H8
Calluna vulgaris-Ulex gallii heath

Synonymy
Limestone heath Hope-Simpson & Willis 1955 *p.p.*; *Agrosto-Ulicetum gallii* Shimwell 1968 *p.p.*; *Ulici-Ericetum cinereae* Bridgewater 1970; *Calluno-Scilletum vernae*, *Ulex gallii* subassociation Malloch 1971; *Calluna-Ulex gallii* heaths Gimingham 1972; Grass-heath Ward *et al.* 1972*a p.p.*

Constant species
Calluna vulgaris, *Erica cinerea*, *Ulex gallii*.

Rare species
Agrostis curtisii, *Viola lactea*.

Physiognomy
The *Calluna vulgaris-Ulex gallii* heath is a floristically rather diverse community with only three constants overall, but its characteristic mixture of *Calluna vulgaris*, *Ulex gallii* and *Erica cinerea*, typically lacking *E. tetralix*, *Molinia caerulea* or *Agrostis curtisii*, is quite diagnostic. Often, the three sub-shrubs are co-dominant, though their proportions are quite variable and locally each can be poorly represented, *E. cinerea* in particular tending to become patchy where the community extends on to cooler aspects and to higher altitudes. In the latter situations, too, this kind of heath can have small amounts of *Vaccinium myrtillus*. On disturbed ground, as along pathways or over abandoned fields and settlements, *U. europaeus* may occur with some abundance.

Typically, the sub-shrub canopy is of high cover, sometimes excluding all but a very sparse herbaceous component but, quite often, the bushes are separated by systems of grassy runnels and, where the vegetation has been open to grazing, the structural contrast between these two components can be sharply accentuated. Where the bushes themselves are nibbled, a common occurrence, the canopy can be reduced in height: it is generally less than 30 cm, and a frequent picture is of dense 'hedgehogs' of gorse with short, but rather more untidy, bushes of heather scattered amongst them. In coastal stands, too, exposure to wind helps limit sub-shrub growth and, in exceptional cases, cliff-top heaths which are also heavily grazed can have a very tight cover of woody growth no more than a few centimetres high. Burning can also affect the structure and composition of the vegetation: controlled fires are rare but accidental burns can open up the ground, providing an opportunity for local dominance of *U. gallii* which can sprout vigorously from surviving buried stools, or *E. cinerea*, which can seed prolifically and out-perform *Calluna* in the early years of recovery, particularly on warmer aspects. Such temporary perturbations of dominance may also allow *Pteridium aquilinum* to increase its representation in this kind of heath. Generally speaking, this is an occasional in the community and not abundant, sometimes excluded by the dryness of the soil or by exposure but often limited by the dense sub-shrub cover and thus able to expand where vigorous marginal growth of its rhizomes coincides with opening up of the canopy (e.g. Watt 1955): mosaics of the *Calluna-Ulex* heath and the *Pteridium-Galium* community, presumably mediated at least in part by competition, are common. *Rubus fruticosus* agg, can also occur among the bushes but it is generally infrequent and usually indicative of a local transition to *Ulex-Rubus* scrub over disturbed ground; even there, its abundance can be much reduced by grazing.

Among the herbaceous associates, few species are common throughout and none is consistently abundant, but plants characteristic of Nardo-Galion swards provide the most obvious floristic element, with grasses being especially prominent in many stands, occurring as rough tussocks among the sub-shrubs or forming the bulk of the close-grazed areas of turf between. *Agrostis capillaris* and *Festuca ovina* are the most frequent species overall, with *A. canina* spp. *montana*, *F. rubra*, *Anthoxanthum odoratum* and *Danthonia decumbens* occasional to frequent, but rather more unevenly distributed, *Deschampsia flexuosa* and *Nardus stricta* much more patchy

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in their occurrence. As mentioned above, *Molinia caerulea* is typically scarce in this community but it can occur locally in south-west England and in west Wales, where, together with *E. tetralix*, it transgresses far into drier heath: then, there may be some difficulty in separating this community from the *Ericetum tetralicis* or the *U. gallii-Agrostis* heath. Burning and grazing of stands on somewhat moister soils can also lead to a reduction in sub-shrub cover and the development of vegetation transitional to the *Molinia-Potentilla* grassland. Such problems of diagnosis are a real reflection of the confluence of these communities in the more humid west of Britain.

Among the grassy ground, or growing up as scattered and attenuated plants through the more open bushes, there is often some *Potentilla erecta* and *Galium saxatile*, much more occasionally some *Teucrium scorodonia* and *Polygala serpyllifolia*, but even they can be reduced to very sparse individuals in the densest sub-shrub covers. Then, it may be just scattered patches of scuffed ground, transitions to rocky outcrops or the tops of ant-hills that provide a niche for occasional plants of *Aira praecox*, *Rumex acetosella* and *Jasione montana*. Usually, however, the herbaceous element is a little more extensive than this, though its particular character is strongly dependent upon local edaphic and climatic conditions. By and large, a mesophytic element is poorly represented in this kind of heath, though a slightly preferential occurrence of *Viola riviniana* and *Carex pilulifera*, less so of *C. binervis*, helps define the *Danthonia* sub-community. More striking, on the generally quite sharply draining soils that support this vegetation, is the enrichment of the community calcifuges by more calcicolous plants, or at least by species indicative of a transitional soil base-status, notably *Sanguisorba minor*, *Helianthemum nummularium* and *Carex flacca*, in the *Sanguisorba* sub-community; or by plants typical of maritime heaths, in the *Scilla* sub-community, *S. verna* itself, *Plantago maritima* and *Hypochoeris radicata*. Finally, in the *Vaccinium* sub-community, as well as *V. myrtillus*, there is a preferential occurrence of *Deschampsia flexuosa*, *Nardus stricta* and *Digitalis purpurea*.

In general, the bryophytes and lichens of the community are not very numerous or diverse, nor do they strikingly reflect the floristic trends visible among the vascular plants: quite often, the sub-shrubs are so dense and the grassy herbage so rank or tightly knit as to leave little available ground for their extensive development. However, there is quite often some *Hypnum cupressiforme* and *Dicranum scoparium*, with *Rhytidiadelphus squarrosus* and *Pleurozium schreberi* more occasional, and on moister aspects and at higher altitudes, where the heath is often represented by the *Vaccinium* sub-community, cover of these species can be quite extensive. In more open situations, as on bare ground exposed by burning or disturbance, such mosses as *Campylopus paradoxus*, *Polytrichum piliferum* or *P. juniperinum* can become abundant, representing early stages in recolonisation. Lichens, too, may make some small contribution in such places or in more open areas of turf, with *Cladonia impexa* and *C. squamosa* occurring occasionally.

Sub-communities

Species-poor sub-community: *Ulici-Ericetum typicum* Bridgewater 1970. Extensive and dense sub-shrub canopies are the rule here, sometimes with one of the woody constants obviously pre-eminent in cover, though often with two or three of them sharing dominance in a patchwork of bushes. The canopy can be quite tall, thicker stands being less penetrable to stock, with the heather and gorse in particular likely to become leggy. The associated flora is characteristically very sparse, with grasses such as *Agrostis capillaris*, *Festuca ovina* and *F. rubra* reduced to small scattered tufts and herbs like *Potentilla erecta* and *Galium saxatile* represented by occasional weak individuals growing through the shorter and more open bushes. In many stands, the only enrichment occurs where there has been some opening of the canopy as a result of burning or disturbance, when *U. europaeus* or *Pteridium* may show a local expansion or, on mobile, sandy substrates, *Carex arenaria*; or where, on exposed and more stable soil surfaces, there can be invasion by plants like *Teucrium scorodonia*, *Aira praecox*, *Rumex acetosella*, *Polytrichum juniperinum*, *P. piliferum* and *Cladonia* spp. Apart from in such places, cryptogams are generally infrequent in this vegetation, with just a few patches of *Hypnum cupressiforme* growing among the bushes.

***Danthonia decumbens* sub-community:** *Ulici-Ericetum caricetosum* Bridgewater 1970. The sub-shrub canopy is well developed in this sub-community, with *U. gallii* and *E. cinerea* especially abundant, but it is not generally so extensive or dense as above and typically there is a system of grassy runnels between the bushes. In these, *Agrostis capillaris* and *Festuca ovina* are quite frequent and occasionally abundant, but much more characteristic is *Danthonia decumbens* with, somewhat less commonly, *Anthoxanthum odoratum*, *F. rubra* and *Agrostis canina* spp. *montana*. Mixtures of these species typically form the bulk of a rough cover growing among the sub-shrubs or, where stands are grazed, the basis of stretches of smooth turf running between them, and then having their taller culms and inflorescences confined to the protected fringes of the bushes. Also very typical of this kind of heath is *Carex pilulifera*, though it seems to be rather patchy in its occurrence and is distinctly more abundant where fires have provided open ground into

which it can spread. *Viola lactea* can also show local prominence in such places and disturbance may provide an opportunity for colonisation by *U. europaeus*. Few other floristic features are distinctive though, with *Potentilla erecta* and *Galium saxatile* which become very frequent here, there is occasionally a little *Viola riviniana* and, with *Hypnum cupressiforme* among the grasses, *Pseudoscleropodium purum* is weakly preferential. Locally, in south-west Britain, *Molinia* can become frequent in this vegetation but it is generally of low cover and not usually accompanied by either *Erica tetralix* or *Agrostis curtisii*.

***Sanguisorba minor* sub-community:** Limestone heath Hope-Simpson & Willis 1955 *p.p.*; *Agrosto-Ulicetum gallii* Shimwell 1968*a p.p.* In its floristics, this is the most striking kind of *Calluna-U. gallii* heath. Its sub-shrub cover and the composition of much of the herbaceous component are very similar to the *Danthonia* sub-community, as is the structural variety in the organisation and appearance of these elements in relation to the intensity of grazing. But, here, there is a group of strongly preferential herbs which enrich the vegetation between the bushes. Some of these species are of a more broadly tolerant and mesophytic character, such as *Plantago lanceolata*, *Lotus corniculatus*, *Galium verum*, *Carex caryophyllea*, *Dactylis glomerata*, *Brachypodium sylvaticum* and *Avenula pubescens*, each occurring at generally low covers, though with the grasses showing occasional prominence where they grow tussocky with lack of grazing. Others, notably *Stachys betonica* and *Hypericum pulchrum*, found as scattered individuals, are indicative of some shift in soil base-status while a third, most distinctive, group is more obviously calcicolous, with *Sanguisorba minor*, *Carex flacca*, *Helianthemum nummularium*, *Thymus praecox* and *Linum catharticum*. Where numbers of these are present together in stands which are grazed, a treatment that accentuates the contribution of the hemicryptophytes and chamaephytes to the turf, the vegetation can give the appearance of stretches of Mesobromion grassland growing among islands of the heath sub-shrubs; and, indeed, there is every gradation between this more mixed vegetation and just such mosaics where the *Calluna-U. gallii* heath occurs over limestones (see below).

***Scilla verna* sub-community:** *Calluno-Scilletum vernae*, *Ulex gallii* subassociation Malloch 1971. *Calluna*, *U. gallii* and *E. cinerea* typically occur here as co-dominants in fairly extensive canopies, though ones which, in exposed situations, can be very low, with a tight mat of woody shoots but a few centimetres high. Among the sub-shrubs, there is usually a rather species-poor herbaceous element, with *Festuca ovina* very much the most frequent grass, often the only one, and growing as scattered tussocks. *Potentilla erecta* remains common but other community herbs are scarce, although this vegetation shares with the *Sanguisorba* sub-community occasional records for *Lotus corniculatus* and *Thymus praecox*. More distinctive, however, is the preferential occurrence of *Hypochoeris radicata* and, particularly common, though easily missed when not in its spring flowering period, *Scilla verna*. *Plantago maritima* also occurs quite frequently, and can be abundant in stretches of grazed sward and on cliff-top paths through this vegetation, but this is usually the limit of any maritime element in the flora.

***Vaccinium myrtillus* sub-community.** *Erica cinerea* occurs with reduced frequency in this kind of heath and, though it can remain locally abundant, the most prominent sub-shrub is usually *U. gallii* with smaller amounts of *Calluna* and, strongly diagnostic here, *Vaccinium myrtillus*. Grasses can be of quite high total cover between the bushes with *Agrostis capillaris*, *Festuca ovina* and *Anthoxanthum* all quite frequent, but *Deschampsia flexuosa* is preferential and especially prominent where knolls protrude from among the sub-shrubs. *Nardus stricta* can also occur with local abundance but associated dicotyledonous herbs are few: *Galium saxatile* and *Digitalis purpurea* are occasional. In more open areas, bryophytes can form a fairly lush but patchy cover with *Rhytidiadelphus squarrosus*, *Pleurozium schreberi* and *Dicranum scoparium* supplementing *Hypnum cupressiforme*.

Habitat

The *Calluna-U. gallii* heath is a community of free-draining, generally acid to circumneutral soils in the warm oceanic regions of lowland Britain. Local climatic and edaphic conditions influence floristic variation within this vegetation type and grazing, and sometimes burning, affect its physiognomy and composition. Ultimately, it is these biotic factors, and perhaps, in some situations, exposure to wind, that maintain the community against succession to woodland, and the susceptibility of the soils to improvement for agriculture means that this kind of heath now often survives patchily on marginal grazing land.

The community includes most of the drier, non-maritime heath that is to be found through the British lowlands within the overlapping ranges of *E. cinerea* and *U. gallii*. This region takes in much of the South-West Peninsula, Wales, parts of the north-west of England and the Isle of Man and then swings round through the southern Pennines to take in the seaboard of East Anglia. Climatically, the distinguishing feature of this zone is the equable character of the temperature regime: the summers are generally warm, with mean annual maxima over 25 °C (Conolly & Dahl 1970) but, more

importantly for the vigour of oceanic sub-shrubs like *U. gallii* and *E. cinerea*, the winters are mild, February minima being usually over 1 °C (*Climatological Atlas* 1952) and frost days few, particularly close to the coastal fringe where many stands occur.

Across the range of the community, however, certain climatic variables differ considerably and, apart from these two sub-shrubs, this kind of heath has no consistently strong oceanic contingent in its flora. Indeed, summer temperatures themselves, though generally high, differ quite widely across the country from a mean annual maximum close to 30 °C on the east coast to 25 °C on the extremities of Cornwall and Lleyn (Conolly & Dahl 1970). And rainfall varies greatly, from less than 600 mm annually in Suffolk, with less than 120 wet days yr^{-1}, to over 1200 mm on the fringes of Dartmoor, Exmoor, the Welsh uplands and the Pennines, with close to 180 wet days yr^{-1} (*Climatological Atlas* 1952, Ratcliffe 1968). By and large, where the climate becomes cooler and wetter than this, the *Calluna-U. gallii* heath is replaced by other sub-shrub communities and the beginnings of one shift can be seen in the *Vaccinium* sub-community, where *E. cinerea* is partially replaced by bilberry, and where *Deschampsia flexuosa*, *Nardus* and bryophytes increase. Such a floristic change can be seen generally in response to altitude: the mean height of the samples of this kind of *Calluna-U. gallii* heath is about 200 m greater than that of the community as a whole and it is characteristic of upland fringes in Dartmoor and mid-Wales. But it also occurs locally at lower altitudes in response to aspect, with the *Vaccinium* sub-community sometimes figuring on the cooler and moister north faces of hills, as in the Mendips. At the opposite extreme, stands of the species-poor sub-community on the East Anglian coast, with a sparse associated flora of bryophytes and lichens, can resemble the continental *Calluna-Festuca* heath in general appearance.

The other climatic control on the occurrence of the community is maritime influence, more especially the deposition of salt-spray. Quite commonly, it is coastal sites which now offer the most extensive tracts of unimproved soils suitable for the development of this kind of heath and the sub-shrub canopy can persist, as a very low and tight cover, even in very windy situations. But *U. gallii* is intolerant of even moderate amounts of sea-salts, so the community is sharply limited seawards where such winds carry spray on to cliffs. Typically, it is the *Scilla* sub-community that occurs where the *Calluna-U. gallii* heath is represented on more exposed coasts, *S. verna* itself, *Hypochoeris radicata* and *Plantago maritima* all marking a floristic transition to the *Calluna-Scilla* heath, which characteristically replaces the community where sub-shrub vegetation continues seaward. Compared with even the least maritime forms of *Calluna-Scilla* heath, the *Scilla* sub-community always receives less salt input: measured as soil sodium/loss on ignition, the latter has been recorded as 87 μmol g^{-1} compared with a mean of 123 μmol g^{-1} for the *Calluna-Scilla* heath (Malloch 1971 and unpublished data).

Between these regional and local climatic extremes, the *Calluna-U. gallii* heath is largely confined to the more free-draining of acid to neutral and generally impoverished soils, which means that the community characteristically marks out exposures of pervious bedrocks or superficials and often occurs on sloping ground, particularly to the west where the higher rainfall can maintain even very immature profiles in a moist state. At one extreme, this kind of heath can occur over excessively-draining sands, as on the East Anglian coast (and perhaps in other stands with the species-poor sub-community); at the other, it can subsist on damp humic soils, as in the west or on the upland fringes (where the *Danthonia* and *Vaccinium* sub-communities predominate). In the latter situations, species such as *Molinia*, *Agrostis curtisii* or *Erica tetralix* may be sparsely represented, but the profiles never show the seasonal waterlogging characteristic of wetter heaths.

The particular nature of the parent materials and the profile type are, however, very variable. The *Calluna-U. gallii* heath occurs over a wide range of arenaceous sedimentaries and acidic igneous and metamorphic rocks as well as on silty and sandy superficials like loess and aeolian sands. In the wetter west of Britain such materials show a general tendency to weather to leached profiles with mor but the community can be found on soils of very different degrees of maturity from rankers through brown earths and brown podzolic soils, to podzols proper, even within the single *Danthonia* sub-community. Superficial pH, here and under most other kinds of *Calluna-U. gallii* heath, is usually from 3.5 to 4.5, which accounts for the generally calcifuge character of the associated flora, and the acidifying properties of *Calluna*, and perhaps also of *U. gallii*, help maintain this edaphic environment (Grubb *et al.* 1969, Gimingham 1972).

The predisposition of this kind of heath for free-draining substrates means that it can develop over limestones provided the controlling influence of the calcareous bedrock on pedogenesis is muffled by a mantel of pervious superficials and rainfall is sufficiently high to prevent upward diffusion of lime in the profile. Loess or aeolian sand is an ideal insulation against the renewal of supplies of calcium throughout the profile and over some important exposures of Carboniferous Limestone in the west of Britain, notably in Mendip, on Gower, in Anglesey and on the Great Orme in Gwynedd, the *Calluna-U. gallii* heath is a characteristic feature of deeper deposits of such materials on plateaus and benches (Gittins 1965*a*, Shimwell 1968*a*, Rodwell

1974). On the thick and more acidic mantles, the *Danthonia* sub-community is typical, while on thinner deposits or where the superficials themselves are somewhat calcareous, the mixed vegetation of the *Sanguisorba* sub-community occurs, with its modest contingent of Mesobromion plants.

In all these kinds of *Calluna-U. gallii* heath, the prominence of the associated herbaceous flora, which is largely what distinguishes the different sub-communities, is very variable and much affected by treatments. Where there is no grazing or burning, and where exposure to wind is not such as to keep the sub-shrubs trimmed low, the bushes grow dense and coalesce to produce the kind of extensive, impoverished cover typical of the Species-poor sub-community. With increasing age, the woody cover can become tall and leggy and individual bushes degenerate and die, thus creating a mosaic of more open areas in which a colonising sequence of bryophytes and herbs, appropriate to the edaphic and climatic conditions, can become established as a patch of the *Danthonia*, *Sanguisorba*, *Scilla* or *Vaccinium* sub-community. Where trees do not invade such gaps directly (see below), the sub-shrubs can eventually reassert themselves creating an uneven-aged but again species-poor heath.

Burning, which here seems usually to be an accidental occurrence rather than a deliberate treatment, can produce more extensive areas of regenerating vegetation assignable to the various sub-communities before the sub-shrub canopy again becomes closed in an even-aged woody cover. If grazing by stock is imposed, however, or if rabbits are numerous, then a heathy mosaic may become a more permanent feature, the proportions and arrangement of the bushes and sward reflecting the particular intensity and pattern of grazing. Sheep-grazing is especially likely to produce neat patchworks of close-trimmed sward and low-cropped bushes, the one snaking between islands of the other. Cattle, which are common stock in cliff-top stands in south-west England and in marginal pasture with this heath along the upland fringes, create rougher mosaics, grazing unevenly and not so closely on the sward, leaving ranker herbage around their dung and sometimes trampling open the turf, admitting coarser weedy species like *Teucrium scorodonia* and *Digitalis* or *U. europaeus*.

Zonation and succession

The *Calluna-U. gallii* heath is found in diverse kinds of zonations and mosaics with other vegetation types in relation to differences in the moisture content, base-richness and trophic state of the soils, and to variation in local climatic conditions, most strikingly maritime influence. Burning and grazing can modify these patterns but they also produce effects of their own, being responsible in most situations for the maintenance of the vegetation against succession to woodland. Reclamation of land for improved agriculture has left many stands as fragments in pastoral landscapes.

Towards the south-western part of its range, the community can occur as the dry-heath component in the characteristic sequences of sub-shrub vegetation developed over acidic soils with varying degrees of drainage impedence. Essentially, it replaces the *Calluna-U. minor* heath on the free-draining profiles in such zonations in the region to the west of the Poole basin, which marks the general divide between the ranges of *U. minor* and *U. gallii* (Proctor 1965). In full sequences of this type, the *Calluna-U. gallii* heath gives way, over gleyed podzols and stagnogleys, developed where an argillic B horizon or iron pan impedes drainage, to the *U. gallii-Agrostis* heath. *U. gallii*, *E. cinerea* and *Calluna* all run on, often in considerable abundance, into this community, but the junction between the two is usually marked by the consistent appearance of *E. tetralix*, *Molinia* and *A. curtisii*, which typically share dominance with them. In other cases, where there is a more sudden switch to mineral soils that are strongly seasonally waterlogged, the zonation can pass directly to some kind of *Ericetum tetralicis*. In this kind of wet heath, *E. cinerea* is scarce and *U. gallii* generally confined to sites with some through-put and aeration, so the junction is often quite clearly marked with a shift in dominance to *Calluna*, *E. tetralix* and *Molinia*.

In fact, within the tracts of heaths in south-western Britain, the *Calluna-U. gallii* type occupies a relatively small proportion of the ground, even where more free-draining soils are quite extensive. On the Devonshire Pebble-Bed commons, for example, where gently-dissected Triassic deposits form an undulating dip slope (Ivimey-Cook *et al.* 1975), on the Devon and Gower commons over Carboniferous deposits (NCC Devon Heathland Report 1980, NCC Gower Common unpublished data) and in Pembrokeshire, where suites of sub-shrub communities occur on the plateau cut into Cambrian and Ordovician rocks (NCC Pembrokeshire Heaths Report 1981), this community is rather poorly represented. This is partly because, with the increasing wetness of the climate in moving to the west and into the upland fringes, the damper kinds of heath are able to extend much further on to the free-draining profiles kept continually moist by high precipation:evaporation ratios. Often, then, it is the *U. gallii-Agrostis* heath that occupies the brown podzolic soils or podzols or, beyond its range, some drier kind of *Ericetum tetralicis*, with the *Calluna-U. gallii* heath confined to small stands over knolls and around rock outcrops. Even where tracts of dry heath could be potentially more extensive, the free-draining soils on lowland commons have often been the focus of past disturbance or cultivation, such that they now support *Ulex-Rubus* scrub or *Pteridium-Galium* vegetation.

Even where the effects of human activity have not

been so gross as this, treatments can mask the contribution of the *Calluna-U. gallii* heath to zonations such as these. Where burning occurs, for example, swales often cut across the soil-related boundaries and develop a temporary prominence of regenerating *U. gallii* or *E. cinerea*, or an eventual dominance of *Calluna*, which masks variation in the associated floras of the different constituent heaths. In other cases, burning can be followed by a great expansion in the cover of *A. curtisii* or *Molinia*, centred on the moister soils, but often extending on to the more free-draining profiles: extensive, fire-climax stands of *Molinia-Potentilla* grassland are a marked feature among heath sequences in lowland western Britain. Grazing may contribute to the maintenance of this kind of rank species-poor sward by helping keep the various regenerating sub-shrubs in check but frequently, in zonations of this kind, it produces a different kind of convergence among the associated herbaceous floras of the various heaths, to form extensive stretches of fairly uniform, close-cropped grassland. In the south-west, the most widespread kinds of *Calluna-U. gallii* heath are the *Danthonia* and *Vaccinium* types, the former especially on warmer and drier slopes, the latter in moister, cooler situations. These vegetation types already show a strong measure of floristic continuity in their herbs with some of the damper heaths, particularly the *Festuca* sub-community of the *U. gallii-Agrostis* heath and the *Succisa-Carex* sub-community of the *Ericetum tetralicis*. The effect of grazing over the boundary between the former and the *Calluna-U. gallii* heath is well seen in the sequence of heaths and grass-heaths described from the Dartmoor fringes by Ward *et al.* (1972*a*) and some perplexing intermediates between the *Calluna-U. gallii* heath and the *Ericetum* are to be seen on certain Pembrokeshire heaths (NCC Pembrokeshire Heaths Report 1981).

The floristic character of the swards derived by grazing the heath vegetation of the *Danthonia* and *Vaccinium* sub-communities places them firmly within the Nardo-Galion: they are characterised by mixtures of such grasses as *Agrostis capillaris*, *A. canina* ssp. *montana*, *Festuca ovina*, *F. rubra*, *Anthoxanthum odoratum*, *Danthonia decumbens*, *Nardus stricta* with *Carex pilulifera*, *Potentilla erecta* and *Galium saxatile*, that is, exactly the herbaceous element of the runnels between the sub-shrubs in the heath itself. Grazing can mediate every gradation between the extremes of dense heath on the one hand and continuous grassy sward on the other, and is the major factor controlling the other common kind of zonation in which the community is found: heath/grassland mosaics over stretches of more or less uniformly free-draining acid soil. These are a particularly characteristic feature of poorer-quality grazing land over acid rocks and superficials around the upland fringes, where the bulk of the sward can usually be referred to some kind of *Festuca-Agrostis-Galium* grassland and where the heath forms patches of varying size and organisation over rocky knolls, around field margins and in neglected corners, sometimes even forming hedgerow vegetation on top of inaccessible earth banks. Improvement of the pasture by the application of farmyard manure (or, perhaps, simply a switch from sheep to cattle as the grazing stock) may succeed in converting the sward to a more mesophytic kind, and use of chemical fertilisers, with top-sowing, can readily effect a full transformation to the *Lolio-Cynosuretum*. Towards the limit of in-by land in farms along the margins of Dartmoor and the Welsh upland, such pasture is the frequent context for remaining fragments of the *Calluna-U. gallii* heath.

Variations in base-richness, as well as in the trophic state of the soils, can produce a further element of complexity in these grazing-related sequences over free-draining profiles. As noted earlier, the community can occur over calcareous substrates where these are mantled by a cover of pervious, more base-poor superficials and on sites like the Mendip (Hope-Simpson & Willis 1955), the South Gower coast (NCC South Gower Coast Report 1981) and the Great Orme in Gwynedd (Rodwell 1974), the *Calluna-U. gallii* heath serves as one effective marker of the location of brown earths derived from patches of exotics such as loess or aeolian sand deposited and retained over gentler slopes (Smithson 1953, Perrin 1956, Ball 1960, Findlay 1965; see also Pigott 1962, 1970*a*). Typically, in such sites, the heath is surrounded by a calcicolous sward, in this case, the *Festuca-Avenula* grassland, developed over thin, dry and highly calcareous rendzina soils on the native limestone, and, where the patches of superficials are sharply defined, there can be an abrupt switch from this to the *Danthonia* sub-community of the heath: this kind of pattern can sometimes be seen where the exotic parent materials have filled up crevices, together with long-weathered and decalcified limestone debris, in the underlying rock surface. Often, however, there is a gradual transition from the rendzinas to the brown earths, with a continuous increase in the soil depth and in the proportion of non-native parent materials, producing some very interesting zonations from the calcicolous sward through to the heath. It is in such situations that the *Sanguisorba* sub-community occurs as an intermediate between the two, sometimes grading directly to the *Festuca-Avenula* grassland, in other cases showing a further transitional zone which can be classified within the *Festuca-Agrostis* grassland. Mixtures of calcicoles and calcifuges are characteristic of this intermediate kind of vegetation, together with some other species such as *Stachys betonica*, *Hypericum pulchrum* and, in Wales and Derbyshire, *Viola lutea* (Balme 1953, 1954, Pigott 1962, Grime 1963*a*, *b*). The term 'limestone heath' is often used to describe it, or part of it, but it should be noted that such transitional vegetation can

occur in zonations and mosaics between other constituent grasslands and heaths. The clarity of such patterns, though ultimately dependent upon the edaphic variation, is also much affected by the grazing intensity: relaxation allows most of the calcicolous plants to be overwhelmed by coarse grasses of broad ecological tolerance and perhaps permits an expansion of the sub-shrubs on to somewhat more base-rich soils which they can acidify (e.g. Grubb *et al.* 1969).

One further environmental variable, which can exert a controlling influence on zonations involving the *Calluna-U. gallii* heath, is salt-spray deposition. Over tracts of pervious, acidic rocks and superficials, the improvement of deeper profiles has been so extensive that, in some parts of south-west Britain, the community is now confined to the unenclosed fringe of land along the cliff tops, where it is represented by the *Scilla* type. However, as mentioned earlier, it is only on those parts of cliffs which are reasonably sheltered from salt-laden winds that even this kind of sub-shrub vegetation can survive and quite commonly it represents the limit of the semi-natural zonation, being terminated abruptly above by a field boundary with improved pasture or arable beyond. To seaward, where heath vegetation runs on into the more maritime zone, there is a transition to the *Calluna-Scilla* heath: typically, over more acidic soils, this is of the *Calluna* sub-community, from which *U. gallii* is absent and where *Armeria maritima* and *Plantago coronopus* occasionally figure, but which otherwise shows considerable continuity in its floristics, something which is readily seen where the sub-shrub element is reduced by exposure to winds to a very short mat through which the herbs inter-penetrate. Beyond this, the sequence can continue through maritime grasslands of the *Festuca-Holcus* and *Festuca-Armeria* types, with the *Festuca-Plantago* grassland becoming prominent where grazing is particularly heavy and then to maritime crevice communities. Throughout, the zonation can be interrupted by patches of the *Armeria-Cerastium* vegetation over rock outcrops or ant-hills, whose flora can show some continuity with the heath through species such as *Jasione montana* and *Aira praecox*. Such sequences are especially characteristic of the Cornish granite, the sandstones and shales of the north Cornish coast and Dyfed and the Anglesey Pre-Cambrian cliffs.

In certain areas, the *Scilla* sub-community is open to grazing stock though, within the range of the *Calluna-U. gallii* heath, it is frequently beef cattle rather than sheep that are turned on to sea-cliffs and their less assiduous cropping does not have such a marked effect on the vegetation. But, even without such treatment, the invasion of shrubs and trees into this kind of *Calluna-U. gallii* heath is probably much hindered by exposure to wind and modest amounts of salt-spray and it can perhaps be considered a climax vegetation. In more sheltered situations, episodes of heavy grazing with scuffing of the ground or fires can both open up the ground in the short term and allow establishment of seedlings but, for shrubs and trees to get away, such treatments must then be withdrawn. Successions have not been followed in any detail but the most likely woody invaders on the more base-poor soils are birch and oak (with a tendency for *Betula pubescens* and *Quercus petraea* to be pre-eminent in the areas of wetter climate), with *Pinus sylvestris* able to seed in from plantations, and *Sorbus aucuparia* and *Ilex aquifolium*: such developments would be expected to culminate in *Quercus-Betula-Dicranum* woodland. Where the profiles are not so acid, impoverished or excessively draining, it is possible that thorn scrub might develop as a precursor to more mixed oak-birch woodland of the *Quercus-Pteridium-Rubus* or *Quercus-Betula-Oxalis* types. Along such a successional line, the early establishment of *Ulex-Rubus* or *Pteridium-Rubus* underscrub may be of considerable importance in breaking the dominance of the calcifuge sub-shrubs and initiating some measure of soil enrichment. Disturbance could provide the initiating step in such a process and the presence of fragmentary scrubby woodland around abandoned settlements and wartime emplacements bears some testimony to this. Where *Pteridium* is locally established, however, any opening of the heath canopy, either by disturbance or by degeneration of the bushes, may allow it to pre-empt the ground forming dense bracken stands.

Distribution

The *Calluna-U. gallii* heath occurs widely throughout south-western England and Wales, on the Isle of Man and, more sporadically, in the southern Pennine fringes and near the East Anglian coast. The species-poor and *Danthonia* sub-communities occur through the whole range, although there is a tendency for the latter to be better represented in the wetter west. The *Scilla* sub-community is confined to the coastal fringe in this more maritime part of Britain, the *Sanguisorba* sub-community to areas with calcareous bedrock mantled with drift. The *Vaccinium* sub-community is found mainly at higher altitudes in the upland fringes.

Affinities

This kind of vegetation has generally attracted detailed attention in its more unusual forms, like the mixed calcicole-calcifuge heaths described by Hope-Simpson & Willis (1955) and the NCC South Gower Coast Report (1981), and located by Shimwell (1968*a*) in an *Agrosto-Ulicetum*; and the maritime heath included by Malloch (1971) in his *Calluno-Scilletum vernae*. These assemblages represent marked floristic trends but they seem best retained along with less peculiar heaths domi-

nated by *Calluna*, *U. gallii* and *E. cinerea* within the ambit of a single community. In general terms, this can be seen as the more oceanic analogue of the *Calluna-U. minor* heath, including most of the sub-shrub vegetation on more free-draining soils in the lowlands west of Poole Harbour.

Within Böcher's (1943) categories, the community falls among the southerly heaths of the Ericion cinereae, what Gimingham (1972) called *Calluna-Ulex gallii* heaths but which in both these schemes also included the vegetation here placed in the *U. gallii-Agrostis* heath. It is certainly true that, in the more humid west of Britain, the floristic distinctions between wet and dry heaths become rather fluid: *E. tetralix* and *Molinia* and, over its smaller range, *A. curtisii* extend far on to less waterlogged soils and *U. gallii* and, to a lesser extent, *E. cinerea*, can transgress in the opposite direction, into more enriched forms of the *Ericetum tetralicis*. But, over the region as a whole, there is a strong case for separating off sub-shrub vegetation in which *Calluna*, *U. gallii* and *E. cinerea* are the only overall constants. Similar assemblages have been described from France as the *Ulici-Ericetum cinereae* by Géhu & Géhu (1973) into which Bridgewater (1970) had placed heaths here included in the species-poor and *Danthonia* subcommunities.

The other difficulty of definition relates to the influence of grazing in mediating transitions between the community and calcifuge grasslands of the Nardo-Galion (or, in more specialised habitats, of the Mesobromion or Silenion maritimae). Herbs of such swards make up the bulk of the associated flora of the *Calluna-U. gallii* heath and, in grazed stands, can compose extensive areas of sward among the bushes. Zonations and mosaics between the heath and the grassland are of diverse form and clarity (e.g. Ward *et al.* 1972*a*), but problems of discerning boundaries are a real reflection of the continuous nature of grazing's impact.

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Floristic table H8

	a	b
Ulex gallii	V (3–10)	V (5–10)
Calluna vulgaris	V (3–10)	IV (2–8)
Erica cinerea	V (2–8)	IV (2–8)
Potentilla erecta	I (2–3)	IV (2–5)
Danthonia decumbens	I (2–3)	IV (2–8)
Anthoxanthum odoratum	I (5)	III (2–5)
Festuca rubra	I (1–3)	III (2–7)
Agrostis canina montana		II (2–5)
Viola riviniana	I (2–7)	II (3)
Molinia caerulea	I (1–7)	II (2–3)
Carex pilulifera	I (3)	II (2–3)
Pseudoscleropodium purum		II (3–5)
Viola lactea		II (2–3)
Sanguisorba minor		I (1–3)
Plantago lanceolata		I (2–3)
Helianthemum nummularium		
Carex flacca		
Hypericum pulchrum		I (3)
Stachys betonica		I (3)
Galium verum		
Carex caryophyllea		
Brachypodium sylvaticum		
Avenula pubescens		
Linum catharticum		
Dactylis glomerata		
Festuca ovina	I (2–5)	II (3–9)
Scilla verna		I (3)
Hypochoeris radicata	I (1)	II (2–3)
Lotus corniculatus	I (3)	I (3)
Thymus praecox		I (3)
Plantago maritima		I (2)
Deschampsia flexuosa	II (2–7)	II (1–7)
Vaccinium myrtillus		

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c	d	e	8
V (1–9)	V (4–8)	V (5–10)	V (1–10)
IV (1–6)	V (4–8)	IV (3–5)	V (1–10)
IV (1–8)	V (4–8)	II (5–10)	IV (1–10)
III (1–3)	III (1–4)	I (3–5)	III (1–5)
IV (1–6)		I (3–5)	II (1–8)
III (1–6)	I (2)	II (3)	II (1–6)
III (2–5)		I (5)	II (1–7)
III (2–6)		II (3)	II (2–6)
II (1–3)			I (1–7)
		II (2–3)	I (1–7)
I (2–3)		I (3)	I (2–3)
		I (3–5)	I (3–5)
			I (2–3)
IV (1–5)			II (1–5)
III (1–5)	I (1–3)		II (1–5)
III (1–5)			I (1–5)
III (1–4)			I (1–4)
II (1–2)	I (2–3)		I (1–3)
II (1–2)	I (2–4)		I (1–4)
II (1–3)			I (1–3)
II (1–3)			I (1–3)
II (1–6)			I (1–6)
II (1–3)			I (1–3)
II (1–2)			I (1–2)
II (1–5)			I (1–5)
III (1–6)	V (1–5)	III (5–7)	III (1–9)
I (1–2)	V (1–4)		II (1–4)
II (1–3)	IV (1–3)		II (1–3)
II (1–3)	III (1–3)		I (1–3)
II (1–3)	III (1–4)		I (1–4)
	III (1–3)		I (1–3)
I (1–3)		IV (3–7)	I (1–7)
		V (2–5)	I (2–5)

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Digitalis purpurea	I (2)				II (2–3)	I (2–3)
Nardus stricta		I (2–5)			II (3–5)	I (2–5)
Rhytidiadelphus squarrosus		I (3–5)			II (3–5)	I (3–5)
Pleurozium schreberi		I (3–7)			II (3)	I (3–7)
Agrostis capillaris	II (1–5)	III (2–9)	II (1–4)	I (3)	III (5)	II (1–9)
Galium saxatile	I (1–2)	III (2–5)	II (1–3)	I (2–3)	III (3–7)	II (1–7)
Hypnum cupressiforme	II (1–8)	II (3–7)	II (1–4)		III (3–5)	II (1–8)
Pteridium aquilinum	II (2–5)	I (3)	II (1–7)		II (3)	II (1–7)
Dicranum scoparium	II (1–5)	I (2–5)			II (3–7)	I (1–7)
Teucrium scorodonia	I (2–5)	I (3)	I (1–8)	I (3)	I (5)	I (1–8)
Ulex europaeus	I (2–7)	I (3–5)	I (1–6)	I (1–4)		I (1–7)
Erica tetralix	I (1)	I (3–5)		I (1–5)	I (4)	I (1–5)
Holcus lanatus	I (1)	I (2–3)		I (1)	I (6)	I (1–6)
Carex binervis	I (3–4)	I (2–3)		I (3)	I (3)	I (2–4)
Campylopus paradoxus	I (1–7)	I (2–4)			I (2–3)	I (1–7)
Aira praecox	I (2–5)	I (3–5)			I (3)	I (2–5)
Cladonia impexa	I (1–5)	I (3)			I (2–3)	I (1–5)
Polytrichum piliferum	I (2–5)	I (3)			I (2)	I (2–5)
Rumex acetosella	I (2–3)	I (2)			I (3)	I (2–3)
Cladonia squamosa	I (2)	I (3)			I (3)	I (2–3)
Jasione montana	I (2–4)	I (3)			I (2)	I (2–4)
Pedicularis sylvatica	I (4)	I (3)		I (1–3)		I (1–4)
Agrostis stolonifera	I (3)	I (7)	I (2–4)			I (2–7)
Rubus fruticosus agg.	I (1–2)		I (1–6)		I (4)	I (1–6)
Polytrichum juniperinum	I (1–5)			I (2)	I (2)	I (1–5)
Polygala serpyllifolia		I (3)		I (1–2)	I (3)	I (1–3)
Agrostis curtisii	I (2–4)	I (2–3)				I (2–4)
Number of samples	29	32	30	17	9	117
Number of species/sample	9 (4–25)	12 (8–25)	20 (12–32)	17 (6–24)	15 (4–26)	13 (4–32)
Vegetation height (cm)	36 (20–100)	30 (10–45)	28 (10–80)	15 (3–43)	26 (10–50)	28 (3–100)
Vegetation cover (%)	97 (75–100)	94 (40–100)	97 (70–100)	96 (80–100)	85 (50–100)	96 (40–100)
Altitude (m)	118 (12–350)	201 (90–320)	89 (10–152)	50 (10–110)	328 (100–465)	135 (10–465)
Slope (°)	6 (0–30)	16 (0–35)	11 (0–33)	7 (0–20)	17 (0–50)	15 (0–50)
Soil pH	4.1 (3.3–5.3)	4.0 (3.7–4.5)		4.7 (3.9–5.3)	3.9 (3.6–4.2)	4.1 (3.3–5.3)

a Species-poor sub-community
b *Danthonia decumbens* sub-community
c *Sanguisorba minor* sub-community
d *Scilla verna* sub-community
e *Vaccinium myrtillus* sub-community
8 *Calluna vulgaris-Ulex gallii* heath (total)

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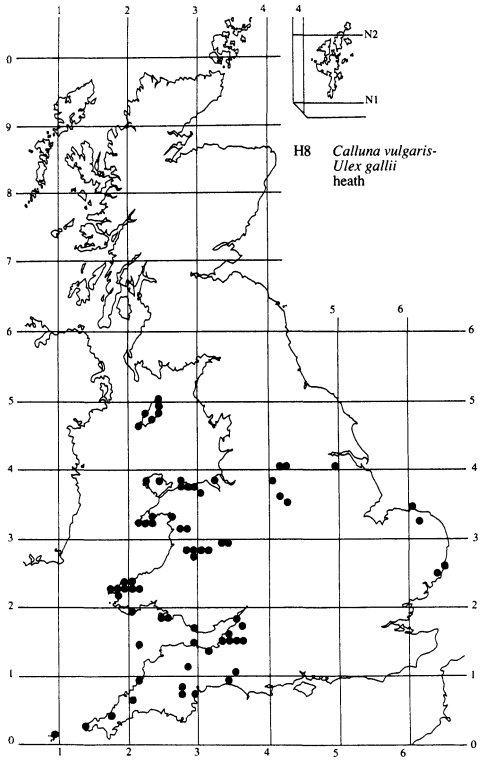

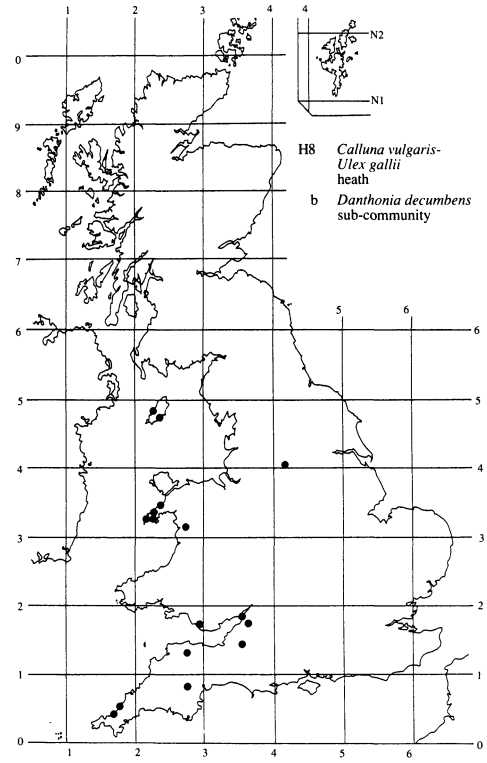

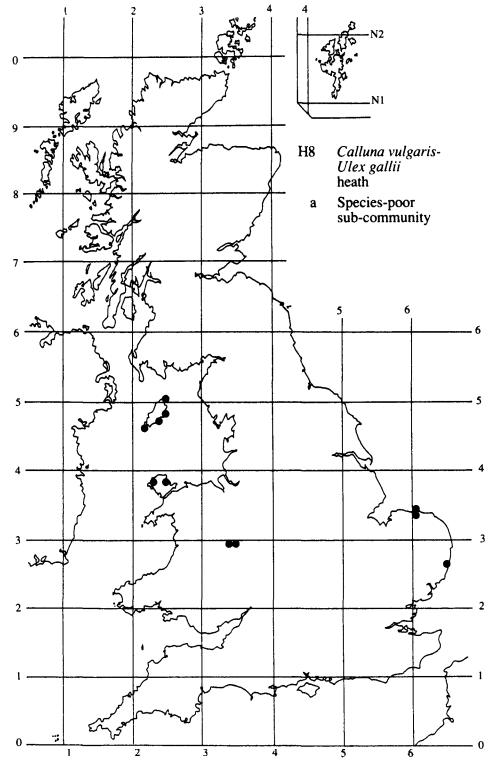

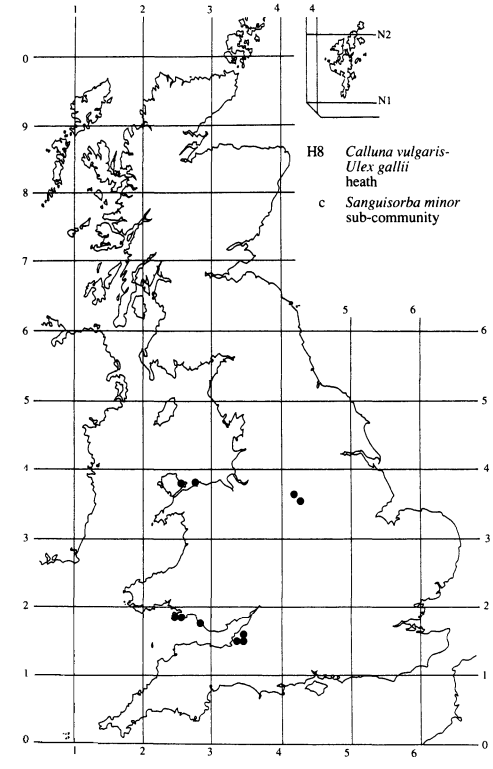

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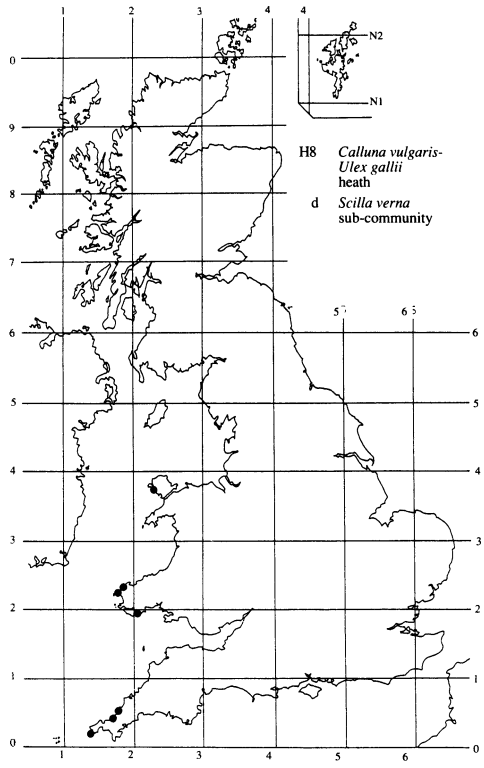

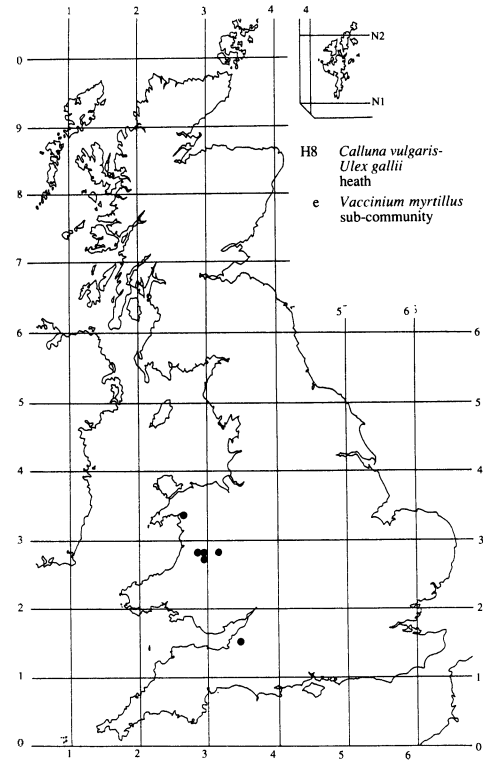

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