophic water draining from the uplands to the south of Claish Moss (Fig 1).

Water samples taken from the stream give values of pH 6.4, considerably higher than those taken from the ombrophilous peats. The drog water was also the only sample where dissolved HCO_3 was recorded; and the calcium ion concentration of 0.20 milli equivalents per litre is higher than anywhere on the mire proper.

The enriched water supply and higher base status of the alluvial soils, thus allow the infiltration of species not found on the more acid peat soils. This is clearly illustrated by the block of species appearing in the lower half of columns L and K of the structured table. (Table 2.2).

As mentioned in the summary of Section 4 and under Section 5.2, Molinia caerulea is the dominant species of the drog basin, supporting the observations of Rutter (1955), associating Molinia with areas subject to ground water flow and a fluctuating water table.

6.2. The Ombrophilous Peats of the Rand and Cupola

The uniformity of the component species on the tertiary peats (Moore and Bellamy 1974) can be attributed to the chemical template which is more or less common to the whole mire surface. Acidity ranges within narrow limits around pH 4; and although it was beyond the scope of the present study, it is doubted whether seasonal variations would be significant, bearing in mind the high monthly rainfall and comparative mildness of the climate. Conductivity and ion concentration are also fairly constant across the rand and cupola. Fluctuations in response to wet and dry periods of weather were observed (Table 4.3), but as the whole bog surface is experiencing the same climatic conditions the trends in direction of fluctuation should be the same. With these chemical conditions prevailing, the vegetation can only be composed of species which either tolerate or require acidic, base deficient conditions. These species make up the 'core-vegetation' of the mire. Variations in the make up of the vegetation depend on the physical conditions prevailing at different locations on the mire surface. It appears that the most important of the physical factors is the water regime of the various parts of the mire complex.

The importance of the position of the water table is stressed in Section 4 and the investigations described in that section reveal that the water table is subject to differing degrees of fluctuation in different parts of the mire.

Approximately the same quantity of water will be received in precipitation by all parts of the mire surface. This water can be lost from the mire to drainage and by evapotranspiration from the surface. Water is able to drain more freely from the bog edges into the drog streams or directly into the lake. Water flow is indicated by the abundance of Molinia caerulea (Rutter 1955) and poor fen indicators such as Eriophorum vaginatum. The areas of the rand close to the drog stream and lake edge often have a more luxuriant growth of Calluna Vulgaris. (See Station A).

In those areas of the mire largely isolated from the influence of drainage streams, lateral movement of water is greatly impeded, resulting in a more stable water table very close to the surface.

Moore's Stratigraphic Profiles of Claish Moss (1977) confirm that the initial peat forming vegetation developed under rheotrophic conditions and consisted of various species of Juncus and Carex.

Decreasing influence of ground water and lowering of the base status with time is indicated by the occurence of Sphagnum imbricatum and Calluna vulgaris. These species are accompanied by an invasion of Eriophorum vaginatum, suggesting that large areas of Claish Moss were now raised above the main influence of ground water.

It would appear that the formation of pools was initiated within this early E. vaginatum vegetation in those areas where the surface peat was subject to swamping.

It is interesting to note that once established, this pool pattern appears to have persisted to the present day, and the Molinia, E. vaginatum rich communities without pools, persists around the edges of the ridge-hollow complex.

It is within the more diverse conditions offered by the formation of hummock and hollows that additional species became established. These species are able to take advantage of both the wetter and drier conditions occuring on the ridge and hollow complex.

In the early stages of development, the vegetation of the ridges is similar to that of the rand, but the more constant high water table allows the establisment of hummock building sphagna, particularly Sphagnum rubellum, Sphagnum magellanicum and Sphagnum papillosum. The hollows are mostly shallow and where free water occurs are filled with Sphagnum cuspidatum and dense growths of algae. The soft mud margins often support lawns of Rhyncospora alba and Eriophorum angustifolium. At this stage peat is still being formed.

As the hummock-building sphagna raise the level of the ridges, other species are able to establish themselves, notably Rhacomitrium lanuginosum and Calluna vulgaris.

The Rhacomitrium hummocks are a conspicuous feature of the more mature areas of the hummock-hollow complex, and may reach a height of a metre or more. These dry hummocks are associated with more abundant growths of Cladonia impexa and C. uncialis. It is worth noting that at Station H where the ridge-hollow system is in an early stage of development, Rhacomitrium has not yet become established, and Cladonia sp. are poorly represented. This can be contrasted with Station E on the main cupola, where the hummocks are well developed. See Table 2.2.

In the pools there is a marked decline in the presence of sphagna, which is oxidised by the dense growths of algae. The heavy oxidised peat sinks to the bottom of the pools, where the sulphide rich conditions make it difficult for plant species to become established. Apart from more robust species such as Menyanthes trifoliata and Eriophorum angustifolium, the pools become devoid of vegetation.

This point having been reached, peat formation ceases both on the dry hummocks, and in the bare pools. The system goes into decline, the hummocks collapse, and the pools become enlarged by erosion.

The problem of erosion at Claish Moss is an interesting one, in that once it has started on a cupola, it would appear that it can spread over a very large area.

Erosion commences at the edges of bare pools where wave action can cut back into the ridges. During periods when the water level is high, the lower ridges are inundated by water flowing down slope from pool to pool. This was observed during the early part of the field work. Where the flow is concentrated, and the ridge is narrow, the peat ridge may be further eroded so that eventually pools become joined. In dry periods when the water level falls, the higher pools drain out leaving a soft bare peat.

On the cupola in the study area, it looks as if this process may have commenced in the region around Station G, where erosion is most advanced today. (Plate 1). Here water drains from the cupola in a well developed channel which runs down to the drog stream on the eastern boundary of the study area. Here pools have joined to form a large 'tarn' which is water-filled during wet periods but drains out completely in long dry spells.

These large areas of exposed pool peats shrink to a greater degree than the ridge peats on drying, causing a depression to form. It may be that this shrinkage is enough to tip the surrounding peat mass inwards, thus leading to drainage of surrounding pools, and therefore further erosion.

Heavy rain may also contribute directly to erosion by rapid run-off washing the exposed peat into pools and channels.

It would be interesting to carry out a long-term study on the progress of erosion to see if a turning point is reached when the system begins to heal again; with pioneer species such as Sphagnum compactum and Eriophorum angustifolium colonising the bare peat.

Summary

The topography, sandy substrate and exceptionally high rainfall, are very important factors in the development of Claish Moss from a rheophilous fen to ombrophilous patterned mire.

Minerotrophic water and alluvial soils in the vicinity of the drog have allowed the persistence of a vegetation not typical of the mire proper.

The chemical template prevailing on the rest of the mire surface today, has determined the establishment of a core vegetation. (See Table 2.2.)

Variations in the composition of this 'core vegetation' can be largely attributed to the differences in the water regime on different parts of the mire surface.

Molinia caerulea dominates those areas associated with ground-water flow and wide range of water table fluctuation. These lagg communities are essentially found at the bog margins.

Myrica gale (a marginal species at Claish Moss) is found in the lagg communities.

Molinia is less aggressive on the rands, which form a transition zone between the laggs and the main cupola. Here a mixed sward develops with much Eriophorum vaginatum.

Calluna is an important species on the better drained parts of the rand.

Where the water table is close to the surface and more stable, Sphagna become important and a ridge-hollow complex develops, alignment being determined by the gently sloping site.

With age, the ridges and hollows become hummocks and pools; peat accumulation ceases in both, leading to the collapse and erosion of the system.

There is some evidence to suggest that this may be a cyclical succession, with Molinia and Calluna showing improved performance as water flow and fluctuation associated with erosion increase; and bare peat is recolonised by Eriphorum angustifolium and Sphagnum compactum.

Final Note

In Section 1, it was mentioned that Claish Moss was of great interest in that here was an example of an excentric raised mire occuring well outside zone 6 of the Distribution of the European Mires. (Bellamy and Moore 1972). Although the reason for the presence of this type of mire on the Atlantic coast of Scotland has not been fully answered by this study, it is felt that a great deal has been learned about the evolution and plant ecology of Claish Moss itself.

Further study would benefit from a levelled survey of the site. The problems of accurately levelling such hummocky terrain are obvious and it would be impossible to measure the subtleties of slope. However, a series of profiles could be drawn up along which surface vegetation could be correlated with slope, peat depth and mire hydrology; and comparisons between profiles could be made.

A long-term survey to plot the progress of erosion on the hummock-hollow complex would also shed some light on the whole problem of the development of the surface features of patterned mires.

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APPENDIX

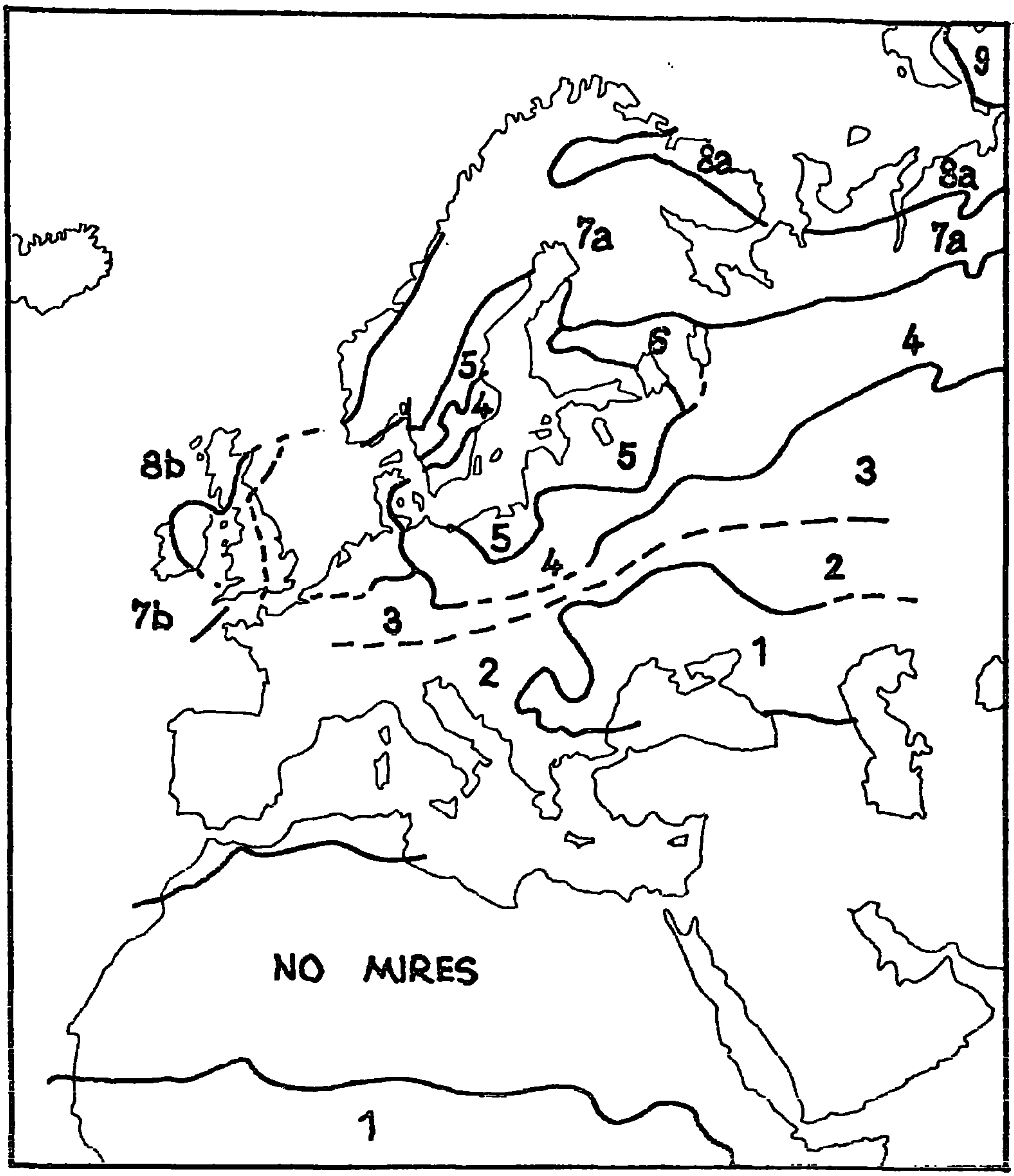


FIG. I. APPROXIMATE DISTRIBUTION OF THE MIRES OF EUROPE.
REDRAWN FROM BELLAMY (1972)

1 PRIMARY AND SECONDARY MIRES ONLY.
2 FLAT TERTIARY MIRES IN OPEN BASINS
3 FLAT TERTIARY MIRES IN CLOSED BASINS
4 PLATEAU MIRES
5 CONCENTRIC DOMED MIRES.
6 EXCENTRIC DOMED MIRES.
7a AAPAMIRES.
8a PALSAMIRES.
7b RIDGE RAISED MIRES
8b BLANKET MIRES
9 ARCTIC MIRES

THE LINES REPRESENT THE APPROXIMATE SOUTH-EASTERN LIMITS OF EACH TYPE.

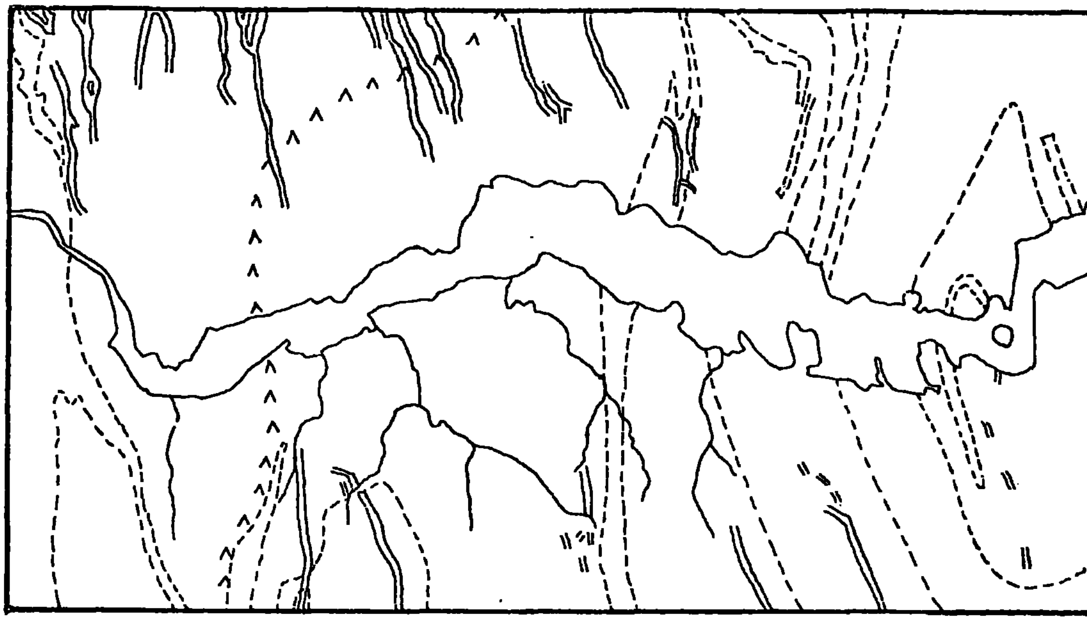


FIG. 2.1.

GEOLOGY : SOLID.

IGNEOUS : TERTIARY

DOLERITE, BASALT OR THOLEIITE, UNDEFINED

METAMORPHIC : MOINIAN

PSAMMITIC GRANULITE, LOCALLY CONTAINING SUBORDINATE SEMI PELTIC TO PELTIC BANDS

PELTIC SCHIST AND GNEISS LOCALLY CONTAINING SUBORDINATE PSAMMITIC TO SEMIPELTIC BANDS

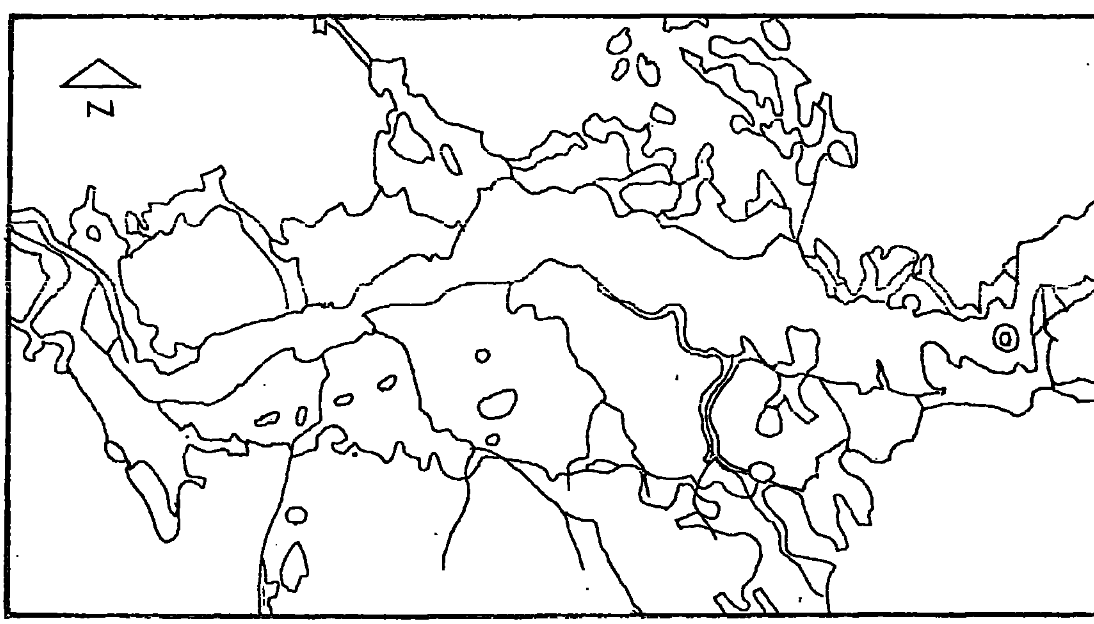


FIG. 2.2

GEOLOGY : DRIFT

PEAT

RAISED MARINE DELTA

MORANIC DRIFT

LAKE TERRACES

FLUVIO-GLACIAL SAND AND GRAVEL

BEDROCK AT OR NEAR SURFACE

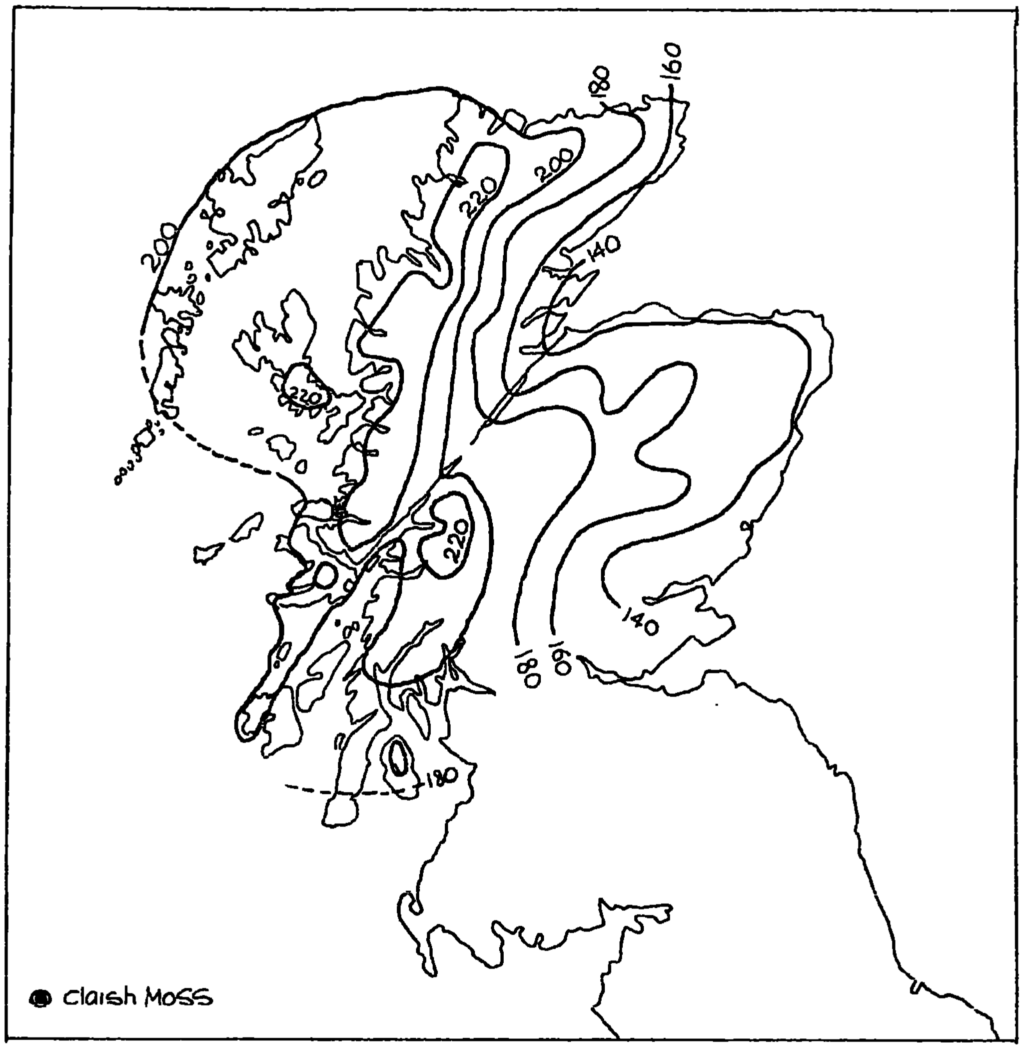


FIG 3 MEAN ANNUAL NUMBER OF WET DAYS (0.04") 1947 - 1956

FIG 4

TWENTY-FOUR HOUR RAINFALL AMOUNTS (MILLIMETRES) FOR MAY, JUNE AND JULY AT INVERAILORT AND FOR FIELD-WORK PERIOD AT CLAISH MOSS

DAY	MAY INVERAILORT	MAY CLAISH MOSS	JUNE INVERAILORT	JUNE CLAISH MOSS	JULY INVERAILORT
1	4.1		Nil		0.2
2	0.3		Nil		0.7
3	4.7		1.9		Nil
4	0.7		7.6		Nil
5	0.4		4.0		Nil
6	56.2	3.9	1.3		Nil
7	4.5	3.8	2.5		Nil
8	Nil	Nil	6.4		1.6
9	5.0	Trace	2.0		Nil
10	1.2	Nil	Nil		Nil
11	16.2	8.6	Trace		Nil
12	3.3		2.0		Nil
13	0.1		2.9		Nil
14	Nil		Nil		Nil
15	Nil		Nil		6.5
16	Nil		Nil		0.8
17	Nil		Nil		10.4
18	Nil	10.3	Nil		3.9
19	1.4	1.06	Nil		13.4
20	Nil	Trace	Nil	Nil	0.6
21	Nil	Nil	Nil	Nil	3.1
22	Nil	Nil	Nil	Nil	17.7
23	Nil	Nil	Nil	Nil	29.6
24	Nil	Nil	2.4	Nil	4.3
25	Nil		1.1		0.8
26	Nil		0.8		0.2
27	Nil		10.9		Nil
28	Nil		Nil		Nil
29	Nil		12.6		Nil
30	Nil		1.0		1.4
31	Nil		X		1.8
Monthly Total	98.1		59.4		97.0

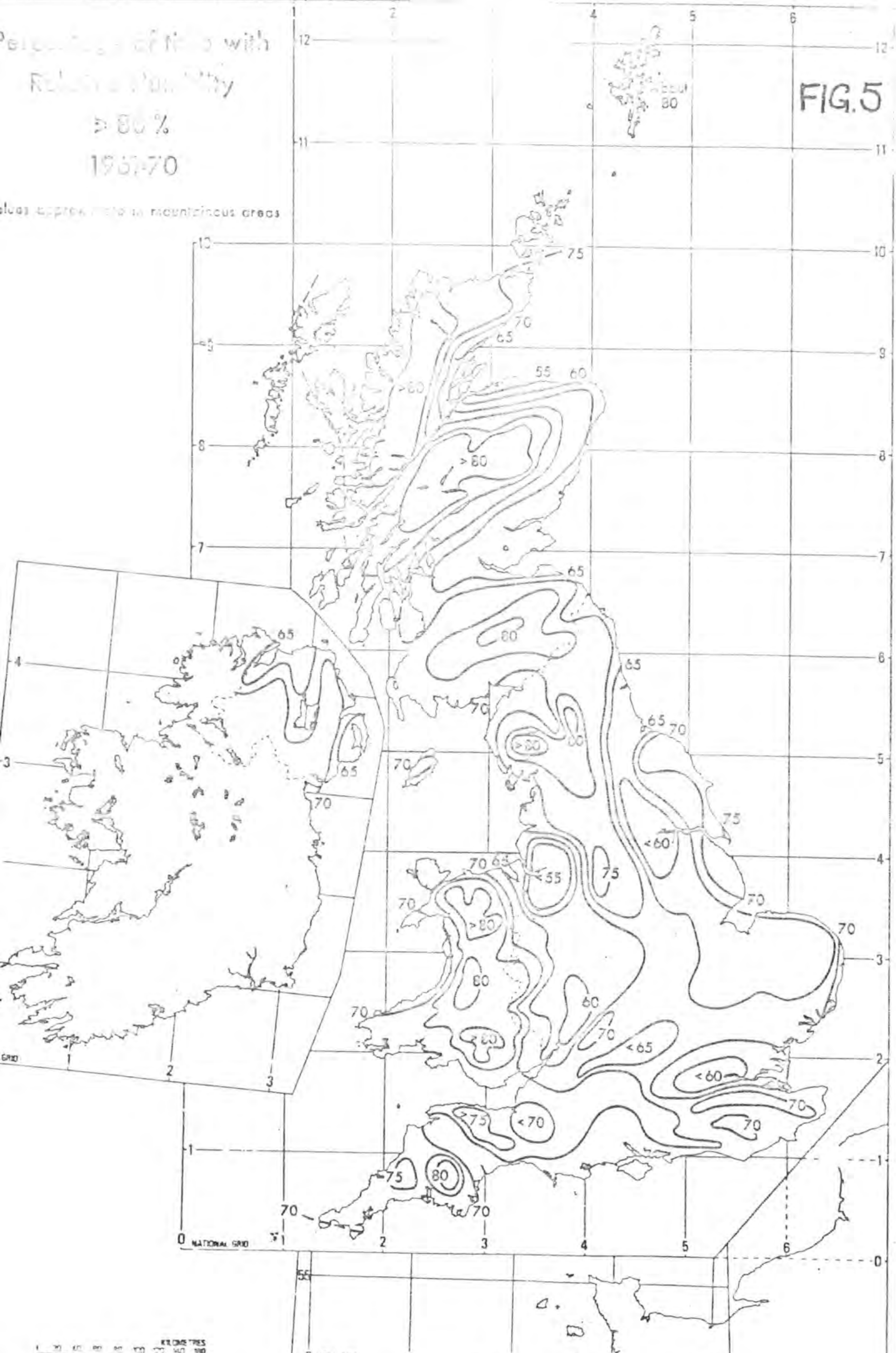
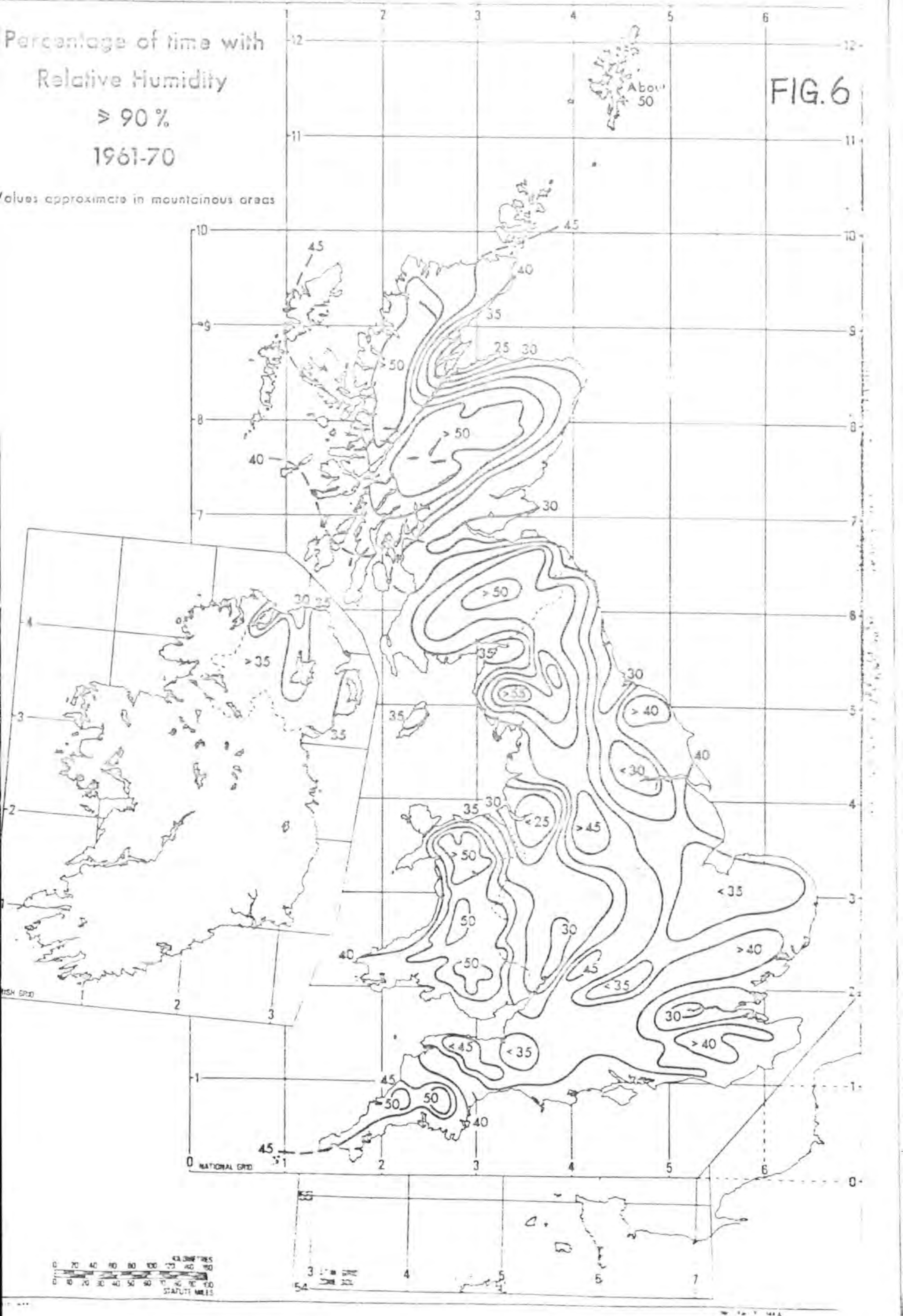


FIG.5

FIG. 6

Percentage of time with Relative Humidity ≥ 90 % 1961-70

Values approximate in mountainous areas



Percentage of time with Relative Humidity ≥ 95 % 1961-70

Values approximate in mountainous areas

FIG.7.

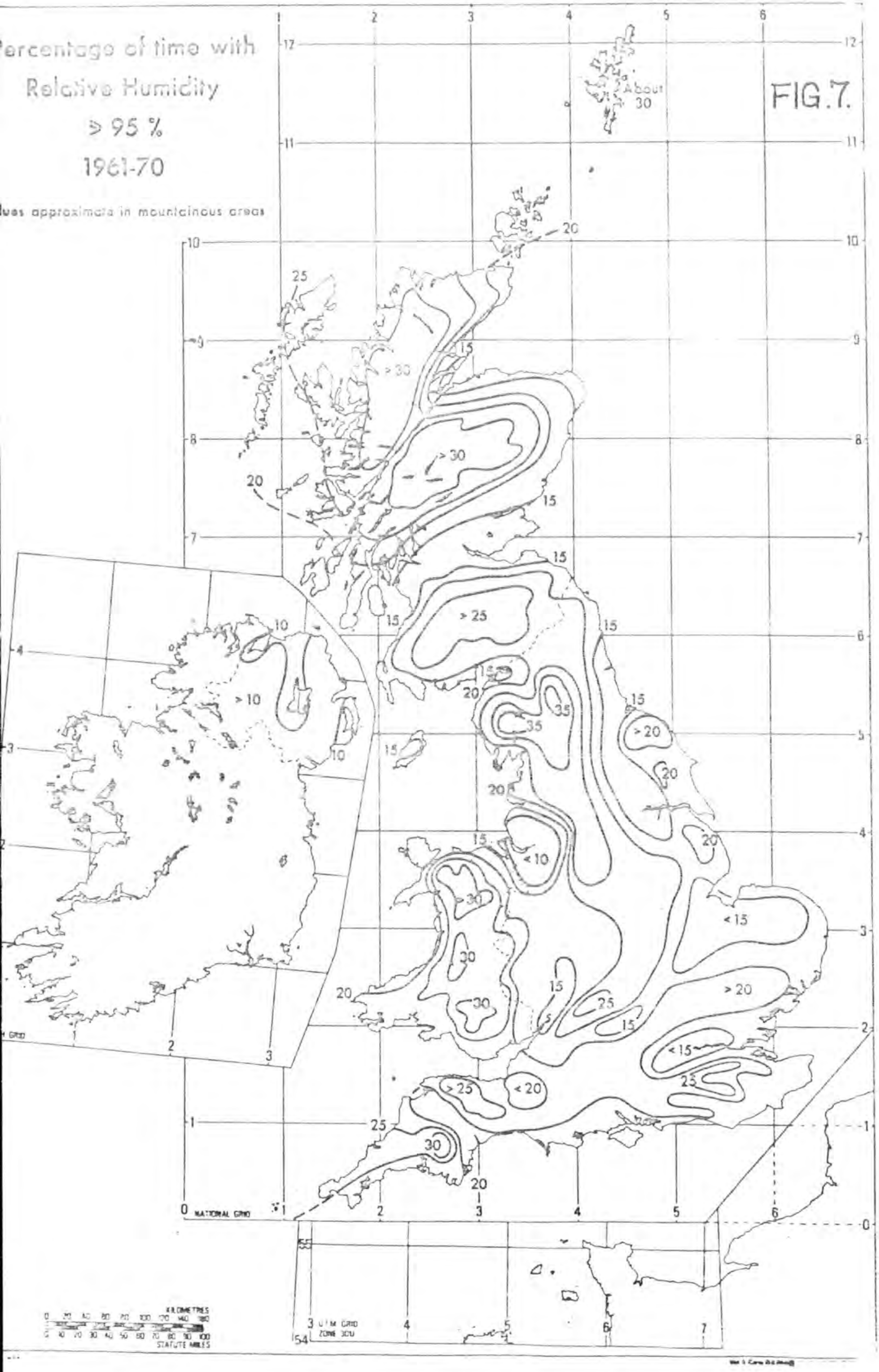
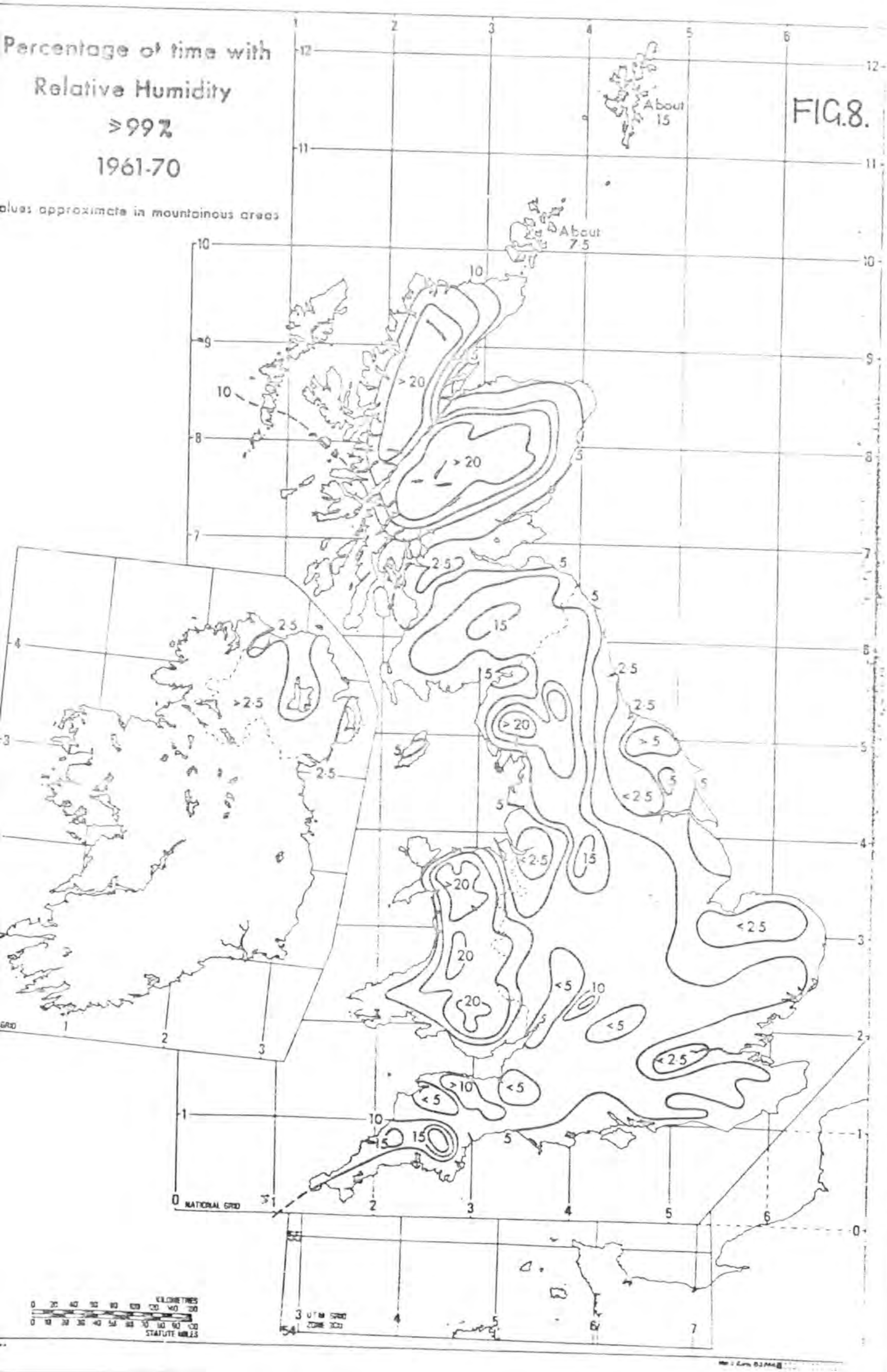


FIG.8.

Percentage of time with Relative Humidity ≥99% 1961-70

alues approximate in mountainous areas



Appendix. Table 1 EXTRACT FROM FIELD NOTE BOOK

DESCRIPTION OF VEGETATION

Site: Claish Moss
Station: A
Date: 5.5.77
Field Notes: Percentage cover: 100%
Height of Stand: Calluna approximately 45 cm.
Angle and direction of slope: Flat
Peat Depth: 107 - 130 cm

METRE	KNOT	PLANT SPECIES RECORDED					
1	1	E.vag,	Cv.				
	2	E.vag.					
	3	E.vag,	Cv,	Et.			
	4	E.vag,	Cv,	Et.			
	5	E.vag,	Cv.				
	6	E.vag,	Cv.				
	7	M,	E.vag,	Cv.			
	8	M,	E.vag,	Cv.			
	9	M,	E.vag,	Cv,	Srec.		
	10	M,	E.vag,	Srec,	Hycup.		
2	1	M,	Cv,	O,	Cf.		
	2	M,	E.vag,	Cv,	O,	Cf.	
	3	M,	E.vag,	Cv,	O,	Cf.	
	4	M,	E.vag,	Cv,	O,	Cf.	
	5	M,	E.vag,	Cv,	Mg,	Hycup.	
	6	M,	E.vag,	Cv,	Ci,	O,	Cf.
	7	M,	E.vag,	Cv,	O,	Cf.	
	8	M,	E.vag,	Cv,	O,	Cf.	
	9	E.vag,	Cv,	O,	Cf.		
	10	E.vag,	Cv,	Et.			

Key to Symbols

E.vag : Eriophorum vaginatum; Cv : Calluna vulgaris; Et : Erica tetralix;
M : Molinia caerulea; Srec : Sphagnum recurvum; Hycup : Hypnum cupressiforme;
O : Odontoschizma sphagni; Ct :Calypogeia fissa; Mg : Myrica gale;
Ci : Cladonia impexa.

TABLE 2. THE RAW TABLE.

F				G						H						J		K						L			M						N						P(June)					
3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	1	2	3	4	5	6	1	2	3	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
1	6	9	3			4	5	3	3	2		2	5	4	2				3	5								5	4	10	2	3	8	8	8	7	4	5	1	2	1	4	6	5
							3		1	2		3	5	3	1			3	1	4							2	1	2	5	1			1	1	5	5	1	1	5	4	2	2	4
						2										1	4						3																					
																		1			1			1																				
																								1																				
																					1																							
	1	3		1	1	4	3	3		5		5	4	8		10	10	7	9	7	5	9	10	4	6	4	1		5	3	1	3	2	4	2	4	1	6	2	2	5	3	6	3
3	2	6		2	1	3	1		2	5		2	1	3	2				3										1		4	5							1	1	1		3	
2		1				1				5		1	1	1	1	8	8										1		1				6	3	6	3	7	6	2	1	1	3	3	
																					1	2		4	5	4																		
			1												1												5	2									1	4	6	2	3	2		3
2		2										1	2		1												1		1					1					6	6		4	3	4
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																								1																				
			1																												1													
																											5																	
								1																																				
												1	1					4		1		2																						
														1																														
		1					2						1	3	1	9		2	1	5	2	3									7	1	1	1			6	7						
																		2	3	2				3									8	7	10	10	1			1				
																		2			1	3	4	3																				
10	10			4	9	8	5	6	1																			2	5	5	1	4									1	1	1	
																					3																							
																																	1	1	1			1						
						3	1																																					
			1							2	9	3			2												2	1											2					
			2											1	3													2						1			5	1	3	3	2	1	2	2
																	1				4	4	7																	1		1		1
		1								3	2			1	4												3	1	1		1								1	1	3	1	1	2
																					8	5	1																	2	4	6	1	3
										1				1			1											1					5	5	3	5	5	1			1	2	1	3
		3	1							7		3	1	5	1		3			1	4	9	7	2		3			2					1			2	9	2	5	4		2	
																		2			2																							
																					1	4	1											2								1	1	
		4	2							6		1	5	3	2	2	6	2	4	1	2	5	1				1	2	2				4	1	2		10	2		3	3	7	1	7
		1	1										1	1	3		3					2	1														1	6		1	4	2	1	
																						1																						
1		6						1							1	3	4	4	1									5	5	7		1	2			1	1			3	4	1	4	2
	1	4								1		2	1																2	2											1			
																			1																									
																								2	3																			
										2																			1	2											4	2	4	6

Table 4 SPECIES RELEVE TOTALS CONVERTED TO PERCENTAGE COVER

Length of stand transects	6	6	6	6	6	6	6	6	6	6	6	2	6	3
SPECIES	A	N	B	C	H	P	D	E	M	F	G	J	K	L
Calluna vulgaris	72	67	12	30	25	32	20	38	40	37	25		13	
Erica tetralix	20	22	38	27	23	30	32	3	18		7		13	
Myrica gale	1.7										3	25	5	
Agrostis tenuis													3	3
Poa pratensis														3
Festuca ovina agg													1.7	
Molinia caerulea	48	32	83	67	37	35	20	18	21	12	20	100	78	47
Phragmites communis		17												
Carex nigra										1.7				
Eriophorum angustifolium			17	8	21	10	37	27	17	35	15		5	
Eriophorum vaginatum	88	52	37	8	15	17	13	8	3	8	1.7	80		
Juncus effusus													5	43
Narthecium ossifragum		8			1.7	27			12	5				
Trichophorum caespitosum		1.7	42	43	7	38	27	17	3	8			1.7	
Rhyncospora alba							7	17	7					
Drosera rotundifolia		3				20			1.7					
Anemone nemorosa														3
Potentilla erecta														3
Filipendula ulmaria														3
Ranunculus repens													3	
Ranunculus acris														7
Ranunculus ficaria														3
Veronica officianalis														3
Menyanthes trifoliata									1.7	1.7				
Campylopus atrovirens									8					
Campylopus flexuosus											1.7			
Dicranum scoparium	5		7		3								12	
Hylocomium splendens					1.7									
Hypnum cupressiforme	30	25	12	10	8		5	3	13	3	3	45	22	
Hypnum ericetorum	3	60				1.7							12	10
Leucobryum glaucum		7												
Plagiothecium undulatum													17	10
Rhacomitrium lanuginosum				20		5	3	22	28	58	55			
Rhytidiadelphus squarrosus													5	
Sphagnum compactum							8				7			
Sphagnum cuspidatum			10	5	27	3	23	3	5	1.7				
Sphagnum magellanicum		12			7	21	5	7	3	3				
Sphagnum palustre			1.7	5		5		1.7				5	25	
Sphagnum papillosum				1.7	17	15	5	1.7	10	5				
Sphagnum plumullosum						27							23	
Sphagnum recurvum	28	40	13	20	3	12	13	18	1.7			5		
Sphagnum rubellum	5	20	33	7	28	21	32	25	3	7		15	35	17
Sphagnum subsecundum auriculatum							1.7							
Thuidium tamariscinum													7	
Calypogeia trichomaris	17	3	3	1.7		3		1.7					10	
Odontochisma sphagni	42	38	52	35	28	35	40	27	8	10		40	25	
Mylia anomole	28	12	20	28	8	13	17			3		15	5	
Lephozia bidentata													1.7	
Cladonia impexa	1.7	7		13	1.7	23	10	57	30	17	1.7	35	8	
Cladonia uncialis				3	7	1.7		8	7	15				
Hypogymnia phaysodes													1.7	
Ctenidium molluscum														17
Plurozea purpurea			1.7		3	27	5	17	5					
Eurynchium praelongum														3

Table 5 COMPARING CLASS LIMITS OF TWO SCALES OF COVER

CLASS	DOMIN SCALE	BRAUN-BLANQUET SCALE
+	A single individual	Less than 1%
1	1 - 2 individual	1 - 5%
2	Less than 1%	6 - 25%
3	1 - 4%	26 - 50%
4	4 - 10%	51 - 75%
5	11 - 25%	76 - 100%
6	26 - 33%	
7	34 - 50%	
8	51 - 75%	
9	76 - 90%	
10	91 -100%	

Table 8 THE BRAUN-BLANQUET SCALE OF CONSTANCY OR DEGREE OF PRESENCE : CLASS LIMITS

SCALE	DEGREE OF PRESENCE	
V	CONSTANTLY PRESENT	: 80 - 100% of stands
IV	MOSTLY PRESENT	: 60 - 80% of stands
III	OFTEN PRESENT	: 40 - 60% of stands
II	SELDOM PRESENT	: 20 - 40% of stands
I	RARE	: 1 - 20% of stands

Table 6 **PERCENTAGE COVER CONVERTED TO DOMIN AND BRAUN-BLANQUET SCALES OF COVER**

(Domin scale left column in each releve, Braun-Blanquet scale in right hand column).

SPECIES	DABB		N		B		C		H		P		D		E		M		F		G		J		K		L		Const. Class
Calluna vulgaris	8	4	8	4	5	2	6	3	5	2	6	3	5	2	7	3	7	3	7	3	5	2			5	2			V
Erica tetralix	5	2	5	2	7	3	6	3	5	2	6	3	6	3	3	1	5	2			4	2			5	2			
Myrica gale	3	1																			3	1	5	2	4	1			II
Agrostis tenuis																									3	1	3	1	
Poa pratensis																											3	1	I
Festuca ovina agg																									3	1			I
Molinia caerulea	7	3	6	3	9	5	8	4	7	3	7	3	5	2	5	2	5	2	5	2	5	2	10	5	9	5	7	3	V
Phragmites communis			5	2																									
Carex nigra																			3	1									
Eriophorum angustifolium					5	2	4	2	5	2	4	2	7	3	6	3	5	2	7	3	5	2			4	1			III
Eriophorum vaginatum	9	5	8	4	7	3	4	2	5	2	5	2	5	2	4	2	3	1	4	2	3	1	9	5					V
Juncus effusus																									3	1	7	3	I
Narthecium ossifragum			4	2					3	1	6	3					5	2	4	1									III
Trichophorum caespitosum			3	1	7	3	7	3	4	2	7	3	6	3	5	2	3	1	4	2					3	1			III
Rhyncospora alba													4	2	5	2	4	2											I
Drosera rotundifolia			3	1							5	2					3	1											II
Anemone nemorosa																											3	1	I
Potentilla erecta																											3	1	I
Filipendula ulmaria																											3	1	I
Ranunculus repens																									3	1			I
Ranunculus acris																											4	2	I
Ranunculus ficaria																											3	1	I
Veronica officianalis																											3	1	I
Menyanthes trifoliata																	3	1	3	1									I
Campylopus atrovirens																	4	2											I
Campylopus flexuosus																					3	1							I
Dicranum scoparium	3	1			4	2			3	1															5	2			II
Hylocomium splendens									3	1																			I
Hypnum cupressiforme	6	3	5	2	5	2	4	2	4	2			4	1	3	1	5	2	3	1	3	1	7	3	5	2			V
Hypnum ericetorum	3	1	8	4							3	1													5	2	4	2	II
Leucobryum glaucum			4	2																									I
Plagiothecium undulatum																									5	2	4	2	I
Rhacomitrium lanuginosum							5	2			4	1	3	1	6	3	6	3	8	4	8	4							III
Rhytidiadelphus squarrosus																									4	1			I
Sphagnum compactum													4	2							4	2							I
Sphagnum cuspidatum					4	2	3	1	6	3	3	1	5	2	3	1	4	1	3	1									III
Sphagnum magellanicum			5	2					4	2	5	2	4	1	4	2	3	1	3	1									III
Sphagnum palustre					3	1	4	1			4	1			3	1							4	1	5	2			III
Sphagnum papillosum							3	1	5	2	5	2	4	1	3	1	4	2	4	1									III
Sphagnum plumullosum											6	3													5	2			I
Sphagnum recurvum	6	3	7	3	5	2	5	2	3	1	5	2	5	2	5	2	3	1					4	1					VI
Sphagnum rubellum	4	1	5	2	6	3	4	2	6	3	5	2	6	3	5	2	3	1	4	2			5	2	7	3	5	2	V
Sphagnum auriculatum													3	1															I
Thuidium tamariscinum																									4	2			I
Calypogeia trichomaris	5	2	3	1	3	1	3	1			3	1			3	1									4	2			III
Odontochisma sphagni	7	3	7	3	8	4	7	3	6	3	7	3	7	3	6	3	4	2	4	2			7	3	5	2			VI
Mylia anomole	6	3	5	2	5	2	6	3	4	2	5	2	5	2					3	1			5	2	4	1			III
Lephozia bidentata																									3	1			I
Cladonia impexa	3	1	4	2			5	2	3	1	5	2	4	2	8	4	6	3	5	2	3	1	7	3	4	2			V
Cladonia uncialis							3	1	4	2	3	1			4	2	4	2	5	2									III
Hypogymnia phaysodes																									3	1			I
Ctenidium molluscum																											5	2	I
Plurozea purpurea					3	1			3	1	6	3	4	1	5	2	4	1											II
Eurynchium praelongum																											3	1	I

Table 7 **BRAUN-BLANQUET SCALE OF COVER VALUES AND DEGREE OF PRESENCE APPLIED TO THE STRUCTURED TABLE**

	A	N	B	C	H	P	D	E	M	F	G	J	K	L	Degree Const.
Molinia caerulea	3	3	5	4	3	3	2	2	2	2	2	5	5	3	V
Cladonia impexa	1	2	-	2	1	2	2	4	3	2	1	3	2	-	V
Calluna vulgaris	4	4	2	3	2	3	2	3	3	3	2	-	2	-	V
Erica tetralix	2	2	3	3	2	3	3	1	2	-	2	-	2	-	V
Eriophorum vaginatum	5	4	3	2	2	2	2	2	1	2	1	5	-	-	V
Hypnum cupressiforme	3	2	2	2	2	-	1	1	2	1	1	3	2	-	V
Sphagnum rubellum	1	2	3	2	3	2	3	2	1	2	-	2	3	2	V
Sphagnum recurvum	3	3	2	2	1	2	2	2	1	-	-	1	-	-	VI
Odontochisma sphagni	3	3	4	3	3	3	3	3	2	2	-	3	2	-	VI
Mylia anomola	3	2	2	3	2	2	2	-	-	1	-	2	1	-	III
Calypogeia fissa	2	1	1	1	-	1	-	1	-	-	-	-	2	-	III
Trichophorum caespitosum	-	1	3	3	2	3	3	2	1	2	-	-	1	-	III
Sphagnum magellanicum	-	2	-	-	2	2	1	2	1	1	-	-	-	-	III
Sphagnum palustre	-	-	1	1	-	1	-	1	-	-	-	1	2	-	III
Eriophorum angustifolium	-	-	2	2	2	2	3	3	2	3	2	-	1	-	III
Sphagnum cuspidatum	-	-	2	1	3	1	2	1	1	1	-	-	-	-	III
Plurozea purpurea	-	-	1	-	1	3	1	2	1	-	-	-	-	-	II
Rhacomitrium lanuginosum	-	-	-	2	-	1	1	3	3	4	4	-	-	-	III
Sphagnum papillosum	-	-	-	1	2	2	1	1	2	1	-	-	-	-	III
Cladonia uncialis	-	-	-	1	2	1	-	2	2	2	-	-	-	-	III
Narthecium ossifragum	-	2	-	-	1	3	-	-	2	1	-	-	-	-	III
Drosera rotundifolia	-	-	1	-	-	2	-	-	1	-	-	-	-	-	II
Hypnum ericetorum	1	4	-	-	-	1	-	-	-	-	-	-	2	2	II
Dicranum scoparium	1	-	2	-	1	-	-	-	-	-	-	-	2	-	II
Myrica gale											1	2	1	-	II
Rhyncospora alba							2	2	2						II
Sphagnum plumullosum					3								2		I
Sphagnum compactum							2				2				I
Menyanthes trifoliata									1	1					I
Plagiothecium undulatum													2	2	I
Juncus effusus													1	3	I
Agrostis tenuis													1	1	I
Leucobryum glaucum		2													I
Phragmites communis		2													I
Hylocomium splendens					1										I
Sphagnum auriculatum						1									I
Campylopus atrovirens									2						I
Carex nigra										1					I
Campylopus flexuosus											1				I
Lephozia bidentata													1		I
Thuidium tamariscinum													2		I
Festuca ovina													1		I
Hypogymnia phaysodes													1		I
Ranunculus repens													1		I
Rhytidiadelphus squarrosus													1		I
Anemone nemorosa														1	I
Potentilla erecta														1	I
Veronica officianalis														1	I
Filipendula ulmaria														1	I
Ranunculus ficaria														1	I
Ranunculus acris														1	I
Ctenidium molluscum														2	I
Eurynchium praelongum														1	I
Poa pratensis														1	I

TABLE 9. NATURE CONSERVANCY SURVEY.

18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	Total	Constancy
+	+	+		+	+	+	+	+	+	+	+	+		+	+		+	+	+	+	+	+	34	V
+	+	+	+	+	+	+	+	+	+	+	+	+		+	+	+	+	+	+	+	+	+	37	V
+	+		+	+	+	+	+	+	+	+	+	+		+	+	+	+	+	+	+	+		36	V
+	+	+	+	+	+	+	+	+	+	+	+			+	+		+			+		+	31	VI
+	+	+	+	+	+	+	+	+	+	+	+	+		+	+	+	+	+	+	+	+	+	37	V
												+											1	I
	+		+	+				+	+		+			+			+	+	+		+		23	III
+	+	+	+	+	+	+	+		+	+	+	+		+	+		+	+	+	+	+	+	34	V
				?				?	?			+											1	I
																+							2	I
								+	+		+			+	+	+	+	+	+	+			19	III
			+	+	+	+	+	+	+	+	+				+			+			+		18	III
+	+	+	+	+	+	+	+	+	+	+	+	+		+	+	+	+	+	+	+	+	+	37	V
					+																		2	I
							+																2	I
+		+						+														+	6	I
+																							1	I
					+	+	+	+	+		+			+				+	+		+		18	III
																							1	I
+	+		+	+	+	+	+	+	+	+	+	+			+		+		+	+	+	+	31	VI
												+	+	+		+	+		+	+			11	II
								+	+		+		+	+		+	+		+	+			22	III
								+						+			+		+	+			13	II
																+							3	I
+	+	+	+		+	+	+	+	+	+	+	+		+	+		+	+	+	+	+	+	32	V
+	+		+		+	+	+	+	+	+	+	+		+	+		+	+	+	+	+	+	29	VI
+		+	+		+			+	+		+			+	+			+	+	+	+	+	19	III
+																							1	I
			+	+	+	+	+	+		+				+			+			+	+		21	III
		+	+		+	+	+	+	+	+	+	+		+	+		+	+	+	+	+	+	30	VI
			+	+				+	+		+	+				+	+		+				20	III
																	+						3	I
				+	+		+					+		+	+	+	+			+		+	16	III
											+	+				+		+	+	+			6	I
	+		+	+	+		+	+	+	+	+	+		+	+	+	+		+	+	+		30	VI
				+	+	+	+	+		+				+	+								9	II
+	+	+	+	+	+		+	+	+	+	+			+	+	+		+	+		+	+	28	VI
+	+		+	+	+	+	+	+	+	+	+			+	+		+	+	+	+	+		31	VI
				+																			1	I
			+					+			+	+		+		+			+				14	II
																				+			3	I
+		+				+	+	+	+	+				+	+			+		+	+		13	II
					+	+												+					3	I
																				+			1	II

Table 10 VALUES OF pH, CONDUCTIVITY AND ION CONCENTRATION

SAMPLE		pH 12°C		CONDUCTIVITY 25°C		ION CONCENTRATION (P.P.M.) Na		Ca		Mg		K	
		wet period	dry period	wet	dry	wet	dry	wet	dry	wet	dry	wet	dry
A	S	4.15		59		4.8		0.50		0.73		0.59	
	P	4.25	4.75	115	60.5	4.9		0.55		0.49		1.81	
B	S	4.25		50		4.3		0.25		0.57		0.30	
	P	4.40		62		5.0		0.67		0.92		2.40	
C	S	4.05		74		4.5		0.46		1.65		0.42	
	P	3.95		100		6.4		1.18		1.57		1.59	
D	S	4.30	4.30	71	98	5.1	8.7	1.27	1.1	1.41	2.0	0.33	2.1
	P	4.35	4.30	360	111	35	9.5	3.86	1.3	4.70	2.8	9.80	2.0
E	S	4.15	4.20	89	76.8	5.1	7.3	0.38	0.55	0.88	0.95	0.38	0.45
	P	4.60	4.55	690	78.5	75	6.5	11.0	0.8	7.50	1.62	19.7	4.1
F	S		4.20		75.9		7.1		0.46		0.93		0.35
	P		4.15		86.0		7.4		0.40		1.18		1.41
G	S		4.0		90.0		8.7		0.65		1.21		0.84
	P		4.0		238		20.9		2.84		5.1		2.9
H	S		4.2		58.0		5.4		0.34		0.75		0.75
	P		4.3		99.9		7.8		0.95		1.58		4.1
J	S		4.0		86.0		5.7		0.59		1.21		1.03
	P		4.4		89.9		6.4		0.75		0.91		3.5
K	S		3.85		116								
	P		4.75		116		6.1		0.66		1.09		6.5
L			6.4		90.5		9.3		4.0		1.78		1.41
M	S		4.3		112		11.0		0.83		1.72		1.58
	P		4.0		148		8.9		0.63		1.76		0.77
N	S		4.0		63		5.3		0.36		0.62		1.14
	P		5.1		73		8.3		1.50		1.67		5.8
Rain Water													
.5.77		5.0		250		7.7		9.41		1.61		3.1	
.5.77		5.25		49.5		2.3		1.06		0.33		0.55	
.5.77		5.50		82.0		3.3		0.94		0.41		0.93	
.5.77		5.60		33.4		0.98		0.31		0.10		0.40	
.5.77		5.50		139.0		1.85		1.33		0.52		0.98	
stilled water		5.70		1.75									

PERFORMANCE OF MOLINIA ON CLAISH MOSS. MAY 1977

Analysis of variance: One way classification from R. E. Parker
Introductory Statistics for Biology.

The results of the experiment with 14 samples and 50 replicates for each sample were considered.

k = number of samples

n = number of replicates per sample

Grand Total : GT

Grand Mean : $\bar{X}$

Method

i. Calculate the correction term C as $\frac{(GT)^2}{kn}$

This is the square of the sum of all values of x divided by the total number of values.

$C = \frac{409515932.25}{700}$

$= 585022.761$

ii. Calculate the total sum of squares SS as $\Sigma x^2 - c$

$= 651410.75 - 585022.761$

$SS = 66387.989$

iii. Calculate sum of squares for (between) samples.

SST as $\Sigma T^2/n - C$

$SST = \frac{30531335.25}{50} - 585022.761$

$= 610626.705 - 585022.761$

$SST = 25553.944$

iv. Calculate sum-of-squares for error SSE as SS - SST.

$SSE = 66387.989 - 25553.944$

$SSE = 40834.045$

v. Prepare the table.

SOURCES OF VARIATION	SUMS OF SQUARES	DEGREES OF FREEDOM	MEAN SQUARES	F
Samples	SST	k-1	$\frac{SST}{k-1}$	$\frac{SST \times k(n-1)}{SSE \times (k-1)}$
Error	SSE	k(n-1)	$\frac{SSE}{k(n-1)}$	-
Total	SS	(kn-1)	-	-

SOURCES OF VARIATION	SUMS OF SQUARES	DEGREES OF FREEDOM	MEAN SQUARES	F
Samples	25553.944	13	1965.688	33.023
Error	40834.045	686	59.525	
Total	66387.989	699		

Calculated value of F = 33.023

Tabulated value = 1.67

Calculated value is greater than tabulated value, therefore the null hypothesis (that the samples could have been drawn from a single population, or from several populations with equal means) is rejected and it is concluded that the samples have been drawn from populations with different means. i.e., that there are significant differences between the sample means.

PERFORMANCE OF ERIOPHORUM ANGUSTIFOLIUM ON CLAISH MOSS

MAY 1977

Analysis of variance: One way classification.

Unequal numbers replicates: 12 samples.

A minor modification in the calculation of SST will accommodate this for numbers of replicates $n_1, n_2, n_3 .. n_k$

SST is calculated as $SST = \frac{T_1^2}{n} + \frac{T_2^2}{n_2} + \frac{T_3^2}{n_3} .. + \frac{T_k^2}{n_k} - C$

$$= \sum \frac{T^2}{n} - C$$

$GT = 18980.000$

$GT^2 = 360240400$

i $C = \frac{360240400}{563}$

$= 639858.615$

ii $SS = 693966 - 639858.615$

iii $SST = 658001.913 - 639858.615$

$= 18143.298$

iv $SSE = SS - SST$

$= 54107.385 - 18143.298$

$= 35964.087$

Sources of Variation	Sums of Squares	Degrees of Freedom	Mean Squares	F
Samples	18143.298	11	1649.39	25.315
Error	35964.087	552	65.15	
Total	54107.385			

Calculated value of F = 25.315

Tabulated value of F = 1.75

Therefore there are significant differences between sample means.

PERFORMANCE OF NARTHECIUM OSSIFRAGUM ON CLAISH MOSS

MAY 1977

Analysis of variance: One way classification.

Unequal numbers of replicates: 12 samples.

	GT	= 4793.0
	$(GT)^2$	= 22972849
i	C	$= \frac{22972849}{593}$
ii	SS	= 45005.5 - 38740.05
		= 6265.451
iii	SST	= 41484.054 - 38740.05
		= 2744.004
iv	SSE	= 6265.4511 - 2744.004
		= 3521.447

Sources of Variation	Sums of Squares	Degrees of Freedom	Mean Squares	F
Samples	18143.298	11	1649.39	25.315
Error	35964.087	552	65.15	
Total	54107.385			

Calculated value of F = 25.315

Tabulated value of F = 1.75

Therefore there are significant differences between sample means.