16.

SOME MICRO-HABITATS OF THE BURREN, THEIR MICRO-ENVIRONMENTS AND VEGETATION

by

C. H. Dickinson,[1] M. C. Pearson[2] and D. A. Webb[3]

(Plates XII–XIV)

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Abstract

Studies carried out in the Burren, Co. Clare, on the floristics of grike-floors and woodland-floors showed that there were three groups of plants present. One of these groups was found solely in the grikes, a second solely in the woodland and a third in both habitats. Micro-environmental studies of these habitats and of the ground surface showed that the grikes and the woodland were similar to each other with respect to the ground surface, but that there were suggestions of differences between themselves. Tentative correlations are made between the floristic differences and the variations in micro-environments of the two habitats.

Introduction

Although the study of the immediate micro-environment of natural communities is a relatively backward branch of ecology, it has received an increasing amount of attention in recent years (Oosting and Hess, 1956; MacHattie and McCormack, 1961; Heslop-Harrison, 1960). Heslop-Harrison's paper showed clearly how great can be the climatic differences between two points, geographically very close together, in a terrain such as the fissured limestone pavement of the Burren region of Co. Clare; and it seems clear that if the peculiar flora of this region is to be explained in climatic terms, it is more likely to be in terms of the micro-environment than of the region as a whole.

The observations here presented were made in August, 1961, about 4 km. south of Black Head, Co. Clare, Ireland, by members of the Nottingham University Biological Society's expedition.* They consist of a comparison of the flora and of the micro-environmental factors of two types of habitat well represented in the Burren — the field-layer of the dense *Corylus* scrub which covers large areas, and the grikes (vertical fissures) in the limestone pavement. One of the striking features of the Burren flora is the occurrence in quantity on bare, rocky hillsides of plants usually associated with woodland (Webb, 1962). Such plants are usually (though not always) rooted in the grikes, and it is tempting to explain their occurrence by suggesting that in the grikes they find a micro-climate not unlike that of a wood. Heslop-Harrison's results are certainly enough to show how well they are insulated

[1] & [2] Department of Botany, University of Nottingham.
[3] School of Botany, Trinity College, Dublin.

*Members of the expedition were C. H. Dickinson (leader), R. C. W. Berkeley, P. Carter, L. B. Jones, S. J. Lodge, V. M. Martin, B. B. Rawdon, D. H. S. Richardson, M. Smith, and C. D. Woodward.

from the heating and drying effects of prolonged sunshine. But the two habitats have obviously their differences as well as their resemblances, both in physical factors and in flora; this study attempts an assessment of both differences and resemblances.

Description of the Area

The experimental site was on the south side of the valley of the Caher River, some 450 feet (135 m.) above sea level (grid reference M 36 F). The main features of the site (Fig. 1) are a gently sloping area of bare, broken limestone pavement dissected by numerous grikes running predominantly from north-west to south-east, and locally covered by a shallow and discontinuous layer of drift. The patches of drift support vegetation ranging from grass-heath, characterised by *Sesleria caerulea,** *Festuca ovina* and *Calluna vulgaris,* through grass-heath with occasional *Corylus avellana,* to small thickets of young *Corylus.* At the lower margin of the experimental area is a narrow wood, dominated by *Corylus* with occasional *Crataegus monogyna* and *Sorbus aucuparia,* and with a continuous ground-layer of vegetation (Plate XII). The two main habitats studied were the floor of the grikes and the floor of the hazel woodland. For comparison, a further micro-environmental study was carried out on the ground surface of the limestone pavement, stations being set up on the bare rock and in a patch of grass-heath dominated by *Sesleria caerulea* and *Festuca ovina.*

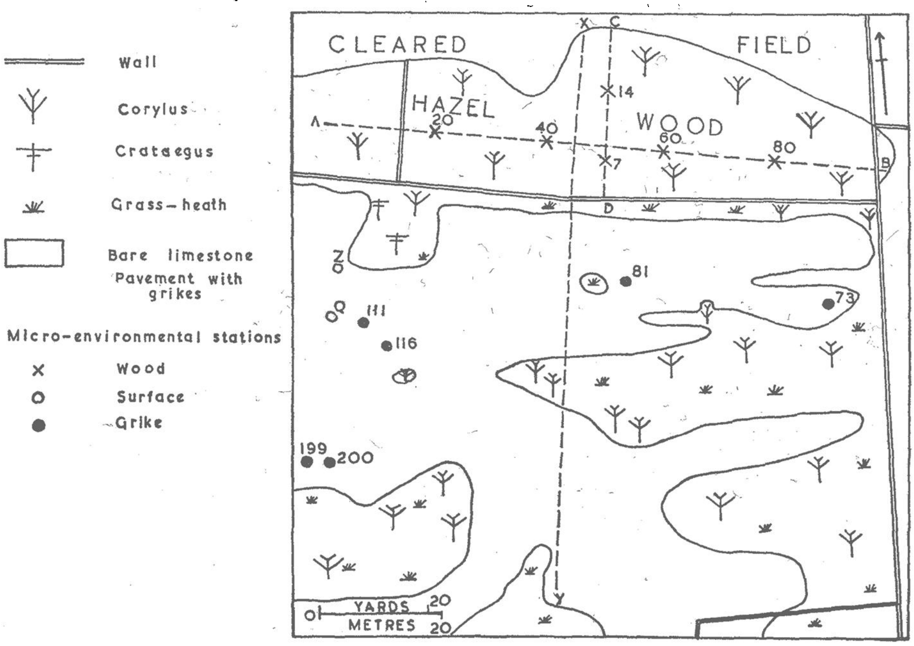

Fig. 1. — Map of the experimental site showing the vegetation, topography and the location of the micro-environmental stations.

* Nomenclature and authorities follow Clapham, Tutin and Warburg (1962) and Watson (1955).

METHODS

(*a*) *Micro-environmental measurements*

Micro-environmental stations were set up at six sites on the woodland floor, at the bottom of six grikes, and at the two exposed stations mentioned above (surface of bare rock; grassy heath). The woodland stations were spaced at regular intervals along the two transect-lines *AB* and *CD*. The grikes were selected so as to give a fair representation of the range of variation to be found in the area, both in dimensions and in vegetation-cover. Although it is the exceptionally deep grikes which catch the eye and remain in the memory, the majority are between 10 and 25 cm. wide, and between 5 and 50 cm. deep. The vegetation varies from almost nil to an almost closed community of bryophytes and vascular plants (U.N.B.E., 1960).

A larger number of stations would, of course, have reduced the chances of purely fortuitous variation; but their number had to be limited by the time required to complete the various readings, so that all the readings could be regarded as simultaneous without serious error. Although the grikes were chosen as reasonably representative, six samples cannot be held to cover anything like the whole range of variation; an extensive survey is really required to supplement the intensive investigations reported here.

Measurements of light-intensity, temperature and relative humidity were made at each of the fourteen stations at 2-hour intervals over periods of 18 to 24 hours on six separate days. The periods were begun either about midday or about midnight, so that both for day and for night uninterrupted readings are available. The observation periods were as follows:

Date	*Hours (G.M.T.)**	*Weather*
7.8.1961	0400–2200	Overcast
9.8.1961	0400–2200	Equal cloud and blue sky
16.8.1961	0000–2400	Foggy
17.8.1961	0000–2200	Drizzle
21.8.1961	1200–2400	Overcast/Cloudy
22.8.1961	0000–1200	Overcast/Cloudy
26.8.1961	1400–2400	Equal cloud and blue sky
27.8.1961	0000–1200	Cloudy

Light was measured by E.E.L. photometers; the light-sensitive cell was held horizontally and was not shielded by vegetation. Temperature was recorded by horizontal mercury thermometers, which were not shielded; in addition maximum and minimum temperatures were recorded by " Sixes " thermometers and by separate mercury and alcohol thermometers. Humidity was measured by static wet- and dry-bulb thermometers and by " Tintometer " cobalt thiocyanate paper. At relative humidities below 95% these two methods showed good agreement, but at the highest values the paper tends to be bleached irreversibly. An independent estimate of the evaporating power of the air was made with modified Piché evaporimeters; these were not calibrated in absolute terms, but served to give comparative values for the

*The experimental area lies about 9¼° (37 minutes of time) west of Greenwich.

different habitats. All measurements were made within 15 cm. of the surface of the ground.

At those stations where soil was present measurements were made of its pH, water content, loss on ignition and content of exchangeable calcium. pH was measured with a B.D.H. Capillator. Water content was determined by drying to constant weight at 105°C.; loss on ignition by heating at 500°C for six hours. This latter figure includes, of course, the loss of some carbon dioxide from any carbonates that may have been present in the soil, but except for the lowest values it approximates closely to the organic content. Exchangeable calcium was determined on an ammonium acetate leachate by the versene (E.D.T.A.) method (Chapman and Pearson, 1962).

(*b*) *Floristic Analysis*

Examination of the floras was by three different methods. An overall picture of the site was obtained by examining a point transect X-Y down the valley side (see fig. 2). The transect data show the physiography, the distribution of grikes and soil, and the distribution and height of the woody species.

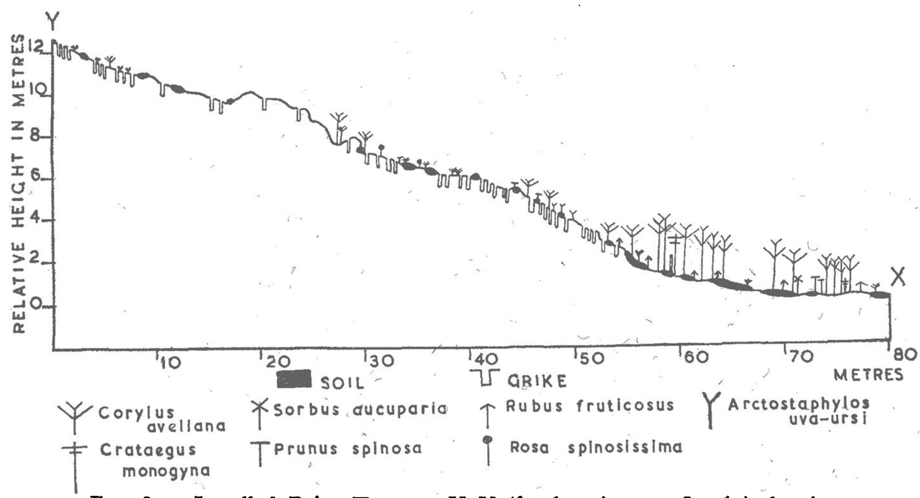

FIG. 2.—Levelled Point Transect X–Y (for location see fig. 1a) showing the physiography, the distribution of grikes and of soil, and the distribution and height of the woody species.

The ground flora of the hazel-wood was examined by recording the presence or absence of all plant species in 100 quadrats, each 25 cm. square, sited at regular intervals along two transects A-B and C-D, traversing the wood at right angles to each other and passing through its centre (see fig. 2).

On the limestone pavement 200 segments of grike, each 1 metre long and at least 1 metre apart, were marked centrally and numbered. The hundred with even numbers were sampled and the following recordings made:—

(i) The plant species on the floor of the grike.

(ii) ,, ,, ,, ,, ,, walls ,, ,, ,,

(iii) The average depth and width of the grike.

(iv) The depth of the lowermost plants.

(v) A brief description of the grike, including soil characters.

(c) *Meteorological Methods*

An Auxiliary Grade Meteorological Station, conforming to Meteorological Service standards, was set up at Expedition Base Camp about half a mile (1 Km.) lower down the Caher valley from the Experimental Site, at an altitude of 260 feet (78 m.) above mean sea level. At the Experimental Site on "observation days" measurements were made of the temperature and humidity of the air, using a whirling psychrometer.

RESULTS

(a) *Micro-environmental and Meteorological Results*

The micro-environmental and meteorological data are closely inter-related, the latter providing a background against which to view the former. The meteorological data recorded at Base Camp and the Irish Meteorological Service data for Fanore, Ballyvaughan (Corkscrew hill) and Shannon are given in Table 1. The rainfall values for Base Camp are about normal, in marked contrast to the rainfall during May 1959 (the month of Heslop-Harrison's observations) which approached the lowest recorded values for that month in many parts of the country (Heslop-Harrison, 1960). Values for both sunshine and temperature were below normal. During the days when observations were made the skies were overcast for most of the time, in contrast with the continuous cloudless conditions for the period of Heslop-Harrisons' observations.

The micro-environmental data relating to light, temperature and humidity are presented graphically in fig. 3, 4, and 5 respectively. For each factor the averages covering the six-day period are given; the data for all the stations in each habitat are averaged to give the individual day's record. The daily records for each of the three factors are remarkably consistent at all the stations in the wood. Those for the six grike stations are somewhat less consistent, as would be expected, since they were chosen to cover as wide a range as possible of conditions likely to be realized in the grikes. The daily records for the two ground surface stations are the least consistent, the differences being due to the presence or absence of vegetation at the individual stations.

The light values for the grikes are somewhat nearer those for the ground surface (Fig. 3). Note should be made of the earlier (12 noon) peak of the light values for the grikes, which is most likely due to the north-west to south-east orientation of the grikes.

The temperature data for the woodland, grike, ground surface and air at the Experimental Site all follow a similar daily pattern (Fig. 4). The grike and woodland sites have the smallest and most similar range of daily

TABLE 1.—**METEOROLOGICAL DATA (August 2nd—28th, 1961)**

	Total rainfall (mm.)	Mean Daily sunshine (hrs.)	Mean barometric pressure (mb.)	Wind mean speed at 0900, 1200, 1600, and 2000 hours. (knots)	Mean relative humidity at 0900 (%)	Temperature °C				
						Mean at 0900	Absolute Max.	Absolute Min. (screen)	Absolute Min. (grass)
Shannon	74·9	5·0	1015	11·0	83·5	14·9	23·3	5·2	6·6*[3]
Ballyvaughan (Corkscrew Hill).	173·0*[1]	—	—	—	—	—	—	—	—
Fanore	87·4	—	—	—	—	14·2	25·0	6·2	—
Base Camp	95·4	2·9	—	9·0	88·0	13·7	18·4*[2]	3·4	−1·7

Note
1. This figure refers to the whole month of August.
2. Low maximum absolute temperature at Base Camp probably related to low sunshine values.
3. This figure is the value for the month of August.

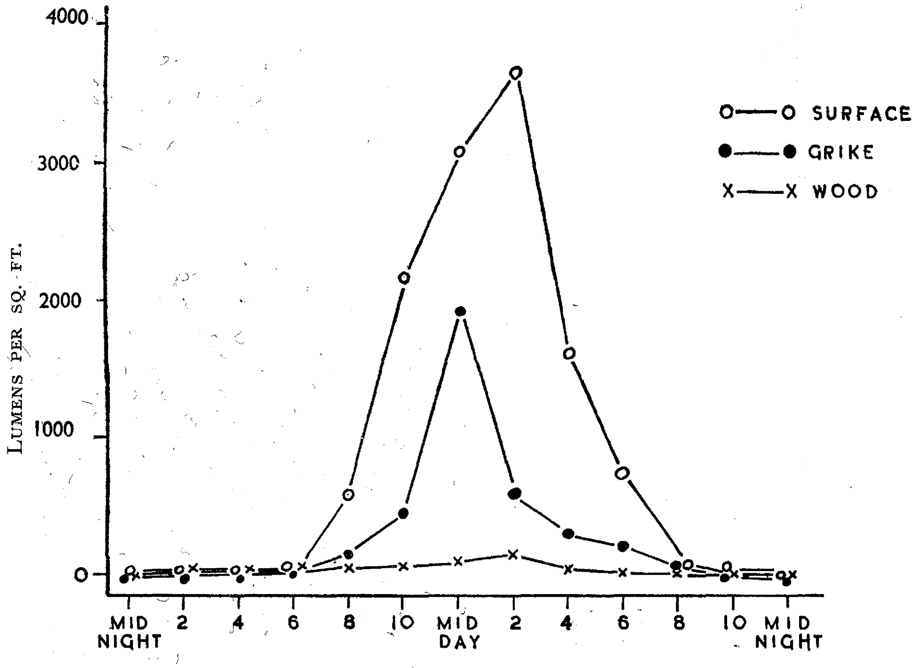

FIG. 3. — Microclimate; daily mean values for light.

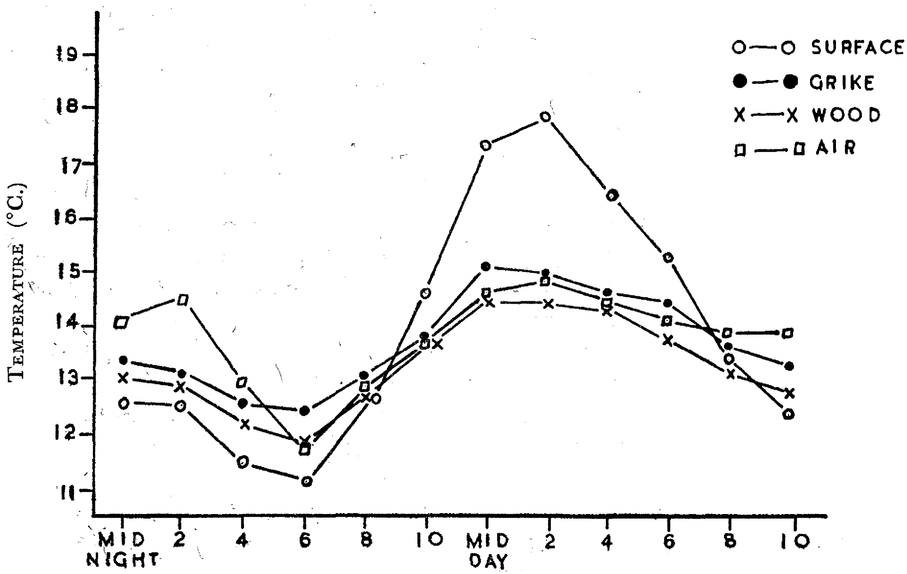

FIG. 4. — Microclimate; daily mean values for temperature.

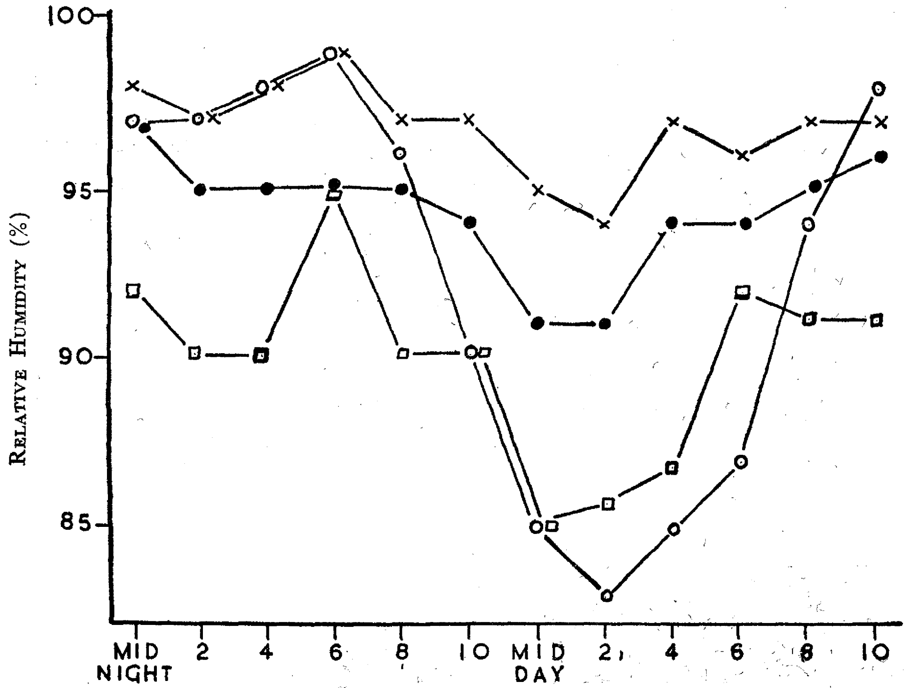

FIG. 5.—Microclimate; daily mean values for relative humidity. Symbols as in fig. 3.

fluctuations (11·8–15·1°C). The air temperature has about the same range of fluctuations but shows higher night values. The ground surface values, as would be expected, show the greatest daily fluctuations (11·2–17·8°C.).

The relative humidity records (Fig. 5) for the grikes and the woodland both show a similar pattern of small daily fluctuations at high values. The curve for the ground surface is broadly similar, but descends to much lower values during the middle of the day. The air humidity records have a daily variation of small amplitude at low values. Attention is drawn to the high pre-dawn value for humidity, which can be correlated with a simultaneous temperature drop, resulting in dew formation. Translation of the relative humidity data into terms of Vapour Pressure Deficit (Gordon, 1940) gives ranges for the woodland, grikes and ground surfaces of 0–1·0, 0–1·0 and 0–2·5 respectively. Heslop-Harrison (1960) gives values of the order of 6·9, 11·0 and 21·5 for similar situations. Comparison of these two sets of results further illustrates the widely differing weather conditions under which they were recorded.

The evaporimeter data, though limited, in the main agree with and amplify the daily trends found in the humidity results. For example the maximum value of relative humidity for one of the few dry days was 90% in the wood, 80% in the grikes and 55% on the ground surface; the simultaneous evaporimeter readings were in the ratio 1 : 3·4 : 5 respectively.

The analytical data for soils (see Table 2) indicate that the soils of grikes and of woodland have similar values for organic content and exchangeable calcium. There is a tendency for the woodland soils to be slightly more acid than those in the grikes.

TABLE 2.—**SOIL DATA (August 1961.)**

Stations	Woodland (7, 14, 20, 40, 60, 80)	Surface (Z)	Grikes (73, 111, 116, 119, 200)
pH	6·0–7·2 (Mean, 6·8)	6·1–6·6 (Mean, 6·4)	6·8–8·1 (Mean, 7·4)
Water content (% of dry weight)	68–300 (Mean, 111)	198–341 (Mean, 274)	62–228 (Mean, 103)
Organic content (% of dry weight)	15–60 (Mean, 28)	73–84 (Mean, 80)	14–58 (Mean, 28)
Calcium content (mg./g. dry weight)	0·32–1·20 (Mean, 0·61)	1·04–1·69 (Mean, 1·35)	0·41–1·32 (Mean, 0·51)

Note Samples were taken from all stations on August 7, 9, 17 and 28, except for Grikes 73 and 200, which were sampled on August 28 only.

(*b*) *Floristic Results*

The results obtained from analyses of the floristics of the grikes and of the woodland in August 1961 are shown in Plates XIII, XIV. A few additional species which were not visible in late summer or were overlooked for other reasons were recorded in the woodland in April 1962. These comprise:

Ranunculus auricomus
Ranunculus ficaria
Potentilla sterilis
Conopodium majus
Lysimachia nemorum
Arum maculatum

The most obvious feature of the floristic results (Plates XIII, XIV) is the presence in each of the two habitats of a unique floristic element. Among the higher plants this comprises numerically more species in the grikes than in the woodland, perhaps a reflection of the more varied nature of the grike habitat. In contrast there are about an equal number of bryophyte species in each of these habitats. In addition to these unique floristic elements there is a smaller group of species common to both habitats. It is this group that forms the basis of theories concerning the inter-relationships between these two habitats. The ratio of the number of bryophyte species common to both habitats compared with those found only in the grikes is greater than the same ratio for higher plants. The difference between the two values for this ratio is due to differences between both the numbers and relative abundance of higher plant species and of bryophyte species in the element confined to the grikes.

Further analysis (see table 3) of the records of some higher plants found only in the grikes shows a tendency for these species to be associated with shallow grikes. The records for some other species of higher plants, found in both the grikes and the woodland, show this tendency towards the shallow grikes to a considerably lesser extent.

TABLE 3 — **The distribution of some higher plants in shallow and in deep grikes.**

Depth of grikes	*Less than* 55 *cm.*	*More than* 55 *cm.*
Total number of grikes examined	57	43
Species restricted to grikes		
Pteridium aquilinum	10	13
Phyllitis scolopendrium	9	7
Geranium sanguineum	15	1
Geranium robertianum	29	11
Thymus drucei	18	2
Teucrium scorodonia	24	7
Molinia caerulea	16	0
Species found in both grike and woodland		
Sesleria caerulea	36	5
Festuca ovina	18	2
Asplenium trichomanes	7	4
Rosa spinosissima	8	1
Rubus fruticosus	5	9
Viola spp.	14	5
Hedera helix	14	10
Brachypodium sylvaticum	4	2
Corylus avellana	2	3

DISCUSSION

The samples of grike-floor and woodland-floor habitats show considerable similarities in their floras. These similarities may be correlated with the micro-environments, which are broadly similar in the two habitats; the micro-environments, however, are not identical, and it seems reasonable to suggest that the differences between them may account for the floristic elements unique to the two habitats. These two unique floristic elements cannot be governed by propagule distribution, by biotic factors such as grazing, or by regional climatic differences, as the two habitats are juxtaposed and all three factors operate equally in both. It is possible that these unique species are prevented from spreading to the other habitat by the micro-environmental and edaphic factors affecting their successful germination, growth and reproduction. It is clear that experimentation would be required to show the limits of tolerance to these factors of the individual species unique to the two habitats.

Whilst no definite conclusions may be made, comment on the relative importance of the factors is possible. The temperature would seem to be of little importance, there being a constant difference of only 0·2–0·6°C between the two habitats; most plants are tolerant of much greater differences. Light may be of more importance as there are, during the middle of the day, some quite large differences in the respective light values for the two habitats. In this connection knowledge of the compensation points, both of the unique species and of the species common to both habitats, would be of value. The relative humidity of the two habitats is probably of prime importance in limiting the spread of the unique element. The significance of this factor is borne out by the ranges obtained under extremes of wet and dry weather.

In this investigation the grike-floor habitat has been considered mainly as one of average dimensions, with an average microclimate. In consideration of the data for individual grikes of varying depth and width a trend towards a more "woodland-floor-like" environment is apparent in the deeper narrower grikes studies. Further studies of the relation of all three dimensions of grikes to the micro-environments and floristics are necessary before more conclusions may be drawn concerning their relationship to the woodland.

ACKNOWLEDGEMENTS

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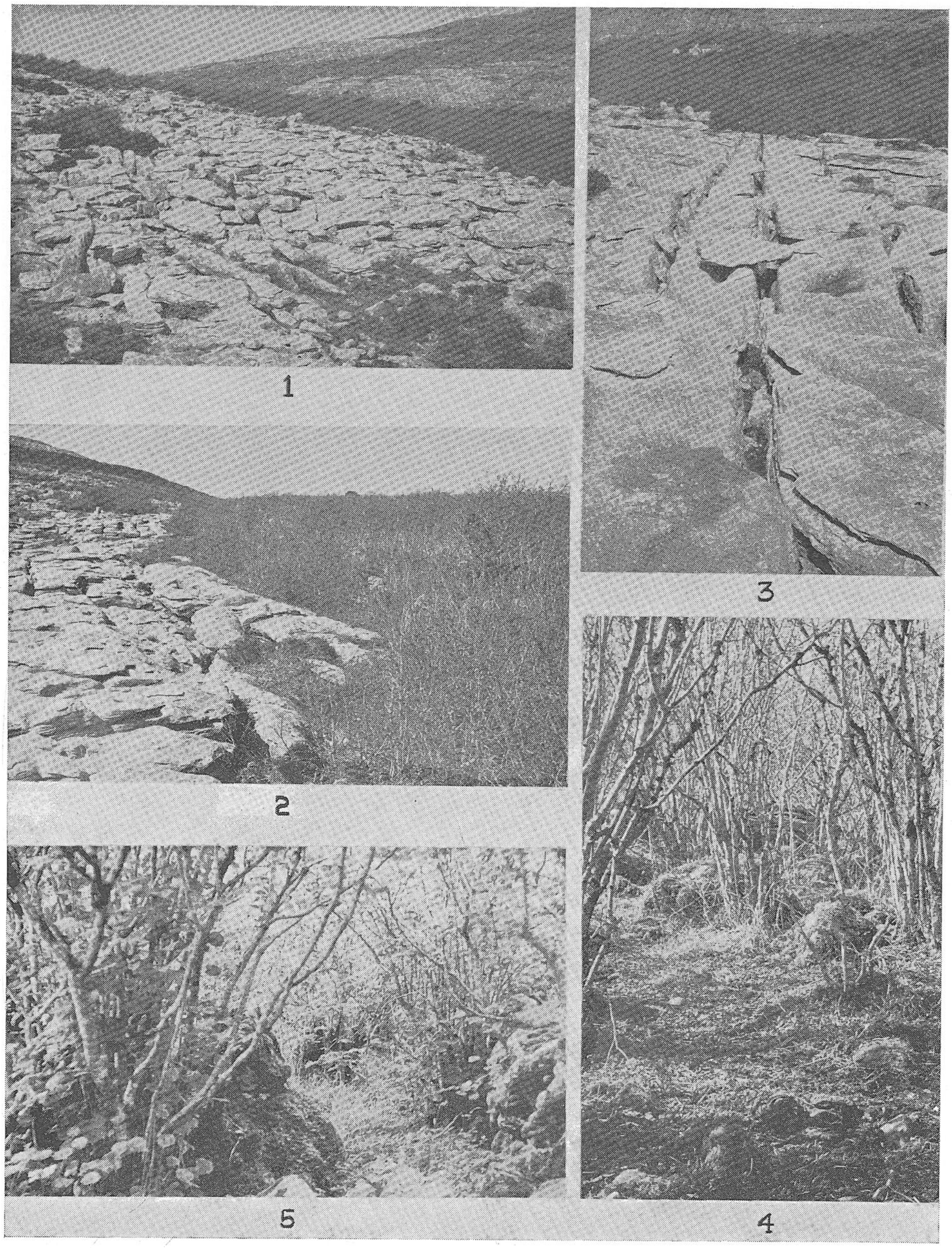


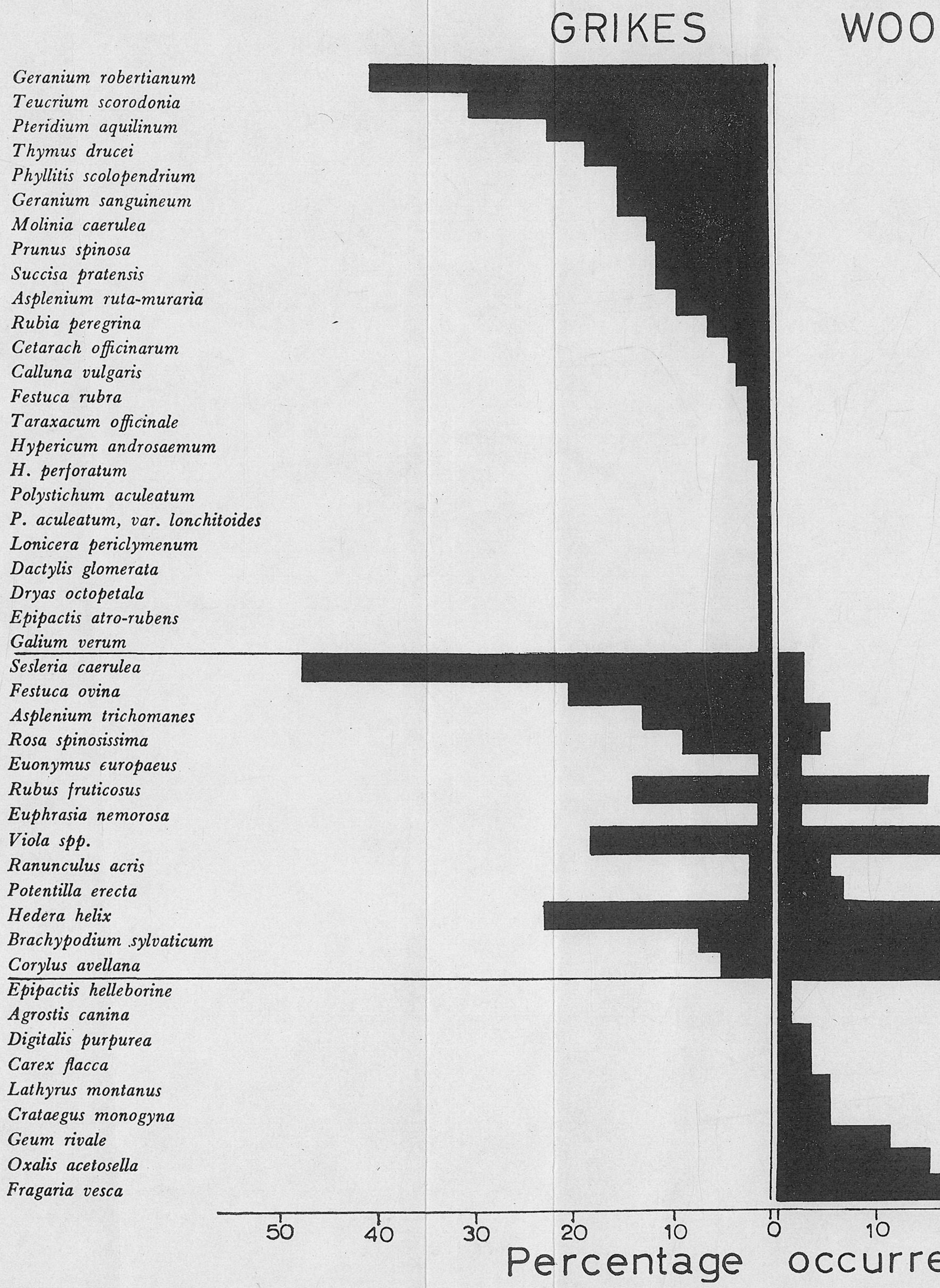
1. View of Experimental Site looking down the Caher Valley. Photos. 1–4 were taken in April 1962.

2. Part of the Experimental Site where the wood adjoins the grikes.

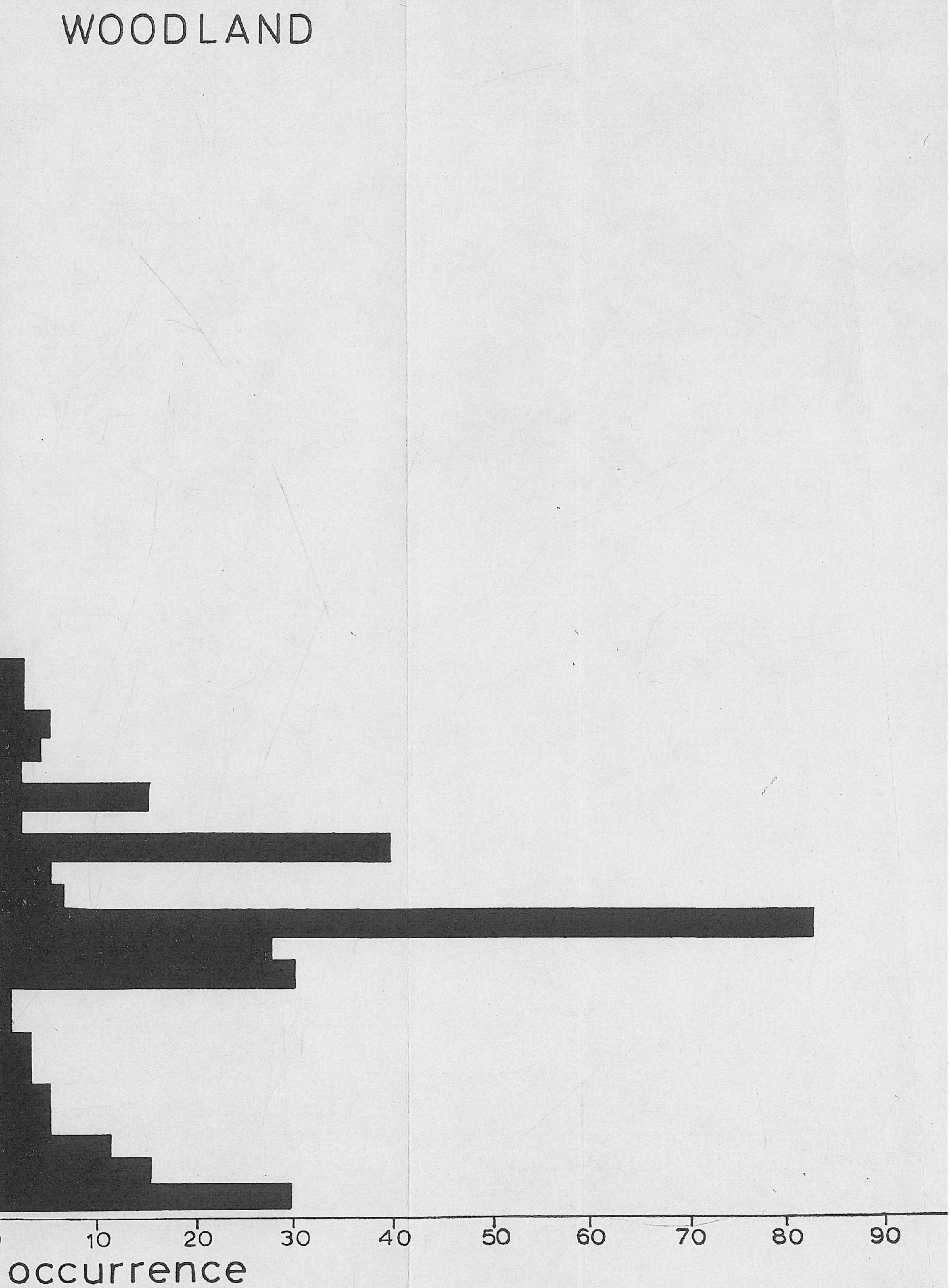
3. Close-up view of one of the deeper grikes.

4. Interior of the wood showing hazel bushes and the rocky floor of the wood.

5. Interior of the wood in August 1961 (when the expedition was in the field).



Distribution of higher plants in the woodland and in the grikes.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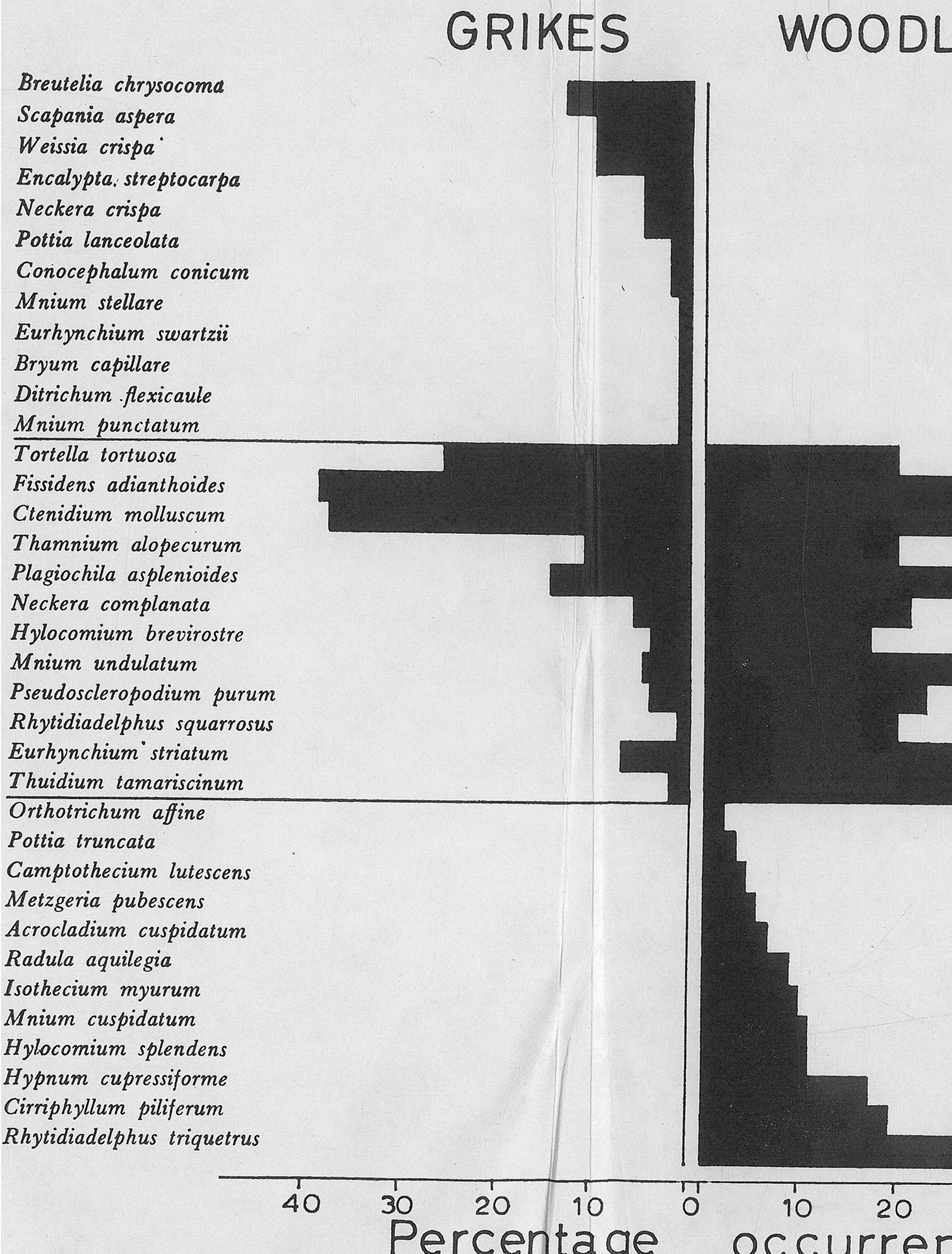
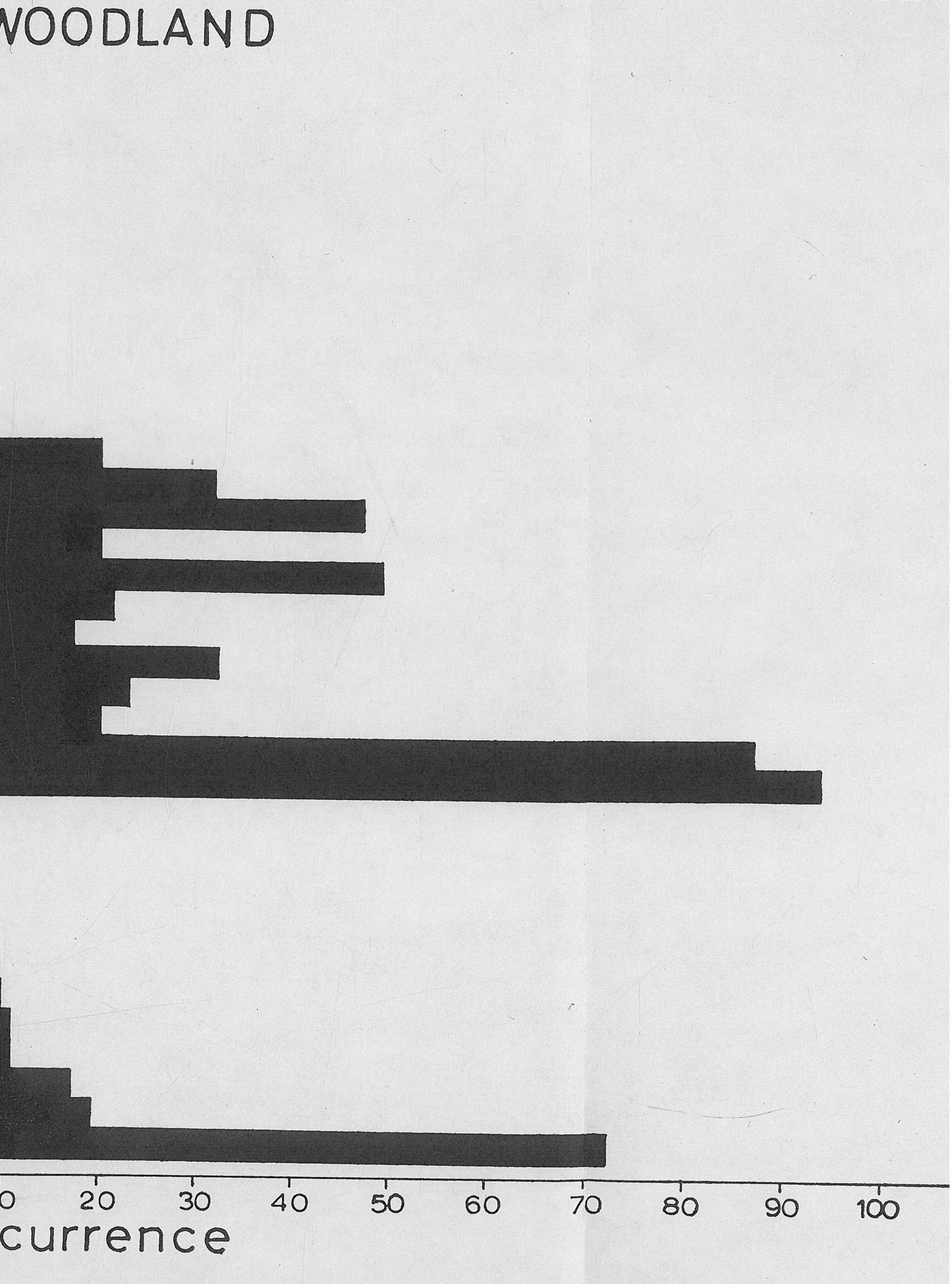


Distribution of bryophytes in the woodland and in the grikes.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