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PLANT COMMUNITIES ON THE MALVERN HILLS

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METHODS. A major survey of the Malvern Hills was first attempted in 1969 followed by intermittent visits culminating in an extensive re-survey in 1982.

Even-numbered northings of the National Grid were used to line transects across the backbone of the Malvern Hills spaced every 200m down the length of the Hills. On each transect quadrats were spaced at 100m horizontal equivalent by locating them on each easting. This sample grid gave 293 quadrats, excluding the surrounding woodlands and low level commons. All species, their cover and basic environmental variables were recorded.

The results reported here are from 2m square quadrats subjected to Association Analysis (Williams & Lambert, 1959). This uses the chi-squared (X^2) statistic of association between each pair of species to compare their relative presence and absence across the sample. The species with the highest total of positive and negative association with all other species is selected. This species is the most effective at discerning pattern in vegetation. Thus, sites with this species will have a species assemblage distinctly different from sites with and sites without this pattern-discerning species in order to select further subdividing species. The analysis stops once the level of association remaining within a subdivision is insignificant as a result of the sites being similar in their species composition. The results of the analysis are used to map each subdivision as a separate community onto the sample grid (Fig.2). The average composition of each community is described by a phytosociological summary table (Table 1).

RESULTS. *Rubus fruticosus* is the chief pattern-discerning species (Fig 1). It divides the 65% of sites where it is present and is associated with the lower altitude communities from the 35% of sites where grassland predominates. The former sites are divided by the presence of the middle altitudes of the Malvern range. The latter sites are divided by *Festuca ovina* whose presence marks a low-growing or open grass community.

Colonization by *Ulex* species commonly follows soil disturbance (Tubbs & Jones, 1964). The thickest patches are seen along the spoil beside tracks and along paths begun by trampling on slopes. Natural soil slumping provides sites for seedling establishment. *Ulex* regenerates well from rootstock after the removal of above ground parts by burning which may also stimulate seed germination. *Rubus*, *Pteridium aquilinum* and *Chamaenerion angustifolium* also recover well from rootstock and rhizomes, while *Digitalis purpurea* and other many-seeded plants, such as *Rumex acetosella*, have their seed banks stimulated by the open conditions following a fire.

Grasses have varying capacities and speeds of recovery from fire. One of the first to re-establish is *Anthoxanthum odoratum* which is the character species for Community 1 in the *Rubus-Ulex* group (Table 1). It is the most species-rich community on account of the removal of competition by disturbance. *Anthoxanthum* is a constant species on the drier hillside spurs where soils are

thin and disturbed by downslope creep and any fires are fanned by exposure to winds. Community 2 marks the more productive sites of hillside combs where water is better supplied. These sites are recovering from previous disturbance. Particularly characteristic is an increase in *Chamaenerion* whose circular patches begin to locally exclude the widespread *Pteridium-Agrostis* community. *Arrhenatherum elatius*, better than most grasses, is able to withstand the increasing competition that results in a decline of species-richness at these sites.

The *Rubus* communities without *Ulex* have less often suffered from severe disturbance. Community 3 is a distinctive woodland-edge community characterised by the presence of *Viola riviniana* and nine other species of at least constancy II (Table 1). *Pteridium* is frequent though less luxuriant than in more open situations where the frond height and density increases. Community 4 with *Agrostis tenuis* as the character species has *Pteridium* as a constant associate, often with *Holcus mollis* and with sparse *Endymion non-scriptus* to brighten the community in spring before the bracken canopy expands. Community 5 exhibits a sharp drop in species richness where the highest densities of bracken fronds and litter exclude species such as *A. tenuis*. Most species grow more sparsely including *Rubus*, and its companion species such as *Teucrium scorodonia* are less constant.

The Malvern Hills support bent-fescue acid grasslands in response to grazing by commonable animals. Owing to recent low and variable stocking rates this grassland is increasingly rare. It is best represented by Community 6 which occurs at only 17 sites in the sample, and even then bracken fronds are encroaching at low density. A moderately high species density is achieved with small species such as *Campanula rotundifolia* and *Rumex acetosella* in evidence. Community HB is similar but for the lack of *Festuca ovina* that is generally a sign of slightly higher plant biomass and lower species diversity owing to a shortage of grazing on slopes below the summit ridges.

Community 7 is a higher altitude community characterised by *Festuca ovina* and the lack of *Pteridium*, which is most likely restricted by late spring frosts. *A. tenuis* and *F. rubra* are frequent but *Deschampsia flexuosa* is increasingly dominant on higher slopes. Some sites with dense *D. flexuosa* are classified under the residual, species poor Community 9 which includes the clearly perceptible *Vaccinium myrtillus* patches on the Worcestershire Beacon, as well as pure stands of *Ulex* or *Pteridium* and the somewhat different lower altitude grasslands. The preponderance of *D. flexuosa* at higher altitudes is reversed on thin soils near rocky outcrops where *Galium saxatile*, *Polytrichum* and *Cladonia* lichens increase in frequency.

Figure 2 maps the distribution of these communities on the sample grid with the northern hills on the left and the southern hills continued on the right (see Fig. 1 for the key to communities). Altitude is clearly an important influence (Fig. 3). It explains the first analytical division, as there is a highly significant difference between the mean of 232m for communities with *Rubus* as against 293m for those without.

Grassland communities dominate most ground above 300m. On the Worcestershire Beacon moderate sheep grazing and relatively mild slopes enable them to extend to lower altitudes. At the beginning of the century, the cutting of bracken and stronger grazing by sheep, cattle and rabbits, controlled coarser

vegetation. As a result, and judging by old photographs, grasslands held their own down to at least 250m. This would correspond to 57% of the present sample rather than the 35% recorded. It is noteworthy that *D. flexuosa* - the distinctive high altitude grass of the Malverns - occurs upwards from 250m and clothes slopes over 300m. *Holcus mollis* is a fairly robust grass that is clearly competitive with *D. flexuosa* where they come into contact (Jowett & Scurfield, 1949) which on the Malverns is especially around 270-300m. The mean altitude of sites lacking *Pteridium* is 284m. Temperature controls the upper limit of *Pteridium* but the influence of altitude is moderated by other factors such as exposure, slope and the distance from the summit. For example, the pioneer fringe of rather depauperate *Pteridium* reaches 372m in this sample, in the lee of Table Hill on the slopes of North Hill. This spot is higher than many summits along the ridge where exposure is too great for *Pteridium* to grow.

The mean altitude for both *Pteridium* and *H. mollis* is 249m. At lower altitudes good spring growth of *H. mollis* is possible though survival through the summer depends on the frond density of *Pteridium* not being too great. At lower altitudes, as any quadrat recorder knows to his cost, bracken can grow high and dense and the main associate is tangled bramble which pulls and tears with progress already impeded by the lower, middle slopes of the Hills! *Rubus* survives on the lower slopes where the density of trees increases and many species of the open communities of hills decline in vigour. Shade tolerant species such as *Viola riviniana* mark many of the lower altitude sites around the peripheries of the hills and more widely in the southern hills.

Table 1. Phytosociological summary table.

Community number	7	6	8	9	1	2	4	5	3
<u>Polytrichum spp.</u>	II	I	I	.	.	.	.	.	.
<u>Aira praecox</u>	I	.	.	.	.	.	.	.	.
<u>Luzula campestris</u>	I	.	.	.	.	.	.	.	.
<u>Galium saxatile</u>	III	II	II	II	II	.	I	.	.
<u>Galium verum</u>	I	.	.	.	.	.	.	.	.
<u>Vaccinium myrtillus</u>	.	.	.	I	.	.	.	.	.
<u>Deschampsia flexuosa</u>	IV	III	III	II	II	.	I	.	.
<u>Poa pratensis</u>	III	III	II	.	I	.	I	.	I
<u>Anthoxanthum odoratum</u>	IV	IV	IV	II	VI	.	II	.	I
<u>Hieracium pilosella</u>	I	.	.	.	I	.	.	.	.
<u>Campanula rotundifolia</u>	.	II	.	.	.	.	.	.	.
<u>Festuca ovina</u>	VI	VI	.	.	III	.	I	.	.
<u>Agrostis tenuis</u>	V	VI	VI	.	III	V	VI	.	II
<u>Festuca rubra</u>	III	III	II	I	I	.	.	.	.
<u>Rumex acetosella</u>	II	III	II	.	II	.	.	.	.
<u>Ulex gallii</u>	I	II	II	II	VI	VI	.	.	.
<u>Pteridium aquilinum</u>	.	.	VI	IV	II	IV	IV	VI	VI
V	.	.	.	.	.	.	.	.	.
<u>Holcus mollis</u>	I	.	II	II	I	II	III	III	I
<u>Digitalis purpurea</u>	.	II	I	.	III	II	II	II	II
<u>Chamaenerion angustifolium</u>	.	.	.	.	II	III	II	II	.
<u>Rubus fruticosus agg.</u>	.	.	.	.	.	VI	VI	VI	VI
VI	.	.	.	.	.	.	.	.	.
<u>Teucrium scorodonia</u>	.	.	.	.	II	III	II	II	.
<u>Arrhenatherum elatius</u>	.	.	I	.	I	II	I	I	I
<u>Endymion non-scriptus</u>	.	.	.	.	.	.	I	I	.

<u>Cytisus scoparius</u>						I		.	.
<u>Dactylis glomerata</u>			.	.	I		.	.	I
<u>Corydalis claviculata</u>		I		.	I	.	I	.	I
<u>Holcus lanatus</u>	.	.	I	.	.	I	.	.	I
<u>Fragaria vesca</u>	.			.			.	.	II
<u>Galium aparine</u>								I	II
<u>Viola riviniana</u>	.	.	.	.		.
<u>VI</u>									
<u>Stellaria media</u>	.	.				.	I	.	II
<u>Oxalis acetosella</u>			.		.		I	I	II
<u>Brachypodium sylvaticum</u>	.			.		.	.	.	II
<u>Crataegus Monogyna</u>	.	.	.	.		I	I	.	II
<u>Urtica dioica</u>	.		.	.	.		.	I	II
<u>Agrostis stolonifera</u>					.	.	.	.	III
<u>Glechoma hederacea</u>									II
Average species/25 common	5.8	7.2	5.5	2.5	10.3	5.7	6.4	3.8	6.4
Average altitude, m	310	289	294	264	265	250	241	223	190

. = 0-9; I = 10-19; II = 20-39; III = 40-59; IV = 60-79; V = 80-90; VI = 91-100
 Constancy as % of quadrats in the community

The Association Analysis subdivisions are shown by the hierarchy of solid boxes marking presence and dashed boxes marking absence.

[NVC equivalent: I = 1-20%; II = 21-40%; III = 41-60%; IV = 61-80%; V = 81-100%].