CG9

Sesleria albicans-Galium sterneri grassland

Synonymy

Limestone hill pasture Smith & Rankin 1903; *Festucetum ovinae* Moss 1911 *p.p.*; Limestone grassland Tansley 1939 *p.p.*; Carboniferous Limestone grassland Pigott 1956, Ratcliffe 1977 *p.p.*; Sugar Limestone grassland Pigott 1956; Limestone Grassland E Sinker 1960; *Potentilla fruticosa* localities Elkington & Woodell 1963 *p.p.*; *Seslerieto-Festucetum* Ratcliffe 1965; 'Ordinary' Limestone grassland Ratcliffe 1965; *Sesleria-Caricetum pulicariae* Shimwell 1968*a*; *Asperulo-Seslerietum typicum*, *Helianthemum* variant Shimwell 1968*a*; *Potentilletum fruticosae* Shimwell 1968*a p.p.*; *Agrosto-Festucetum*, *Sesleria* facies Eddy *et al.* 1969; *Dryas octopetala* localities Elkington 1971 *p.p.*; *Festuca ovina-Sesleria albicans* vegetation Jeffrey & Pigott 1973; *Seslerio-Caricetum pulicariae* Shimwell 1968*a* *emend.* Jones 1973; *Thymo-Festucetum sesleriosum* Evans *et al.* 1977; *Thymo-Agrosto-Festucetum* Evans *et al.* 1977 *p.p.*; *Sesleria albicans* grassland Ratcliffe 1977; Dry sugar-limestone grassland Ratcliffe 1978.

Constant species

Briza media, Campanula rotundifolia, Carex flacca, Festuca ovina, Galium sterneri, Helianthemum nummularium, Koeleria macrantha, Linum catharticum, Sesleria albicans, Thymus praecox, Viola riviniana, Ctenidium molluscum.

Rare species

Alchemilla glaucescens, A. minima, Aster linosyris, Carex capillaris, C. ericetorum, Cypripedium calceolus, Draba incana, Dryas octopetala, Galium sterneri, Gentiana verna, Helianthemum canum, Hypochoeris maculata, Kobresia simpliciuscula, Minuartia verna, Myosotis alpestris, Polygala amara, Potentilla crantzii, P. fruticosa, P. tabernaemontani, Primula farinosa, Sesleria albicans, Thalictrum alpinum, Veronica spicata, Viola rupestris, Tortella densa.

Physiognomy

The *Sesleria albicans-Galium sterneri* grassland can occur as closed or open swards or, in very rocky situations, as on stabilised talus and small rock ledges or over pavement clints, be reduced to fragmentary assemblages, in which one or more of the major species of the community attain local prominence. The vegetation can be short, but a few centimetres high, with an even close-cropped appearance when grazed, or be taller and decidedly tussocky. *Sesleria albicans* is the most frequent grass and, though it can vary in abundance from dominant to sparse, it is frequently conspicuous with its tufts of rather stiff, glaucous leaves, choked below by persistent sheaths. When growing vigorously and ungrazed, plants can attain a considerable size, spreading laterally by long creeping rhizomes. Then the species behaves more like a winter-green chamaephyte, though its slowly-growing leaves are often masked by dead material which can give a brown tinge to the sward in winter (Dixon 1982).

Koeleria macrantha and *Festuca ovina* are also constant components of the vegetation and, in some sub-communities, they can be abundant, occasionally attaining co-dominance with *S. albicans*. *F. rubra* is generally uncommon here and rarely prominent, a marked contrast to the *Festuca-Agrostis-Thymus* grassland. *Briza media* and *Avenula pratensis* are also frequent but somewhat unevenly represented throughout and generally not abundant. There is occasionally a little *Danthonia decumbens* and, in some sub-communities, *Agrostis capillaris* and *Deschampsia cespitosa* are common though rarely prominent. There are almost always some sedges in the sward. *Carex flacca* and *C. caryophyllea* are most frequent overall and the former especially can be abundant. In certain kinds of *Sesleria-Galium* grassland, *C. pulicaris*, *C. panicea* and (much less commonly) *C. capillaris* and another cyperaceous species, *Kobresia simpliciuscula*, also attain prominence.

The woody chamaephytes *Thymus praecox* and *Helianthemum nummularium* are both constant and, though the latter is somewhat patchy in its occurrence, each can be locally abundant as prostrate or low sub-shrubs. In contrast to many lowland calcicolous grasslands, however, *Hieracium pilosella* is generally infrequent. Another mat-former and a very characteris-

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tic species of this community is *Galium sterneri* and there are frequently some procumbent patches of *Lotus corniculatus*. Other common dicotyledons, especially hemicryptophytes and ephemerals, are few in number. Among the former, only *Viola riviniana* and *Campanula rotundifolia* are constant throughout with *Plantago lanceolata* sometimes frequent, each of these occurring as scattered, usually sparse, individuals in the sward. Important Mesobromion species like *Sanguisorba minor*, *Leontodon hispidus* and *Scabiosa columbaria* are, generally speaking, scarce. The commonest pauciennials are *Linum catharticum* and *Euphrasia officinalis* agg. (generally *E. nemorosa* or, in some sub-communities, *E. confusa*, where taxa have been distinguished). *Gentianella amarella* is occasional.

The community provides an important locus for a number of nationally rare vascular plants. Most of these show a strongly preferential distribution among the various sub-communities and, when numbers of them occur together at different sites, they give the vegetation a unique composition. One rarity which is found sparsely in most kinds of *Sesleria-Galium* grassland is the Arctic-Alpine *Minuartia verna*, an early, though perennial, colonist of bare patches in the sward.

Bryophytes are always an important component of the vegetation, occurring both among the vascular species of the sward itself and over, or in the crevices within, bedrock exposures. The commonest species throughout are *Ctenidium molluscum*, *Tortella tortuosa* and *Hypnum cupressiforme* with, less frequently or more unevenly distributed among the different sub-communities, *Ditrichum flexicaule*, *Dicranum scoparium*, *Pseudoscleropodium purum*, *Fissidens cristatus*, *Rhytidiadelphus squarrosus*, *Neckera crispa*, *Hylocomium splendens*, *Scapania aspera* and *Frullania tamarisci*. Most kinds of *Sesleria-Galium* grassland also have more markedly preferential mosses and hepatics.

Lichens are not so varied or abundant but there is occasionally some *Cladonia rangiformis* or *C. pocillum* and, in some sub-communities, *Cornicularia aculeata* and *Cetraria islandica*.

Sub-communities

***Helianthemum canum-Asperula cynanchica* sub-community:** *Helianthemum canum* localities Griffiths & Proctor 1956 *p.p.*; *Helianthemum canum-Thymus drucei* Association, *Sesleria caerulea* facies Proctor 1958; *Asperulo-Seslerietum typicum*, *Helianthemum* variant Shimwell 1968*a*; *Hippocrepis comosa* localities Fearn 1973 *p.p.*; *Hypochoeris maculata* localities Wells 1976 *p.p.* The sward here is characteristically open, often occurring as fragments of vegetation distributed over small rock ledges or as individual plants rooted in crevices over broken cliff faces. Both *S. albicans* and *F. ovina* can have high total cover, though they frequently grow as discrete tussocks, rather than forming the basis of an intact turf. There is occasionally some *Koeleria macrantha* and *Avenula pratensis* and sometimes a little *Danthonia decumbens* but, as in lowland arid calcicolous grasslands, *Briza media* is scarce. Chamaephytes are always a prominent feature. *Thymus praecox* is constant and occasionally abundant and there is frequently some *Hippocrepis comosa*, here growing very much towards its north-western limit. Also *Helianthemum nummularium* is sometimes accompanied by *H. canum* or, at certain sites, totally replaced by it in striking patterns of vicarism towards cliff tops or around rock outcrops (e.g. Proctor 1958). Among the hemicryptophytes too, there are similarities with southern, calcicolous swards in the preferentially high frequencies here of *Leontodon hispidus*, *Asperula cynanchica*, *Scabiosa columbaria*, *Succisa pratensis* and the biennial *Carlina vulgaris*. In general, the structure and floristics of the vegetation thus come close to those of the Xerobromion grasslands of the *Festuca-Carlina* community and, as there, there are scarce records in this sub-community for a number of national rarities which, like *H. canum*, prefer open, calcareous situations: e.g. *Hypochoeris maculata*, *Potentilla tabernaemontani*, *Aster linosyris*, *Veronica spicata* and *Carex ericetorum*.

The bryophyte element also reflects the nature of the habitat with its high exposure of bedrock and the occurrence of crevices and bare soil. Among the general species of the community, *Ctenidium molluscum*, *Tortella tortuosa*, *Ditrichum flexicaule*, *Dicranum scoparium* and *Fissendens cristatus* are the most frequent and abundant but preferential here are *Homalothecium lutescens*, *Encalypta streptocarpa*, *Weissia* ssp. (mostly *W.* cf. *microstoma*) and, less commonly, *Trichostomum brachydontium*. There are occasionally some scattered plants of *Cladonia rangiformis* and *C. pocillum*.

Typical sub-community: Limestone grassland E Sinker 1960; *Potentilla fruticosa* localities Elkington & Woodell 1963 *p.p.*; *Potentilletum fruticosae* Shimwell 1968*a p.p.*; *Agrosto-Festucetum*, *Sesleria facies* Eddy *et al.* 1969; *Thymo-Festucetum sesleriosum* Evans *et al.* 1977; *Sesleria albicans* grassland Ratcliffe 1977. The floristics here are very much those of the community in general with a few minor differences: *Helianthemum nummularium*, for example, is somewhat less frequent than usual, *Hieracium pilosella* a little more so and, among the grasses, *Festuca rubra* can occasionally rival or exceed *F. ovina*. There is, however, some variety in the composition and structure of the vegetation according to the nature of the topography over which it is disposed and the amount of grazing. Over flat limestone surfaces and on stable fine talus, particularly where there is pasturing, the sub-community typically forms a closed and even sward with its constituents closely mingled. Where it extends on to coarser talus, stable river shingle

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and cliff ledges or into solution hollows on pavement clints, the turf is frequently more fragmented and sometimes reduced to various assortments of a few species which have pre-empted the small niches. Grazing here may preserve some diversity but, where such vegetation is inaccessible to stock or rabbits, it can become very tussocky and species-poor, with *S. albicans* especially growing very vigorously and often accompanied by just a little *Thymus praecox* and *Galium sterneri*. Fragments of this sub-community can also occur, intermixed with components of mixed deciduous woodland and bryophyte-dominated vegetation, in the better-illuminated parts of pavement grikes.

Alchemilla glaucescens and the very rare *A. minima* have been recorded in this vegetation and, at some of its localities along the Tees, *Potentilla fruticosa* forms an open canopy over river-shingle stands (Elkington & Woodell 1963, Shimwell 1968*a*).

***Carex pulicaris-Carex panicea* sub-community:** *Gentiana verna* localities Elkington 1963 *p.p.*; 'Ordinary' limestone grassland Ratcliffe 1965 *p.p.*; *Seslerio-Caricetum pulicariae typicum* & *dryadetosum* Shimwell 1968*a*; *Dryas octopetala* localities Elkington 1971 *p.p.*; *Thymo-Agrosto-Festucetum* Evans *et al.* 1977 *p.p.*; *Sesleria albicans* grassland Ratcliffe 1977 *p.p.* Two floristic features distinguish this sub-community from the former which it resembles in the range of topographically-related physiognomies it can exhibit. First, there is a group of species which become frequent, not only here, but also in the next two sub-communities. The most obvious of these are *Carex pulicaris* and *C. panicea* which here join *C. flacca* and *C. caryophyllea* as common components of the sward. *C. pulicaris* is usually the most abundant sedge and, although it can be under-estimated when it is sparse, it can occasionally attain co-dominance with *S. albicans* in densely-tufted patches. Indeed, where this vegetation becomes fragmented over pavement surfaces, whole solution hollows can be filled with vigorous plants of this species. Also among this group, *Potentilla erecta* becomes constant and, among the bryophytes, *Hylocomium splendens*, which can form prominent sprawling patches. *Frullania tamarisci* is also distinctive, though less frequent and abundant. *Cornicularia aculeata* is constant here, too.

Second, there are differential and preferential species for this sub-community alone. Apart from *Polygala vulgaris*, none of these is especially frequent and they are of somewhat diverse affinities. The most obvious group comprises species characteristic of the base-rich small-sedge mires of the Caricion davallianae: *Pinguicula vulgaris*, *Parnassia palustris*, the Northern Montane rarity *Primula farinosa* and *Carex hostiana* (though usually not either *C. dioica* or *C. lepicocarpa*). These species are, however, never very abundant here, being present generally as scattered individuals, and the vegetation never attains the look of a mire. Indeed, the grassy appearance of the sward is sometimes enhanced by the occasional occurrence of *Anthoxanthum odoratum*, *Agrostis capillaris*, *Deschampisia cespitosa* and *Molinia caerulea*. In other stands, it is the local prominence of dwarf shrubs that give a distinctive physiognomy. *Dryas octopetala* is found in its Craven localities in this sub-community (Shimwell 1968*a*, Elkington 1971) but, though it can be abundant as a low patchy canopy, the vegetation is otherwise not floristically distinct. By contrast, the local abundance of *Calluna vulgaris* and/or *Empetrum nigrum*, which are occasionally encountered in stands of this vegetation, is usually accompanied by some impoverishment of the flora: *S. albicans* can remain prominent but other species thin out and there is an increase in the cover of bulky pleurocarpous mosses such as *Hylocomium splendens* and *Pseudoscleropodium purum* (Shimwell 1968*a*).

Rare species are few here. *Minuartia verna* sometimes occurs in more open situations where it may be accompanied by a local abundance of *Ditrichum flexicaule* and *Rhytidium rugosum* and prominent *Thymus praecox* and *Hieracium pilosella*. *Gentiana verna* and *Viola rupestris*, though much more characteristic of the next sub-community, can be found in such vegetation too. *Cypripedium calceolus* occurs in a very typical grassy sward of this sub-community at its only British locality.

***Carex capillaris-Kobresia simpliciuscula* sub-community:** Sugar Limestone grassland Pigott 1956; *Gentiana verna* localities Elkington 1963 *p.p.*; *Seslerieto-Festucetum* Ratcliffe 1965; *Seslerio-Caricetum pulicariae kobresietosum* Shimwell 1968*a*; *Seslerio-Caricetum pulicariae typicum* Shimwell 1968*a emend.* Jones 1973 *p.p.*; Dry sugar-limestone grassland Ratcliffe 1978 *p.p.* In floristic terms, the vegetation here has a good deal in common with the last sub-community in that *S. albicans*, *F. ovina* and a diversity of sedges remain frequent and generally abundant in the sward. In this sub-community, however, there is a further enrichment by a variety of Northern Montane, Alpine and Arctic-Alpine species. Some of these are of fairly widespread occurrence throughout the northern and western uplands of Britain, especially in Scotland, e.g. *Selaginella selaginoides*, *Polygonum viviparum* and *Antennaria dioica*, which are all frequent here, and *Thalictrum alpinum*, which occurs very occasionally. Others are much rarer in Britain and, for these, this vegetation provides a very important outpost or, in extreme cases, their major or only mainland British locality. Not all are found together in the same stand and there has been some concentration, in the data available, on the richer swards but, nonetheless, their occurrence in close proximity and unique mixtures gives this vegetation very great floristic interest.

Among these species are *Carex capillaris*, which here

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frequently replaces *C. pulicaris*, and *Kobresia simpliciuscula*, each of which can be present in abundance. Like *Thalictrum alpinum*, *C. capillaris* is fairly widespread in the Scottish Highlands, where it is a prominent component in certain kinds of *Dryas octopetala* vegetation, but *K. simpliciuscula* is very rare outside this grassland and its adjacent mires in Upper Teesdale. *Gentiana verna* is restricted to this locality in mainland Britain and, though it can also occur in other kinds of *Sesleria-Galium* grassland and some types of flush, its major locus is in this vegetation (and it is found in very similar swards in western Ireland: Elkington 1963, Ivimey-Cook & Proctor 1966*b*). Another very rare species present in some stands is *Viola rupestris* and there are occasional records too for *Polygala amara*, *Potentilla crantzii*, *Minuartia verna*, *Dryas octopetala* and the Continental Northern *Carex ericetorum*, here at its altitudinal and northern limit in Britain. Most curiously, the Continental Southern *Helianthemum canum* also occurs in a few stands, in a distinctive form with small leaves, at most sparsely hairy above (Griffiths & Proctor 1956). Of interest, too, is the occasional presence of *Plantago maritima* and *Armeria maritima* at one of their few inland English localities.

Among the bryophytes and lichens, too, there is an obvious montane component. *Racomitrium lanuginosum* is constant here and *R. canescens* frequent. With *Ditrichum flexicaule*, *Hypnum cupressiforme*, *Tortella tortuosa* (sometimes in the form *curta*, now *T. densa*: Smith 1978) and a little *Ctenidium molluscum*, *Scapania aspera*, *Hylocomium splendens* and *Frullania tamarisci*, bryophyte cover can be extensive. There is frequently some *Cetraria islandica*, occurring in scattered patches with *Cornicularia aculeata* and *Cladonia pocillum*.

The other distinctive feature of the vegetation is its physiognomy which, as well as being influenced by sheep- and rabbit-grazing which produces a characteristically close-cropped sward, is very much dependent on the amount of erosion and deposition of the sugar-like sand into which the underlying metamorphosed limestone bedrock weathers. The variety in the appearance of the turf and the floristic changes that can accompany movement of the sand are well illustrated in Pigott (1956*a*). In some places, the vegetation is closed and intact with the constituents closely intermingled. In others, the sward is eroded into a patchwork of humps and hollows, the latter perhaps being initiated by the central decay of grass tussocks and developing into miniature blow-outs with removal of sand by the wind. Sometimes, these gaps are recolonised by runners of chamaephytes and sedges, shoots from surviving fragments of *F. ovina* or seedlings of *Minuartia verna*, but there can be a more extensive destruction of the vegetation once it has been opened up. Then, remaining fragments of the turf become fretted around the margins and undercut, roots being exposed and plants blowing away. Deeper-rooted chamaephytes may survive this process for some time, growing isolated and perched above the eroding surfaces but, eventually, these too may perish. Around such areas of erosion, the limestone sand can be deposited on top of the neighbouring vegetation, burying the grasses but creating a congenial environment for those species able to benefit from the reduced competition. Pigott (1956*a*) noted that acrocarpous mosses and longer-lived vascular species, including rarities like *Carex ericetorum*, *Gentiana verna*, *Viola rupestris*, *Helianthemum canum* and *Dryas octopetala*, seemed to be especially benefited by such conditions, forming vigorous and extensive patches.

***Saxifraga hypnoides-Cochlearia alpina* sub-community:** Carboniferous Limestone grassland Pigott 1956 *p.p.*; *Myosotis alpestris* localities Elkington 1964 *p.p.*; 'Ordinary' limestone grassland Ratcliffe 1965 *p.p.*; *Seslerio-Caricetum pulicariae*, Sub-association of *Saxifraga hypnoides* and *Cochlearia alpina* Shimwell 1968*a*; Rock-ledge vegetation Eddy *et al.* 1969 *p.p.* Like the former sub-community, the vegetation here is a grass- and sedge-rich sward with a distinctive suite of strong preferentials with montane affinities. Mixtures of *F. ovina*, *S. albicans*, *C. pulicaris*, *C. caryophyllea* and *T. praecox* form the basis of the turf; *C. flacca* and *C. panicea* are somewhat reduced in frequency and abundance. Especially frequent among the vascular associates are the Northern Montane *Saxifraga hypnoides*, which can be abundant in lax patches, and the form of *Cochlearia officinalis s.l.* distinguished as ssp. *alpina* or *C. alpina* (and perhaps identical with the European *C. pyrenaica*: Tutin *et al.* 1964). *Gentiana verna* occurs very occasionally here but the most distinctive rarities are two other Arctic-Alpines, *Draba incana*, which is especially obvious in more open patches of turf, and *Myosotis alpestris*, here in a smaller (and possibly genotypically different) form than that found among plants in the dwarf-herb vegetation of the Scottish Highlands, the other main locus for this species in Britain (Pigott 1956*a*, Elkington 1964). Bryophytes are varied and their cover can be extensive. In addition to the general mosses of the community, there are sometimes patches of *Racomitrium lanuginosum* and *R. canescens* and, particularly distinctive here, scattered *Polytrichum juniperinum*. Among the hepatics, *Plagiochila asplenoides* and *Tritomaria quinquedentata* become frequent here, *Barbilophozia barbata* and *Blepharostoma trichophyllum* occasional.

Habitat

The *Sesleria-Galium* grassland is largely restricted to free-draining but moist calcareous lithomorphic soils over usually drift-free Carboniferous Limestone exposures with a sub-montane or montane climate in the northern Pennines. It is often grazed and frequently

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forms an important part of the hill-pasture of upland farms.

Over the whole range of the community, the climate is cooler and wetter than that characteristic of the southern lowland calcicolous grasslands. The mean annual maximum temperature is less than 26 °C (Conolly & Dahl 1970) and the mean annual precipitation always in excess of 1000 mm (*Climatological Atlas* 1952, Chandler & Gregory 1976), with more than 160 wet days yr^{-1} (Ratcliffe 1968) and the bulk of the rain falling in the winter half. Within these general climatic conditions, which are typical of large parts of upland Britain, the *Sesleria-Galium* grassland is almost wholly confined to soils derived directly from Carboniferous Limestone uncontaminated with heavier-textured or non-calcareous drift. There is sometimes a little loessic material or boulder clay in the profile or occasionally some downwash from adjacent deposits (Pigott 1956*a*, Dixon 1982) but the soils, though often moist throughout the year, are typically free-draining. However, despite the generally high precipitation/evaporation ratios, the profiles remain highly calcareous, at least below, because supplies of calcium carbonate are continually renewed by weathering of the underlying limestone and frequently by gentle flushing with lime-rich waters from the surroundings slopes. Surface base-status, though, is not always high: typical stands are commonly found on soils with a superficial pH down to 5.5, though the community is most characteristic of the range 6.0–7.5, sometimes up to 8.0 (Griffiths & Proctor 1956, Pigott 1956*a*, Elkington 1963, 1964, 1971, Eddy *et al.* 1969, Jones 1973, Dixon 1982).

Rendzina soils of this kind are found in a variety of topographic situations over upland exposures of Carboniferous Limestone (e.g. Bullock 1971, Curtiss *et al.* 1976, *Soil Survey* 1983 where they are mapped largely as humic rankers). In crevices and between talus fragments, on ledges and in solution hollows, they may be extremely shallow and fragmentary accumulations of weathering limestone particles and organic detritus. In other cases, as over stabilised fine talus and well-colonised pavement surfaces, soil cover may be more extensive but the profiles are still generally shallow, rarely exceeding 20 cm depth. Deeper soils over these exposures are less influenced by the underlying rock and often perched upon and partly derived from drift deposits, in which case they may be too ill-drained or acid to carry this vegetation; or, towards the bottoms of slopes, they may be bulked up by colluvial downwash and be accessible to agricultural improvement. In general, though the community can extend some way on to brown calcareous earths provided they remain free-draining, it usually gives way at such boundaries, and over gleyed soils, to other vegetation types.

The soils which carry the *Carex-Kobresia* sub-community are worthy of special comment because, though they share many features with typical rendzinas, they have some peculiar characteristics which influence the vegetation. This sub-community is confined to those parts of Upper Teesdale where the Carboniferous Limestone has been metamorphosed by contact with the intruded Whin Sill dolerite into a form of marble which weathers into the very aptly-named 'sugar-limestone', a mass of discrete calcite crystals with the texture of coarse granulated sugar (Pigott 1956*a*, 1978*a*, Johnson 1978). Over the slowly-weathering banks and knolls of the exposed marble and on the remnants of often very thick beds of sugar-limestone that have been produced by extensive disintegration under a drift cover and then exposed, shallow black rendzinas develop and it is on these that the *Carex-Kobresia* sub-community characteristically occurs, extending a little on to brown calcareous earths where there is an intermixing of the limestone particles and shallow drift (Pigott 1956*a*, 1978*b*, Ratcliffe 1965, 1978). The extreme permeability of the sugar-limestone helps offset the effects of the very heavy rainfall of the area to such an extent that the surface layers of the soils can become very dry in summer (Welch & Rawes 1969) and its particulate nature makes it highly susceptible to frost-heave and wind erosion (Pigott 1956*a*). The soils are also particularly rich in lead, not only around the spoil of the extensive local workings but over the outcrops in general (Jeffrey & Pigott 1973). The impact of these characteristics is taken up below.

The general climatic and edaphic features of the environment are reflected in the community as a whole in the following ways. First, though the swards have a strong core of species characteristic of more oligotrophic and calcareous soils, there is here a shift away from the more exacting calcicoles of the southern lowland Mesobromion grasslands and especially from the Continental element in those communities. The most frequent calcicoles which the *Sesleria-Galium* grassland has in common with, say, the *Festuca-Avenula* grassland are those of somewhat broader edaphic and climatic amplitude, such as *Carex flacca*, *Briza media*, *Koeleria macrantha*, *Thymus praecox*, *Helianthemum nummularium* and *Linum catharticum*. Important species in the southern swards, like *Leontodon hispidus*, *Scabiosa columbaria*, *Asperula cynanchica* and *Hippocrepis comosa* are much reduced here and attain high frequency only where there is a pronounced local amelioration of the environmental conditions. Even *Sanguisorba minor* is rather restricted in occurrence. By contrast, *Galium sterneri*, a calcicole with a Northern Montane distribution in Britain, becomes constant.

Second, the slight tendency towards surface eluviation of calcium and a drop in pH in the soils is marked by the beginning of a trend, which becomes much more

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pronounced in other upland limestone swards, towards the occurrence, intermixed with the calcicoles, of Nardo-Galion species. *Potentilla erecta* is generally at least occasional here and, in some sub-communities, attains constancy. *Hylocomium splendens*, too, rises to prominence in certain kinds of *Sesleria-Galium* grassland. The accumulation of mor humus is never more than a local phenomenon here but it can be marked by the occurrence of scattered ericoids or, occasionally, by their patchy abundance in the sward.

Third, the higher levels of soil moisture are reflected by the abundance in many of these swards of species typical of damper conditions and tolerant of a high base-status, plants which are never encountered in lowland calcicolous grasslands. The most obvious of these are *Carex panicea* and *C. pulicaris* but there is also sometimes a hazy representation of other species characteristic of Caricion davallianae mires. This is a trend which is repeated in other upland calcicolous communities.

Fourth, the common occurrence of crevices within the typically very hard Carboniferous Limestone bedrock means that there are abundant niches for calcicolous bryophytes such as *Ctenidium molluscum*, *Tortella tortuosa*, *Fissidens cristatus* and *Neckera crispa*, though this group is also typical of other upland calcicolous swards over similar exposures.

Finally, what makes the community especially distinctive is the occurrence, within swards characterised by the above features, of *Sesleria albicans* at high frequencies and, generally, in abundance. Exactly why this species should be largely confined in Britain to this community and to the geographically close (but floristically rather different) *Sesleria-Scabiosa* grassland is, as mentioned earlier, a considerable puzzle. However, it certainly thrives under the environmental conditions here and, within the northern Pennines, is clearly restricted to situations which are characterised by the above-listed floristic features.

As well as being of general importance for the community as a whole, climatic and edaphic variation across its range has a marked influence upon the composition and distribution of the sub-communities. These form a crude altitudinal sequence running from the Morecambe Bay exposures to the west, below 250 m and, at one locality, almost at sea-level, to the slopes of Mickle Fell in the east, at almost 750 m (Figure 22). Around Morecambe Bay, the climate, though still moist, is considerably warmer and sunnier than that at higher inland localities. Though the annual precipitation here, at least away from the coast, can considerably exceed 1000 mm (Griffiths & Proctor 1956, Proctor 1958), the temperature rises earlier in the spring and attains higher levels in the summer than it does in the hinterland, with average daily means in the hottest month on Scout Scar in Cumbria, for example, of 15 °C (Griffiths & Proctor 1956) and mean annual maximum temperatures along this whole coastal fringe touching or slightly exceeding 26 °C (Conolly & Dahl 1970). Daily sunshine totals for July in the area are around 6.5 hours (Chandler & Gregory 1976). The winters are relatively mild with comparatively few frosts and infrequent snow-lie. It is to rocky, south- and west-facing slopes where the warm and sunny character of this somewhat oceanic climate is further accentuated, that the *Helianthemum-Asperula* sub-community is confined. Here, southern Mesobromion species such as *Leontodon hispidus*, *Scabiosa columbaria*, *Asperula cynanchica* and *Hippocrepis comosa* are better represented than anywhere else in the *Sesleria-Galium* grassland. Further, the very open, dry and highly calcareous conditions, with soils showing a strong tendency to summer parching, which restricts the growth of the grasses and prevents invasion by shrubs and trees, have provided a congenial environment for the survival here of a number of rare species such as *Helianthemum canum*, *Aster linosyris*, *Carex ericetorum*, *Veronica spicata* and *Hypochoeris maculata*. These are, as in their other localities in Britain, variously represented in different sites, a feature which suggests that there has been some fortuitous element in their historical survival.

S. albicans is a highly eurythermal species and, though it may show some adverse response to droughting in especially hot and dry summers (Dixon 1982), it can apparently recover well and maintain itself as a tussocky open cover in the *Helianthemum-Asperula* sub-community, together with most of the community constants (*Briza media* being a notable exception here, as elsewhere). However, it is on the deeper, moister soils in this coastal region and in the cooler, wetter conditions found over the inland exposures of the Craven uplands, that these species begin to form the basis of the intact or, if fragmentary, then more luxuriant swards of the Typical sub-community. In moving to this higher ground, the climate begins to approach that so fittingly described for the northern Pennines by Manley (1936, 1942) as cold, wet, windy and cloudy. In Craven, the mean annual precipitation rises to as high as 1500 mm (*Climatological Atlas* 1952) with up to 180 wet days yr^{-1} (Ratcliffe 1968). The growing season may start as much as three weeks later than near the Lancashire coast and temperatures attain lower peaks in a shorter summer with mean annual maxima around 25 °C (Conolly & Dahl 1970). The winters are colder and frosts and snow more frequent. Under these conditions, the Typical sub-community occurs extensively, mostly between 250 and 500 m, on valley-side slopes and over colonised pavement, most frequently where there is still free drainage, less flushing and a complete absence of glacial drift.

The *Carex pulicaris-Carex panicea* sub-community, though it is much less widespread than the Typical sub-

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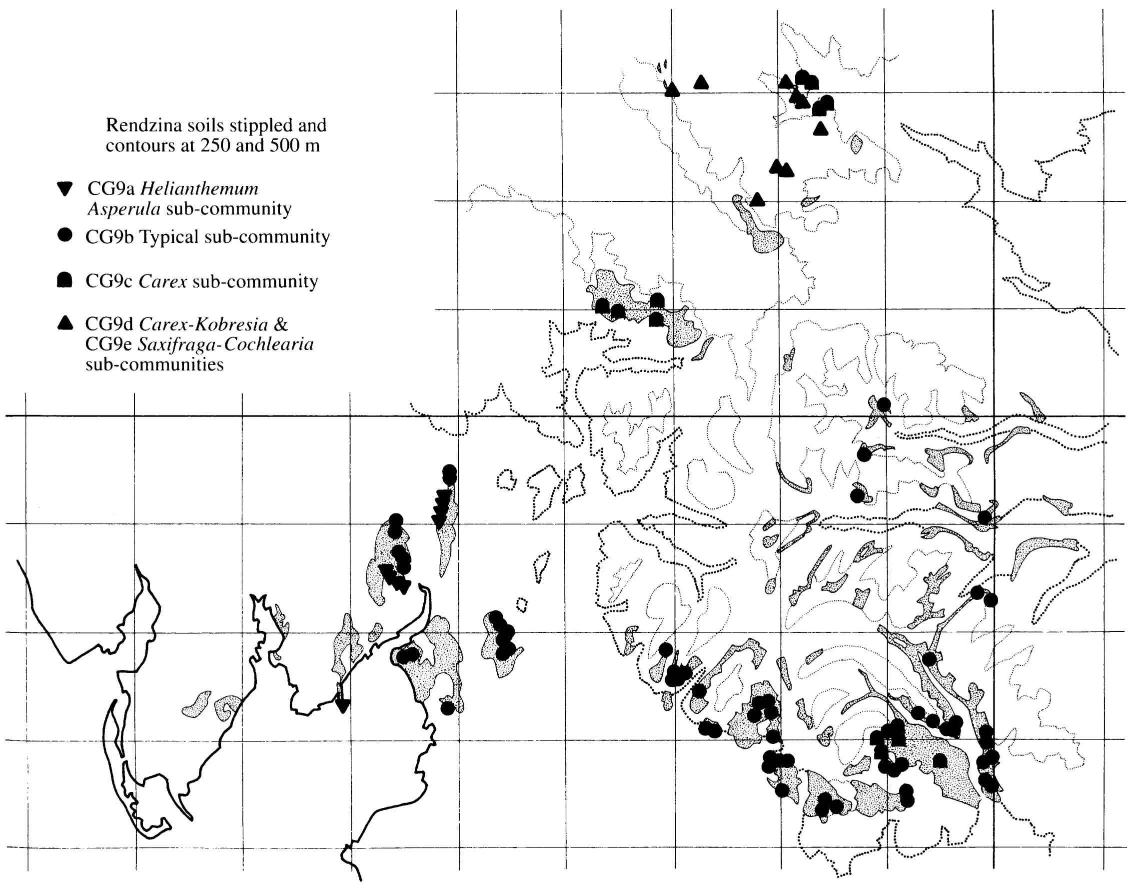
community and extends on to somewhat higher ground, both at occasional sites within Craven and to the north, is found under generally similar climatic conditions and exactly what influences its particular floristic features is not fully understood. It is slightly more restricted to south- and west-facing slopes than the Typical sub-community but, in the sharply-aligned glaciated valleys of Craven, this may be simply a reflection of available topographies. Part of the answer may lie in distinct edaphic conditions, for its preferentials are those characteristic of somewhat moister and perhaps less free-draining soils and of slight accumulation of mor humus.

The two remaining kinds of *Sesleria-Galium* grassland, the *Carex-Kobresia* and *Saxifraga-Cochlearia* sub-communities, are much more restricted to the highest parts of the north Pennine Carboniferous Limestone, occurring around or above 500 m in Upper Teesdale and the fells immediately to the west. Here, the climate makes its closest approach in England to the very severe conditions characteristic of mountains in the Scottish Highlands and on the European mainland. There is a very late start to the growing season with low mean maximum temperatures and frequent frosts extending into May. Because the annual mean temperature curve is so flat in the northern Pennines, relatively small increases in altitude in this region are accompanied by a very pronounced reduction in the length of the growing season (Manley 1945) and summers are characteristically brief and cloudy, with temperatures below the critical mean for plant growth for perhaps more than half the time (Pigott 1956*a*) and mean maxima less than 25 °C (Conolly & Dahl 1970). The autumn is typically windy and very wet, the winter stormy and bitter with as many as 50 days of snow or sleet and a long spring snow-lie (Manley 1936, 1940, 1942). Over the year as a whole, precipitation may exceed 1750 mm (Glasspoole 1932, *Climatological Atlas* 1952).

Both these sub-communities are characterised by the maintenance of that floristic component (*Carex panicea* and *C. pulicaris* (sometimes alternatives here), *Potentilla erecta* and *Hylocomium splendens*) indicative of a perhaps delicate balance between moderate flushing

Figure 22. Distribution of different types of CG9 *Sesleria-Galium* grassland around Morecambe Bay and in the Yorkshire Dales.



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with base-rich waters and surface eluviation. More distinctive, however, is the appearance of various members of a Northern Montane, Alpine or Arctic-Alpine element comprising species which are largely confined in Britain to calcareous soils within a mean maximum summer isotherm of 25 °C (often falling to 23 °C for the Scottish localities: Conolly & Dahl 1970). These are all perennial species and the survival of the rarer members of the group is perhaps indicative of the maintenance of open conditions, free from both tree invasion and the spread of blanket mire, for a very considerable period of time (Godwin 1949, Pigott 1956*a*, Ratcliffe 1965, 1978, Turner 1978).

Within these harsh climatic conditions, the distribution of the *Carex-Kobresia* sub-community is largely maintained and restricted by the occurrence of the exposures of sugar-limestone. The extreme permeability of this material and its susceptibility to wind erosion and frost-heave sustain a patchwork of immature, calcareous soils over which this kind of open *Sesleria-Galium* sward shows spatial and temporal shifts in composition and structure in response to movement of the substrate (Pigott 1956*a*), rather like those described from the Breckland grasslands (Watt 1962, 1981*a*, *b*). As there, the soils seem to be markedly oligotrophic, being especially poor in phosphate, the uptake of which may be further inhibited by the large amounts of lead present (Jeffrey 1971, Jeffrey & Pigott 1973, Pigott 1978*b*). Such nutrient poverty probably plays a prominent part in restricting the growth of the grasses which here respond very markedly to the addition of phosphate fertiliser (Jeffrey 1971, Jeffrey & Pigott 1973) and the open texture of the sward is probably of major importance in the survival here of some of the rare species such as *Viola rupestris* and *Helianthemum canum*.

The *Saxifraga-Cochlearia* sub-community is more typical, within these same climatic conditions, of unaltered Carboniferous Limestone, but there are perhaps some particular environmental features which influence its occurrence. It is sometimes found over rockier ground on blocky talus or ledges but also extends, as a closely-grazed turf, on to brown calcareous earths where there is some drift downwash (Pigott 1956*a*). Some strands also show the effect of disturbance and eutrophication by stock (Shimwell 1968*a*).

This variation in climatic conditions over the range of the community modifies the effect of grazing by stock and rabbits, a common feature in these grasslands. Stands of the *Sesleria-Galium* grassland are an important component of the 'out-by' summer grazing of Pennine farms. Typically, the stock, mostly hardy breeds of sheep, are turned out on to the hills from the winter-grazed 'in-by' meadows in late April to early May, remaining there until the onset of the severe weather or, in milder periods and on more sheltered sites, throughout the winter. In the dales of the Craven area, the community often occurs in the typical long and thin Parliamentary enclosures which run up from the edge of the valley-bottom alluvial fields, over the scree-strewn slopes and to the cliffs above (Taylor 1975). Generally, however, the topography is too intractable for any kind of agricultural improvement of the soils and, typically, they receive no manuring apart from the dung and urine of the stock. Stands in this kind of situation which are close to farms are sometimes used as pasture for dairy cattle.

Grazing plays an important part, throughout the community, in the maintenance of a short and more diverse sward in which the palatable grasses are held in check and light-demanding chamaephytes and rosette species can make an important contribution to the vegetation. Because it is sheep rather than cattle which are the usual grazers, mosaics of lusher herbage around faeces are typically absent here but there may be some enrichment of the soils around the places where sheep lie-up and then species such as *Lolium perenne*, *Urtica dioica*, *Cirsium arvense* and *C. vulgare* can make an appearance. Trampling, too, along sheep paths, can be marked by a local abundance of *Cynosurus cristatus* in the sward. More severe erosion effects are particularly important in the *Carex-Kobresia* sub-community, for here trampling by stock (and the scuffing and burrowing activities of rabbits) can loosen the friable sugar-limestone substrate and encourage destruction of the turf by wind erosion (Pigott 1956*a*).

In the extreme habitats of the *Helianthemum-Asperula*, *Carex-Kobresia* and *Saxifraga-Cochlearia* sub-communities, climatic and edaphic conditions are such that grazing probably does little more than reinforce their influence in keeping the vegetation sparse and open (Griffiths & Proctor 1956, Proctor 1958, Jeffrey 1971, Jeffrey & Pigott 1973), although it may have some particular effect on the sexual reproduction of certain species which have their flowers (e.g. *Dryas octopetala*: Elkington 1971) or fruits (e.g. *Gentiana verna*: Elkington 1963) bitten off. By contrast, the Typical and *Carex pulicaris-Carex panicea* sub-communities are, over the bulk of their range, plagioclimax vegetation in which grazing plays a primary role in preventing the invasion of shrubs and trees.

Zonation and succession

Vegetation sequences involving the *Sesleria-Galium* grassland are generally related to edaphic transitions or, with some sub-communities, are a reflection of seral changes mediated by grazing.

Two kinds of soil-related zonations are especially noteworthy. First, the community often forms part of a range of vegetation types which run from fragmentary communities over crevice protorendzinas on very rocky topographies to calcifugous grasslands and heaths over deeper, drift-contaminated brown earths. Such patterns are especially well seen on the characteristic benches which alternate with cliffs on the valley sides of the Craven dales (Rodwell 1974) but they occur widely in more fragmentary form wherever there is heterogeneity in the soil cover over the limestone. In some cases, as on the warm and dry edges of exposures around Morecambe Bay, it is the *Helianthemum-Asperula* sub-community of the *Sesleria-Galium* grassland itself which occurs as the most open vegetation type, giving way, further back from the cliff edges to the Typical sub-community as the soil cover deepens and becomes more extensive. Inland, where the climate is cooler and damper, the Typical sub-community usually gives way, over cliff crevices and on small ledges, to some kind of fern-dominated vegetation, either Asplenion communities or, especially on screes and in deeper crevices, to stands of *Gymnocarpium robertianum*. In other cases, transitions to screes are marked by a gradation to various mixtures of *Arrhenatherum elatius*, *Geranium robertianum*, *Brachypodium sylvaticum* and *Mercurialis perennis*. Over pavements, fragments of the Typical sub-community, or of the *Carex pulicaris-Carex panicea* sub-community where it occurs in solution hollows, may give way sharply to grike vegetation of which various species of the *Sesleria-Galium* grassland can make up an important component.

On the deeper soils in such sequences, typically found some way back from cliff edges or over infilled, concealed grikes, there is almost always some loess or boulder clay. Here, the Typical sub-community gives way, with a sharpness that is often a direct reflection of the distance to the underlying limestone or the extent of contamination of the soils with superficials, to some kind of Nardo-Galion sward, sometimes with an interposed band of the *Festuca-Agrostis-Thymus* grassland in which there is a gradual shift from calcicoles to calcifuges as the dominant element in the vegetation. In the drier parts of the range of the community, as over the Morecambe Bay limestones, the sequence may continue to *Calluna-Erica* heath over acid but still fairly dry and light-textured soils. Where there is a complex patchwork of different soils over often very uneven bedrock surfaces, these different vegetation types may occur in close proximity, forming the intimate mixtures sometimes described as 'limestone heaths (e.g. Moss 1911, Dixon 1982).

Inland and at higher altitudes, this latter part of such sequences shows a shift towards vegetation types characteristic of moister soils. The Typical sub-community may be replaced here by the *Carex pulicaris-Carex panicea* sub-community which may pass to *Nardus-Galium* or *Juncus-Festuca* grasslands and then to Erico-Sphagnion ombrogenous mire. In the peculiarly extreme conditions in Upper Teesdale, such zonations tend to be telescoped so that the *Carex-Kobresia* sub-community is restricted to 'windows' within an expanse of wet heath and bog (Bradshaw & Jones 1976).

The second kind of edaphically-related zonation is less common, though very distinctive. It occurs wherever there is some soligenous flushing of these grasslands, as when water percolating through the limestone hits some interbedded and less permeable stratum. In such situations, the Typical sub-community of the surrounding slopes gives way, sometimes through a zone of the *Carex pulicaris-Carex panicea* sub-community, to a Caricion davallianae mire, usually of small extent. At lower altitudes, this latter vegetation is usually the *Briza-Primula* sub-community of the *Pinguiculo-Caricetum* but, in Upper Teesdale, the *Carex-Juncus* sub-community can figure in these sequences or, on gravelly areas near to the flush heads, the *Gymnostomum* sub-community. The subtle patterns which these vegetation types form, and their susceptibility to disturbance, makes them a very precious component of the upland limestone landscape.

Other, less frequent, zonations involve transitions to mesotrophic grassland over deeper, moister but still moderately calcareous soils. The typical situation for such floristic shifts is towards the bottom of scree slopes where there is an accumulation of colluvium, but these are frequently obscured by the enclosure and agricultural improvement of the swards. On rare occasions, however, there may be gradations to unimproved meadow communities like the *Centaureo-Cynosuretum* or, in dale heads at higher altitudes, the *Anthoxanthum-Geranium* grassland. In a very few localities, the *Sesleria-Galium* grassland passes to the *Filipendulo-Arrhenatheretum* on north-facing slopes where, towards the foot of cliffs, there is an absence of grazing.

Although scattered wind-cut trees, such as *Taxus baccata*, *Fraxinus excelsior* and, in some sites, the endemic *Sorbus lancastriensis*, are a distinctive feature of crevices in the cliffs over which the *Helianthemum-Asperula* sub-community occurs (Proctor 1958, Clapham & Nicholson 1975), this kind of *Sesleria-Galium* grassland and the two montane sub-communities can be seen as climatic climax vegetation types from which the withdrawal of grazing would probably have little effect. With the Typical and *Carex pulicaris-Carex panicea* sub-communities, on the other hand, the soils are neither too dry nor too wet, and the climate insufficiently cold, to prevent the invasion of woody species. Stands which are inaccessible to stock show a marked increase in the grass cover, especially of *S. albicans* which can form virtually pure clumps but, though this species and many of the associates can persist for some time under a light woody canopy, these sub-communities are eventually replaced by scrub when grazing is

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withdrawn. Succession has never been followed in detail but the most likely invaders would seem to be *Crataegus monogyna*, *Prunus spinosa*, *Corylus avellana*, *Sorbus aucuparia*, *Fraxinus excelsior* and *Taxus baccata* with, on drier sites, *Betula pendula* and, over more mesotrophic soils, *Acer pseudoplatanus* and *Ulmus glabra*. Mixtures of these species commonly occur as dense thickets on scree slopes which are ungrazed and they can expand out from grikes on inaccessible stretches of pavement. On drier and warmer slopes, the succession can be to *Fraxinus-Acer-Mercurialis* woodland but *Acer campestre* itself, and two common invaders of grasslands on Carboniferous Limestone further south, *Cornus sanguinea* and *Rhamnus catharticus*, are very much towards their northern limit in this area and are only sparsely seen in developing or mature woodlands. On moister and cooler slopes, the *Fraxinus-Sorbus-Mercurialis* woodland, the climax community on base-rich soils in the north and west of Britain, may be a more likely development.

Distribution

The community is confined to the Carboniferous Limestone of the Morecambe Bay area, to the Craven district of North Yorkshire and to the borders of Cumbria, Durham and North Yorkshire around Upper Teesdale. The sub-communities show a fairly marked distribution pattern within this range. The *Helianthemum-Asperula* sub-community is confined to a few cliffs in the western lowlands on Scout, Underbarrow and Whitbarrow Scars, on Humphrey Head and around Silverdale, though stands approaching it in composition occur on south-facing slopes in Craven, as for example above Grassington. The Typical sub-community is the most widely distributed and extensive type and it also occurs on the Morecambe Bay exposures though it is especially characteristic of the Craven district, where large stands are common between 250 and 500 m on the Great Scar Limestone of the southern dales. The *Carex pulicaris-Carex panicea* sub-community is more restricted: it occurs around the Malham area in Craven, on exposures around the headwaters of the Lancashire Lune and in Upper Teesdale. The *Carex-Kobresia* sub-community is confined to the sugar-limestone in the last area, where some stands have been lost with the flooding of the Cow Green reservoir. The *Saxifraga-Cochlearia* community also occurs in Upper Teesdale and at scattered localities over the fells to the immediate west.

Affinities

British grasslands in which *S. albicans* plays a prominent role occupy a floristic and geographical position which is intermediate between the lowland southern Mesobromion swards and those upland communities of the north and west where montane calcicoles replace those with Continental affinities, and Nardo-Galion species become a constant accompaniment to calcicoles of broader ecological amplitude. Just as the *Sesleria-Scabiosa* grassland can be seen as a close relative of the *Festuca-Avenula* grassland, so the *Sesleria-Galium* grassland can be seen as having strong affinities with the *Festuca-Agrostis-Thymus* grassland, though its particular floristic features amply justify its treatment as a distinct vegetation type.

In this country, therefore, *S. albicans* has its major locus in communities which are transitional to the high mountain vegetation generally placed in the Elyno-Seslerietea (Braun-Blanquet 1948, Ellenberg 1978) or some modification of this class (like the Seslerietea of Oberdorfer 1978). Intermediate swards of this kind have sometimes been accommodated within a special subdivision of the Mesobromion, such as the Seslerio-Mesobromion (Oberdorfer 1957, Shimwell 1968*a*, 1971*a*). On such a view, the core of this community is represented by the Typical sub-community and similar vegetation to this has been described from both Germany and France (e.g. Tüxen 1937, Schubert 1963, Stott 1970).

From such a core, the community shows a number of floristic trends within the other sub-communities. That of *Helianthemum-Asperula* has close affinities with drier *S. albicans* grasslands of common occurrence in the Continental lowlands of northern France and sometimes placed in a division of the Xerobromion, the Seslerio-Xerobromion (Allorge 1921–2, Oberdorfer 1957, Braun-Blanquet & Braun-Blanquet 1971). It is also similar to some less xeric vegetation of the Burren Carboniferous Limestone (e.g. Braun-Blanquet & Tüxen 1952, Ivimey-Cook & Proctor 1966*a*) and was treated as a sub-association of an Irish community, the *Asperulo-Seslerietum*, seen as having a foothold in the more equable parts of the Pennines, by Shimwell (1968*a*).

Floristic transitions to the mires of the Caricion davallianae, such as are seen in the *Carex pulicaris-Carex panicea* sub-community, have also been described from the Continent (e.g. Bresinsky 1965), though much more common is the montane and sub-alpine *S. albicans* vegetation, to which the *Carex-Kobresia* and *Saxifraga-Cochlearia* sub-communities are the nearest approach in Britain (e.g. Braun-Blanquet & Tüxen 1952, Pignatti & Pignatti 1975). However, the particular mixtures of Northern Montane and Arctic-Alpine species found at Upper Teesdale in the former sub-community, appear to be unique.

Floristic table CG9

	a	b
Sesleria albicans	V (1–5)	V (3–9)
Thymus praecox	V (1–5)	V (2–7)
Koeleria macrantha	IV (1–5)	IV (1–5)
Galium sterneri	IV (1–3)	IV (1–4)
Campanula rotundifolia	IV (1–3)	V (1–5)
Linum catharticum	IV (1–3)	V (1–4)
Festuca ovina	IV (1–3)	V (1–9)
Ctenidium molluscum	V (1–3)	III (1–3)
Viola riviniana	III (1)	III (1–4)
Briza media	I (2)	IV (1–4)
Carex flacca	IV (1–5)	V (2–6)
Helianthemum nummularium	IV (1–7)	II (1–5)
Leontodon hispidus	IV (1–3)	I (1–4)
Homalothecium lutescens	IV (1–3)	II (1–3)
Encalypta streptocarpa	IV (1–3)	
Asperula cynanchica	IV (3–5)	I (1)
Helianthemum canum	IV (1–3)	
Hippocrepis comosa	III (1–3)	I (1)
Scabiosa columbaria	III (1–3)	
Carlina vulgaris	III (1–3)	I (1–3)
Weissia sp.	III (1)	
Viola hirta	II (1–3)	II (1–3)
Anthyllis vulneraria	I (1)	
Sedum acre	I (1–2)	
Potentilla erecta	II (1)	II (1–3)
Cornicularia aculeata		
Carex pulicaris		
Carex panicea		
Hylocomium splendens		
Frullania tamarisci	I (1)	
Polygala vulgaris		
Anthoxanthum odoratum		I (1–3)

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

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Parnassia palustris		
Primula farinosa		
Dryas octopetala		
Molinia caerulea		
Pinguicula vulgaris		
Carex hostiana		
Pimpinella saxifraga		
Calluna vulgaris		
Empetrum nigrum		
Rhodobryum roseum		
Thalictrum minus		
Racomitrium lanuginosum		
Gentiana verna		
Carex capillaris		
Kobresia simpliciuscula		
Cetraria islandica		
Viola rupestris		
Selaginella selaginoides		
Polygonum viviparum		
Antennaria dioica		
Plantago maritima	I (1)	
Saxifraga hypnoides		
Cochlearia alpina		
Euphrasia confusa		
Draba incana		
Plagiochila asplenoides		
Tritomaria quinquedentata		
Myosotis alpestris		
Veronica officinalis		
Polytrichum juniperinum		
Barbilophozia barbata		
Rhytidiadelphus triquetrus		
Blepharostoma trichophyllum		
Carex caryophyllea	II (1)	IV (1–4)
Avenula pratensis	III (1–3)	III (1–4)
Lotus corniculatus	III (1–3)	III (1–3)

II (1–3)		I (1)	I (1–3)
II (1–3)	I (1)		I (1–3)
II (7–9)	I (3)		I (3–9)
II (1–3)			I (1–3)
II (1–3)			I (1–3)
II (1–5)			I (1–5)
II (1–3)			I (1–3)
I (3–5)			I (3–5)
I (1–5)			I (1–5)
I (1)			I (1)
I (3)			I (3)
II (1–3)	V (1–5)	II (3–5)	II (1–5)
I (1)	IV (1–3)	I (1)	I (1–3)
I (1–3)	IV (2–5)		I (1–5)
	IV (1–8)		I (1–8)
	IV (1–2)		I (1–2)
I (1–3)	III (1–4)		I (1–4)
I (1–3)	III (1–4)		I (1–4)
I (3)	III (1–3)	I (1)	I (1–3)
	III (1–3)		I (1–3)
I (1)	II (1–2)		I (1–2)
I (1)		IV (1–5)	I (1–5)
		IV (1–3)	I (1–3)
II (1–3)	I (1)	IV (1–3)	I (1–3)
		III (1–3)	I (1–3)
I (1)		III (1–3)	I (1–3)
I (1)		III (1)	I (1)
		III (1–3)	I (1–3)
		III (1)	I (1)
		III (1)	I (1)
I (1)	I (1)	II (1)	I (1)
	I (1)	II (1)	I (1)
	I (1)	II (1)	I (1)
III (1–3)	III (1–3)	V (1–5)	III (1–5)
IV (1–5)	II (1–4)	IV (1–3)	III (1–5)
IV (1–3)		III (1–3)	III (1–3)

Floristic table CG9 (*cont.*)

	a	b	c	d	e	9
Tortella tortuosa	IV (1–3)	III (1–4)	IV (1–5)	III (1–5)	III (1–3)	III (1–5)
Hypnum cupressiforme	II (1)	IV (1–5)	II (1–3)	IV (1–3)	V (1–2)	III (1–5)
Euphrasia officinalis agg.	III (1–3)	III (1–3)	IV (1–3)	IV (1–3)	II (1)	III (1–3)
Ditrichum flexicaule	IV (1–3)	I (1)	I (1–3)	IV (1–3)	II (1–3)	II (1–3)
Dicranum scoparium	IV (1–3)	IV (1–5)	II (1–3)	I (1)	II (1)	II (1–5)
Plantago lanceolata	III (1–3)	II (1–4)	III (1–3)	II (1–3)	IV (1–3)	II (1–4)
Pseudoscleropodium purum	III (1)	I (1–4)	IV (1–3)	I (1–3)	II (1)	II (1–4)
Fissidens cristatus	III (1)	II (1–3)	III (1–3)	II (1)	I (1)	II (1–3)
Danthonia decumbens	II (1–3)	II (1–6)	I (1–5)	II (1–3)	I (1)	II (1–6)
Sanguisorba minor	II (1–3)	II (1–4)	III (1–3)			II (1–4)
Hieracium pilosella	I (1–2)	III (1–4)	I (1–3)	II (1–3)		II (1–4)
Racomitrium canescens		II (1–3)	I (1)	III (1–4)	II (1)	II (1–4)
Prunella vulgaris		II (1–3)	II (1–3)		III (1)	II (1–3)
Cladonia rangiformis	II (1)	I (1–3)	I (1)	I (3)	III (1–3)	I (1–3)
Gentianella amarella	I (1)	I (1)	II (1)	II (1–3)	III (1)	I (1–3)
Trifolium repens		II (1–4)	II (1–3)	I (1)	III (1–3)	I (1–4)
Agrostis capillaris		I (1–3)	III (1–3)	I (1)	III (1–3)	I (1–3)
Festuca rubra		II (1–9)			III (1–3)	I (1–9)
Deschampsia cespitosa			II (1–3)		III (1–3)	I (1–3)
Succisa pratensis	III (1–3)		II (1–3)	II (1–2)	II (1)	I (1–3)
Cladonia pocillum		II (1–5)	I (1–3)	II (1–3)	II (1–3)	I (1–5)
Achillea millefolium	II (1)	I (3–4)		I (1)	II (1)	I (1–4)
Scapania aspera	II (1)		II (1–3)	II (1–3)	II (1)	I (1–3)
Minuartia verna		I (1–3)	I (1)	II (1–3)	II (1–3)	I (1–3)
Neckera crispa	I (1)	I (1–2)	II (1)		II (1)	I (1–2)
Bellis perennis	I (1)	I (3–4)		I (1–3)	I (1)	I (1–4)
Cerastium fontanum		I (1–3)	I (1–3)		II (1–3)	I (1–3)
Rhytidiadelphus squarrosus		II (1–4)	II (1–7)		II (7)	I (1–7)
Lophocolea bidentata s.l.			II (1)	I (1)	I (1)	I (1)
Taraxacum officinale agg.	I (1)	II (1–3)	I (1)		I (1)	I (1–3)
Galium verum	I (3)	I (1–4)	II (1–3)			I (1–4)
Thuidium tamariscinum			I (1–3)	I (1)	II (1)	I (1–3)

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Epipactis atrorubens	I (1)	
Hypericum pulchrum	I (1)	
Dactylis glomerata		I (3)
Carex ericetorum	I (1–3)	
Cynosurus cristatus		I (2)
Potentilla tabernaemontani		
Brachypodium sylvaticum		I (1–3)
Rhytidium rugosum		
Cirsium vulgare		
Number of samples	14	54
Number of species/sample	28 (24–32)	19 (13–31)

a *Helianthemum canum-Asperula cynanchica* sub-community
b Typical sub-community
c *Carex pulicaris-Carex panicea* sub-community
d *Carex capillaris-Kobresia simpliciuscula* sub-community
e *Saxifraga hypnoides-Cochlearia alpina* sub-community
9 *Sesleria albicans-Galium sterneri* grassland (total)

I (1)			I (1)
I (1)			I (1)
I (1)			I (1–3)
I (1)			I (1–3)
I (1–3)			I (1–3)
I (1)		I (1)	I (1)
I (3)			I (1–3)
I (1–5)	I (3)		I (1–5)
I (1)		II (1)	I (1)
28	19	9	124
32 (22–48)	31 (20–42)	37 (34–42)	26 (13–48)

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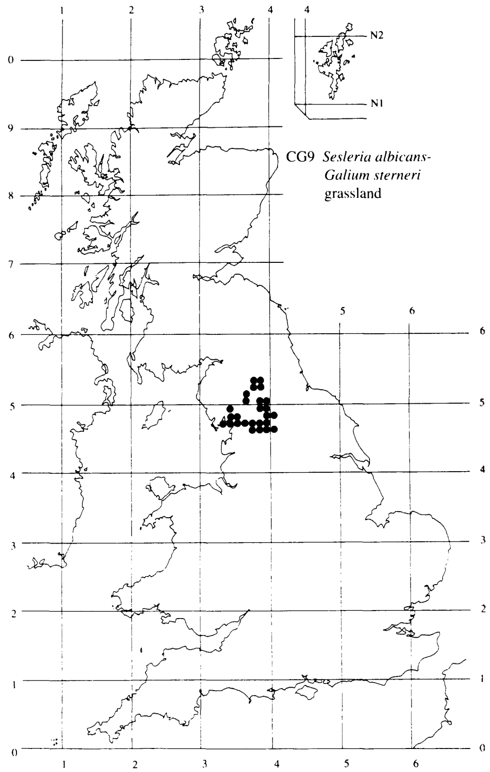

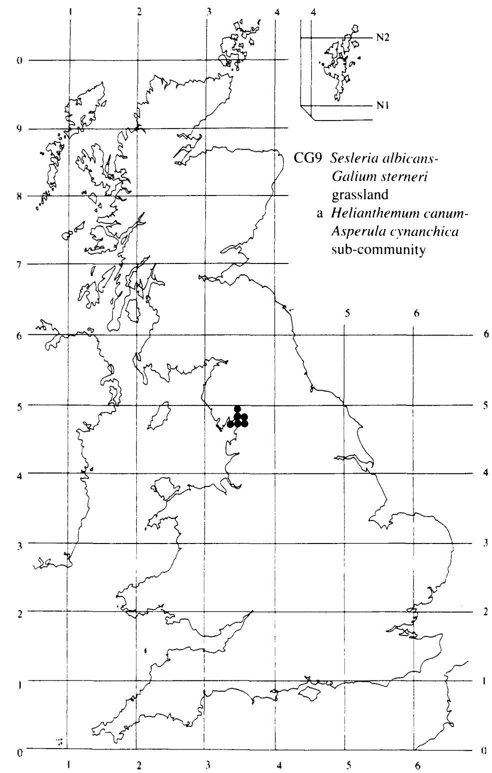

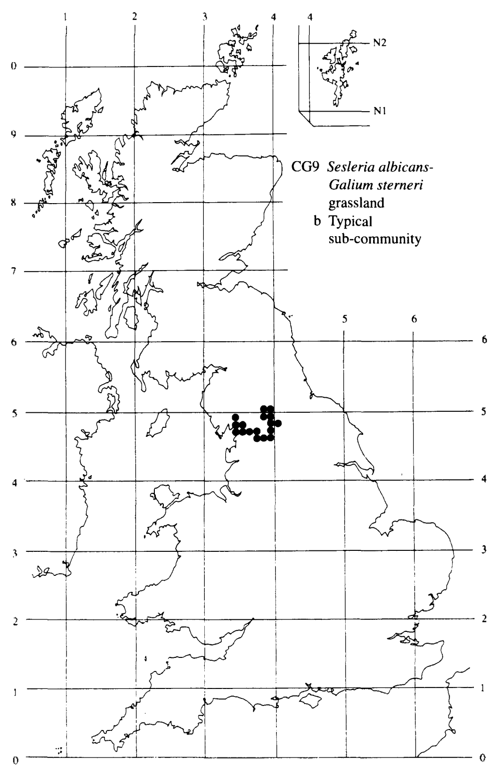

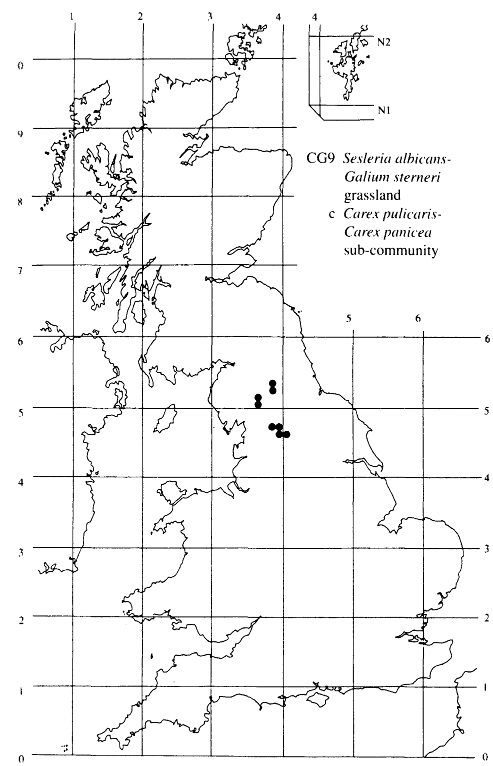

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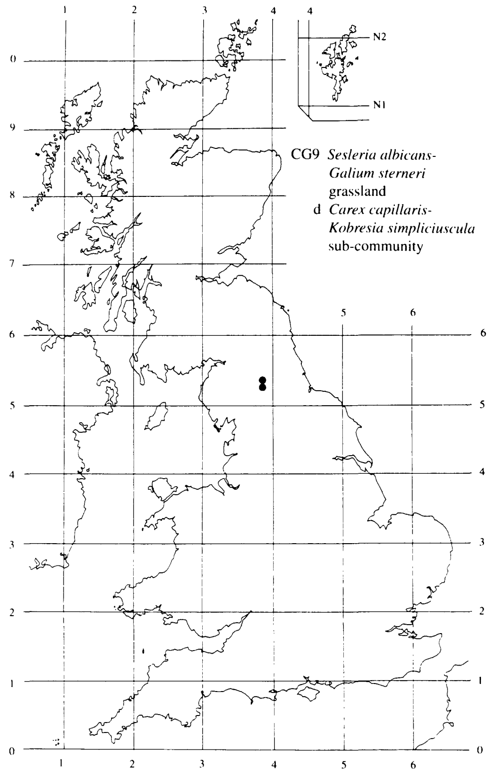

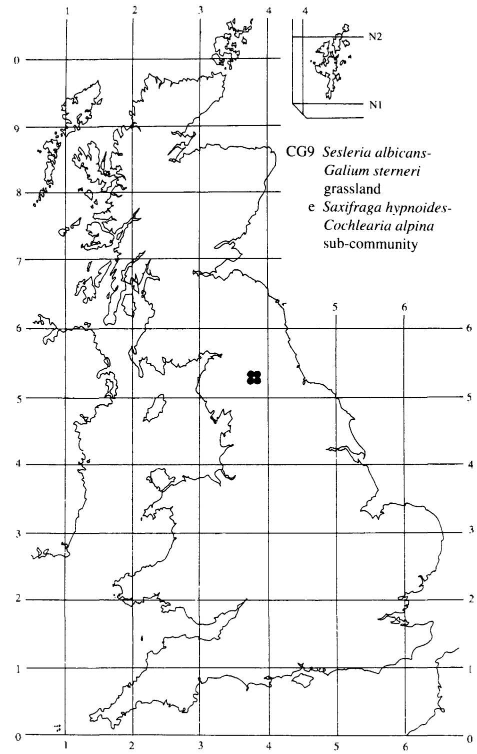

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