U12
Salix herbacea-Racomitrium heterostichum snow-bed

Synonymy
Salicetum herbaceae (Rübel 1912) Watson 1925; *Salix herbacea* nodum Poore 1955*c p.p.*; *Salix* + hepatic crust Ingram 1958; *Rhacomitreto-Dicranetum starkei* McVean & Ratcliffe 1962; *Gymnomitreto-Salicetum herbaceae* McVean & Ratcliffe 1962.

Constant species
Salix herbacea, *Racomitrium heterostichum*.

Rare species
Luzula arcuata, *Minuartia sedoides*, *Sibbaldia procumbens*, *Kiaeria starkei*, *Gymnomitrion corallioides*, *Cetraria delisei*, *Solorina crocea*.

Physiognomy
The *Salix herbacea-Racomitrium heterostichum* community includes a variety of carpets and crusts of bryophytes in which *Salix herbacea* is a constant feature. This tiny willow, rarely more than a couple of centimetres tall here, is sometimes quite abundant as a loose mat of prostrate shoots, their leaves and catkins appearing together in June as the last of the snow melts, or as late as August in the highest stands (Meikle 1984). In other cases, the cover of *S. herbacea* is patchy or generally sparse, when it is usually bryophytes which dominate, most commonly mixtures of *Racomitrium heterostichum* with one or other of *R. fasciculare*, *Gymnomitrion concinnatum* or the rare *Kiaeria starkei*, a moss that is locally abundant here, though not so consistently important as in the *Polytrichum-Kiaeria* community. *R. lanuginosum*, *Conostomum tetragonum*, *Oligotrichum hercynicum* and *Polytrichum alpinum* also occur frequently, though not usually with high cover, but *P. sexangulare* is only occasional. In some stands which are best included with this vegetation, the rare *Marsupella brevissima* (= *Gymnomitrion varians*) is strongly dominant, crowding out many of the associates, and another related rarity *G. corallioides* occurs in this community in some places.

Other bryophytes recorded here include *Pohlia nutans*, *Nardia scalaris* and *Barbilophozia floerkii*, which are quite frequent, and *Diplophyllum albicans*, *Polytrichum piliferum* and *Lophozia sudetica*, which are more occasional. Lichens are typically of sparse cover, but *Cladonia bellidiflora*, *C. uncialis*, *C. pyxidata* and *Cetraria islandica* are fairly common and the community provides one locus for the rare *C. delisei* and *Solorina crocea*.

Apart from *S. herbacea*, only *Carex bigelowii* and *Deschampsia flexuosa* occur frequently throughout this kind of vegetation and these are not generally more than moderately abundant. *D. cespitosa*, *Omalotheca supina* and *Huperzia selago* are occasionally found and there is sometimes a little *Festuca ovina/vivipara*, *Luzula spicata*, *Juncus trifidus* and *Alchemilla alpina*. Arctic-Alpine rarities that can find a place here include *Luzula arcuata*, *Sibbaldia procumbens* and *Minuartia sedoides*.

Sub-communities

***Silene acaulis-Luzula spicata* sub-community:** *Salix herbacea* nodum Poore 1955*c p.p.*; *Rhacomitreto-Dicranetum starkei* McVean & Ratcliffe 1962. Mixtures of *S. herbacea*, *R. heterostichum* and *Kiaeria starkei* are usually dominant in the mossy carpets characteristic of this kind of *Salix-Racomitrium* snow-bed with smaller amounts of *C. tetragonum* and, preferential here, *Polytrichum alpinum*, *P. sexangulare*, *Pohlia nutans* and *Barbilophozia floerkii*. *Cetraria islandica* and *Cladonia pyxidata* also occur more commonly than usual along with *C. bellidiflora*. Vascular plants are somewhat more varied than in the *Gymnomitrion* sub-community and, as well as frequent *D. flexuosa* and *C. bigelowii*, the latter especially common and sometimes quite abundant, there is usually a little *Luzula spicata*, *Juncus trifidus* and *Nardus stricta*.

***Gymnomitrion concinnatum* sub-community:** *Salix herbacea* nodum Poore 1955*c p.p.*; *Salix* + hepatic crust Ingram 1958; *Gymnomitreto-Salicetum herbaceae* McVean & Ratcliffe 1962. *S. herbacea* can again be abun-

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dant in this vegetation, together with patches of *R. heterostichum* or, sometimes, *R. fasciculare* but much of the ground is generally covered by a crust of the leafy hepatics *Gymnomitrion concinnatum*, *Nardia scalaris* and *Diplophyllum albicans* with, more locally, the rare *G. corallioides* and *Marsupella alpina*, the cover often being wrinkled up in a direction running more or less down the slope. Among the other associated mosses, *C. tetragonum* remains common and there is usually some *R. lanuginosum*, *O. hercynicum* and *Polytrichum piliferum*. *Kiaeria starkei* is also quite frequent but not usually abundant. Lichens are usually more occasional than in the *Silene-Luzula* sub-community, but there is sometimes a little *Cetraria islandica*, *Cladonia bellidiflora*, *C. coccifera*, *Cornicularia aculeata* and *Ochrolechia frigida*. Apart from scattered tufts of *C. bigelowii* and *D. flexuosa*, with occasional *D. cespitosa* and *O. supina*, vascular associates are very few.

***Marsupella brevissima* sub-community:** *Gymnomitreto-Salicetum herbaceae*, *Gymnomitrion varians* facies McVean & Ratcliffe 1962. This vegetation is generally similar to the *Gymnomitrion* sub-community in the occurrence of such plants as *R. fasciculare* and *O. hercynicum*, but *Marsupella brevissima* is very abundant in large, pure patches and, apart from sparse sprigs of *S. herbacea* and tufts of *D. cespitosa*, the carpet is very impoverished.

Habitat

The *Salix-Racomitrium* community is strictly limited to late snow-beds with some solifluction or downwash at high altitudes in the coldest mountains of Scotland. It is found, usually in small stands, over gentle to steep ground on snow-bound slopes and in sheltered hollows on plateaus through most of the Highlands north to Beinn Dearg and, in more fragmentary form, on Mull and in the Southern Uplands.

Like the *Polytrichum-Kiaeria* community, this is a vegetation type of some of the most inhospitable ground in the uplands, typical of the middle-alpine zone from about 900 m to more than 1250 m. The geographical boundaries of the *Salix-Racomitrium* community are drawn just a little wider than there, but the climate is still generally very harsh, with brief, cool summers with mean annual maximum temperatures usually below 22 °C (Conolly & Dahl 1970) and long, bitter winters. As there, then, it is Arctic-Alpine plants that give the vegetation much of its general character, with such species as *S. herbacea*, *C. bigelowii*, *L. spicata*, *S. acaulis*, *J. trifidus*, *F. vivipara*, *A. alpina* and *O. supina*, and the high montane bryophytes *K. starkei*, *O. hercynicum*, *P. alpinum*, *C. tetragonum* and *G. concinnatum*.

As with the *Polytrichum-Kiaeria* community, however, it is the accumulation and persistence of snow that gives the *Salix-Racomitrium* vegetation much of its particular stamp. Precipitation is again very variable across the range, from around 1600 mm with 180 wet days yr^{-1} in the east-central Highlands, to more than 3200 mm with over 220 wet days yr^{-1} to the west (*Climatological Atlas* 1952) but much of this falls as snow, with more than 100 days observed snow- or sleet-fall over this higher ground (Manley 1940). The *Salix-Racomitrium* community is not so strictly associated as is the *Polytrichum-Kiaeria* vegetation with north- and east-facing slopes where snow-accumulation is deepest and most long-lasting, but conditions are always sufficiently sheltered here as to catch some snow and for it to persist for lengthy periods. And, again, it seems to be the redistribution of precipitation, the shortening of the growing season and irrigation by melt-waters that are the important factors associated with snow-lie, that influence the vegetation, favouring a predominance of snow-tolerant bryophytes with a scattering of competition-sensitive herbs.

Unfortunately, detailed information is still lacking, but McVean & Ratcliffe (1962) considered that the *Silene-Luzula* sub-community was characteristic of conditions closer to those favoured by the *Polytrichum-Kiaeria* vegetation, with the *Gymnomitrion* and *Marsupella* types somewhat less extreme, though still more chionophilous than, say, the *Carex-Polytrichum* moss heath. Additionally, although it is sometimes difficult to interpret the environmental preferences of these different kinds of late snow-bed when they occur in close proximity, they seem to favour ground with varying degrees of stability. The *Polytrichum-Kiaeria* community, though often found on steep slopes, is generally typical of stable situations, whereas the *Silene-Luzula* type of *Salix-Racomitrium* heath often occurs where melt and rain wash down finer detritus which completely buries the vegetation from time to time. The soils are more strongly gleyed here and, although surface humus is thin, there are often buried humic horizons in the profile.

The *Gymnomitrion* and *Marsupella* sub-communities are different again. Here, the soils are kept permanently moist and, as the melt occurs, the thawed and saturated surface layers shift over the still frozen ground beneath. Drastic slumping and flow of material often obscures the finer effects of such amorphous solifluction but the puckered crust of leafy hepatics characteristic of these kinds of *Salix-Racomitrium* snow-beds is a very good indication of more subtle movements below. Such vegetation is thus generally found on much gentler slopes than those which the *Silene-Luzula* type can colonise, and one very striking habitat for the *Gymnomitrion* sub-community is within the sinking centres of old, expanding *Juncus trifidus* tussocks around which wind-blown and frost-heaved gravel is accumulating on summit fell-

fields (Ingram 1958). Such situations are generally very exposed to fierce winds and bitter cold but even slight depressions can catch and hold a little snow which muffles the effect of the low temperatures.

Zonation and succession

The *Salix-Racomitrium* community is characteristically found with other kinds of chionophilous vegetation over the most snow-bound slopes of the middle-alpine zone, where zonations and mosaics are influenced by the length of snow-lie, the drainage conditions, solifluction and the base-richness of the substrate and irrigating waters. Moving north-westwards from the central Highlands, there are some changes in the vegetation patterns, with the *Salix-Racomitrium* community itself eventually disappearing.

The most complete range of late snow-beds through the range of this community is to be seen over the cold and sunless north- and east-facing slopes on the lee side of the Cairngorms, within hollows and corries in the transition zone from grass- and sedge-heaths to summit fell-field. In some cases, the *Salix-Racomitrium* community is the most chionophilous of the range of vegetation types represented, in others it occurs with patches of *Polytrichum-Kiaeria* moss-heath, the latter marking out ground that is obviously influenced by longer snow-lie still, though generally free of the downwash or solifluction that are characteristic here. Then, a clear shift in dominance from *Racomitrium* spp. or *G. concinnatum* with *S. herbacea* to *K. starkei* may help to delineate the boundaries between the communities. Often, though, where both communities are represented, the patterns are not so well defined as this, nor so readily related to differences in the snow-bed environment, and the *Silene-Luzula* type of *Salix-Racomitrium* moss-heath in particular can grade imperceptibly into the *Polytrichum-Kiaeria* community. Mosaics are especially complex where there has been some disruption in the usual balance of conditions, with, say, a shorter or longer snow-lie than average, or some recent downwash of detritus on to an established carpet, events which are perhaps more the rule than the exception in this harsh environment (Poore 1955*c*, McVean & Ratcliffe 1962).

The *Salix-Racomitrium* vegetation, and especially the *Silene-Luzula* sub-community, characteristically receives intermittent irrigation by melt-waters and downwash from rain, and, where there is a transition to less snow-bound ground which has such periodic flushing, it can pass to the *Alchemilla-Sibbaldia* dwarf-herb community. The two vegetation types share frequent records for such species as *C. bigelowii*, *L. spicata*, *S. acaulis*, *Nardus*, *D. cespitosa*, *Polytrichum alpinum*, *R. fasciculare* and *R. lanuginosum*, but the overall contribution from bryophytes is less in the *Alchemilla-Sibbaldia* community, and there it is mixtures of *Alchemilla alpina*, *Sibbaldia* and grasses which characteristically dominate. Also, where the flushing waters bring a measure of base-enrichment, plants like *Thymus praecox* and *Selaginella selaginoides* make a frequent appearance over the irrigated surrounds to the snow-beds, though this is less a feature in the Cairngorms than where the *Salix-Racomitrium* community occurs over more calcareous substrates, like the Dalradian mica-schists of the Breadalbane range. There, such transitions can be seen among chionophilous swards and montane calcicolous vegetation on Ben Lawers and, more extensively, on Beinn Laoigh (Ratcliffe 1977).

In other places, locally through the more northerly mountains of the central Highlands, the *Salix-Racomitrium* vegetation can be found in close association with the *Carex-Polytrichum* heath, a less chionophilous community but one in which there is a similar abundance of mosses, usually in this case *Polytrichum alpinum* and/or *Dicranum fuscescens*. This, in turn, can grade to stretches of the *Nardus-Carex* grass-heath, various kinds of which form a widespread context for late snow-beds of both the *Salix-Racomitrium* and *Polytrichum-Kiaeria* communities over moderately snow-bound slopes. Towards lower altitudes, the *Nardus-Carex* heath generally gives way to a zone of sub-shrub vegetation, within which a more mildly chionophilous influence can extend down among low-alpine communities. Above, it typically gives way over the exposed summit plateaus of the Cairngorms to the *Juncus-Racomitrium* fell-field, among which small patches of the *Salix-Racomitrium* community can survive wherever there is sufficient shelter to catch and hold a little snow for long periods. Particularly distinctive here are the stands of the *Gymnomitrion* sub-community which occur within the depressed centres of *Juncus trifidus* tussocks.

Even within the east-central Highlands, there is a tendency away from the very bleak tops of the Cairngorms for the *Juncus-Racomitrium* fell-field to be replaced by the *Carex-Racomitrium* moss-heath and, towards the west, stands of the *Salix-Racomitrium* heath usually pick out later snow-beds in the transitional zone from this summit vegetation to the *Nardus-Carex* heath below. Moving westwards, too, the *Cryptogramma-Athyrium* community becomes a more widespread feature of complexes of chionophilous vegetation. It can be found in the Cairngorms, but in the western Highlands occurs much more commonly as a fringe over stabilised block scree around the back of corries or over stretches of boulder-strewn ground on sheltered slopes. In species such as *K. starkei*, *Polytrichum alpinum*, *R. lanuginosum* and *Diplophyllum albicans*, the *Salix-Racomitrium* vegetation may show some continuity with the mossy understorey of the *Cryptogramma-Athyrium*

community, but the prominence of the ferns generally serves to mark out stands of the latter.

Also within the *Cryptogramma-Athyrium* vegetation, there is a rise to prominence of hypnaceous mosses which, towards the western Highlands, and particularly beyond the Great Glen, become increasingly prominent in the carpet of more chionophilous heaths. Even within the central Highlands, the *Deschampsia-Galium* community can figure locally over irrigated slopes around *Salix-Racomitrium* snow-beds, but north of the Affric–Cannich Hills it tends to replace the *Carex-Polytrichum* heath around the margins of the longer lying snow patches. And, beyond Beinn Dearg, where the *Salix-Racomitrium* community peters out altogether, the *Rhytidiadelphus* sub-community of the *Deschampsia-Galium* grassland is often the most chionophilous vegetation of the sheltered and sunless slopes. Gradual transitions and some stands intermediate between this and the *Salix-Racomitrium* community occur in some places, but the difference in dominance in the moss carpet is usually clear. On fell-fields in the north-west Highlands, patches of ground with a little snow cover and some amorphous solifluction which, in the central Highlands, would have the *Gymnomitrion* sub-community of the *Salix-Racomitrium* vegetation, carry the *Silene* sub-community of the *Carex-Racomitrium* heath within which there may be occasional records for *G. concinnatum*.

Distribution

The *Salix-Racomitrium* community occurs widely through the Scottish Highlands as far north as Beinn Dearg, with some outlying locations on Mull and fragmentary stands in the Southern Uplands. The *Silene-Luzula* sub-community is the more common type in the northern and central Highlands, with the *Gymnomitrion* sub-community extending not so far north but being more generally distributed in the south-west Highlands. The *Marsupella* sub-community has been seen only in the Cairngorms.

Affinities

Again, it was McVean & Ratcliffe (1962), extending the work of Poore (1955*c*), who first gave a detailed floristic account of what Watson (1925) had simply refered to as British stands of Rübel's (1912) *Salicetum herbaceae*. In this scheme, their two associations, the *Rhacomitreto-Dicranetum* and the *Gymnomitrio-Salicetum*, have been united into the *Salix-Racomitrium* community, the distinctions between them relegated to sub-community level.

In fact, the *Salicetum herbaceae* Braun-Blanquet 1913, as described from the Alps by Oberdorfer (1978) and Ellenberg (1978), is a rather different kind of vegetation to this, being not so rich in bryophytes. More similar are various of the snow-bed communities described from Scandinavia, like the *Salicetum herbaceae sensu* Gjaerevøll (1956) or his *Weberetum commutatae*, which has a *R. fasciculare* sociation almost devoid of phanerogams but otherwise close to the *Silene-Luzula* sub-community. Both these vegetation types occur on ground which receives periodic irrigation, though the well-drained slopes with the *Salicetum* quickly dry out in summer.

More like the *Gymnomitrion* sub-community is the *Lophozieto-Salicetum* which Dahl (1956) described from Rondane, a vegetation type of sandy humic soils on wet slopes subject to much amorphous solifluction. And his *Luzuleto-Cesietum* from unstable fine detritus in the centre of high-altitude stone polygons comes quite close to more exposed Scottish stands of this sort of *Salix-Racomitrium* vegetation. Gjaerevøll (1956) also had two sociations of snow-bed vegetation in which *Marsupella brevissima* was a prominent feature as in the *Marsupella* sub-community.

Floristic table U12

	a	b	c	12
Salix herbacea	V (1–6)	V (1–8)	2 (1–3)	V (1–8)
Racomitrium heterostichum	V (1–6)	IV (1–4)		IV (1–6)
Carex bigelowii	V (1–9)	III (1–4)	1 (1)	III (1–9)
Polytrichum alpinum	IV (1–4)	II (1–3)		II (1–4)
Cetraria islandica	IV (1–3)	II (1–3)		II (1–3)
Luzula spicata	IV (1–3)	II (1–3)		II (1–3)
Silene acaulis	IV (1–4)	I (1)		II (1–4)
Pohlia nutans	IV (1–3)	I (1)		II (1–3)
Juncus trifidus	IV (1–6)	I (4)	1 (2)	II (1–6)
Nardus stricta	III (1–3)	I (1)		I (1–3)

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Floristic table U12 (*cont.*)

	a	b	c	12
Barbilophozia floerkii	III (1–4)	I (1)		I (1–4)
Cladonia pyxidata	III (1–3)	I (1)	1 (1)	I (1–3)
Polytrichum sexangulare	II (1–3)	I (1–4)	I (3)	I (1–4)
Dicranum scoparium	I (1–3)			I (1–3)
Cetraria delisei	I (1–3)			I (1–3)
Racomitrium languinosum	II (1–3)	V (1–6)	1 (1)	III (1–6)
Nardia scalaris	II (1)	V (1–4)	1 (1)	III (1–4)
Gymnomitrion concinnatum	I (1–4)	V (1–9)		III (1–9)
Oligotrichum hercynicum	I (1)	IV (1–3)	3 (2–3)	III (1–3)
Festuca ovina/vivipara	I (1–3)	IV (1–6)		III (1–6)
Polytrichum piliferum		IV (1–4)	1 (1)	III (1–4)
Diplophyllum albicans		IV (1–4)		III (1–4)
Alchemilla alpina		III (1–3)		II (1–3)
Racomitrium fasciculare	I (1)	II (1–6)	1 (1–3)	II (1–6)
Cladonia coccifera	I (1)	II (1–3)		II (1–3)
Cornicularia aculeata		II (1–3)		I (1–3)
Galium saxatile		II (1–4)		I (1–4)
Agrostis canina		II (1–4)		I (1–4)
Ochrolechia frigida		II (1–3)		I (1–3)
Gymnomitrion corallioides		I (4)		I (4)
Andreaea rupestris		I (1)		I (1)
Marsupella brevissima			3 (9–10)	I (9–10)
Lophozia sudetica			3 (2)	I (2)
Conostomum tetragonum	III (1–4)	III (1–3)	1 (3)	III (1–4)
Cladonia bellidiflora	III (1–3)	III (1–3)	1 (3)	III (1–3)
Deschampsia flexuosa	III (1–9)	III (1–4)		III (1–9)
Kiaeria starkei	III (1–6)	II (1–6)	2 (1–3)	II (1–6)
Deschampsia cespitosa	II (1–3)	II (1–3)	2 (1–3)	II (1–3)
Omalotheca supina	II (1–3)	II (1–4)	2 (2–4)	II (1–4)
Huperzia selago	II (1–3)	II (1–3)		II (1–3)
Cladonia uncialis	II (1–3)	II (1–3)		II (1–3)
Cladonia gracilis	I (1–3)	I (1–3)	I (3)	I (1–3)
Number of samples	11	19	3	33
Number of species/sample	18 (9–29)	19 (11–29)	14 (9–21)	18 (9–29)
Vegetation height (cm)	4 (3–5)	3 (1–5)	no data	3 (1–5)
Vegetation cover (%)	96 (80–100)	76 (70–100)	92 (90–95)	83 (70–100)
Altitude (m)	1123 (914–1250)	1014 (690–1235)	930 (747–1113)	1046 (690–1250)
Slope (°)	24 (2–50)	7 (0–20)	23 (15–30)	14 (0–50)

a *Silene acaulis-Luzula spicata* sub-community
b *Gymnomitrion concinnatum* sub-community
c *Marsupella brevissima* sub-community
12 *Salix herbacea-Racomitrium heterostichum* snow-bed (total)

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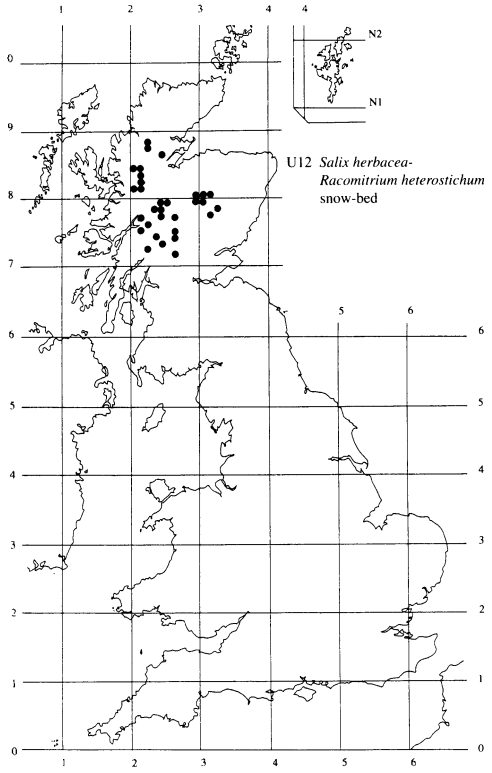

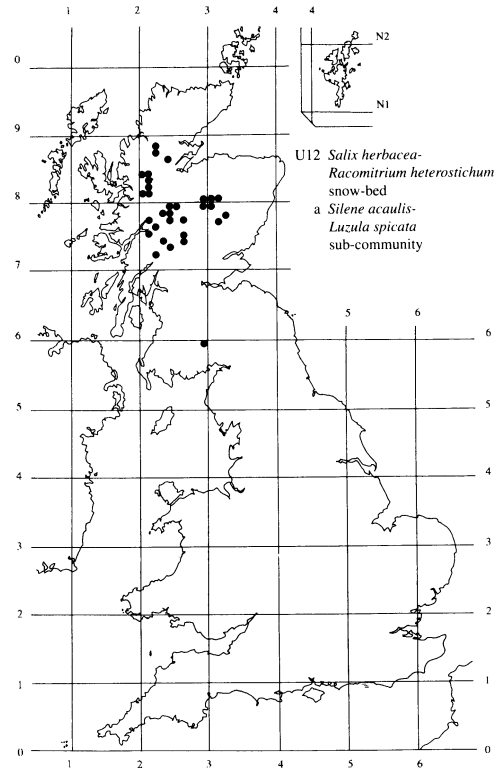

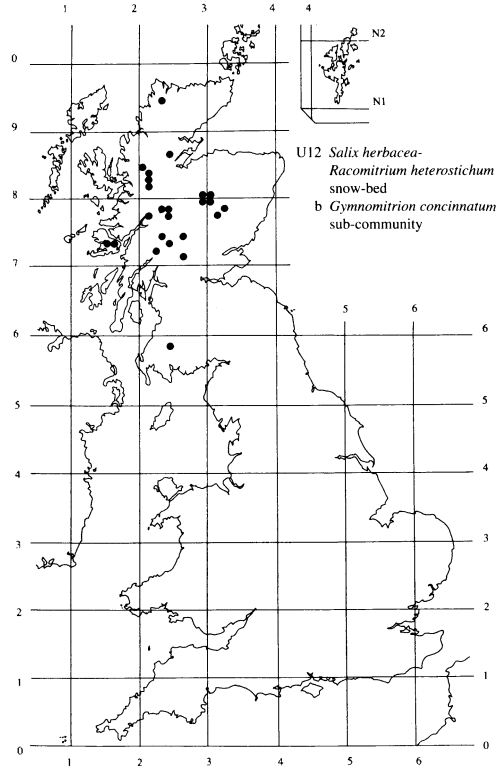

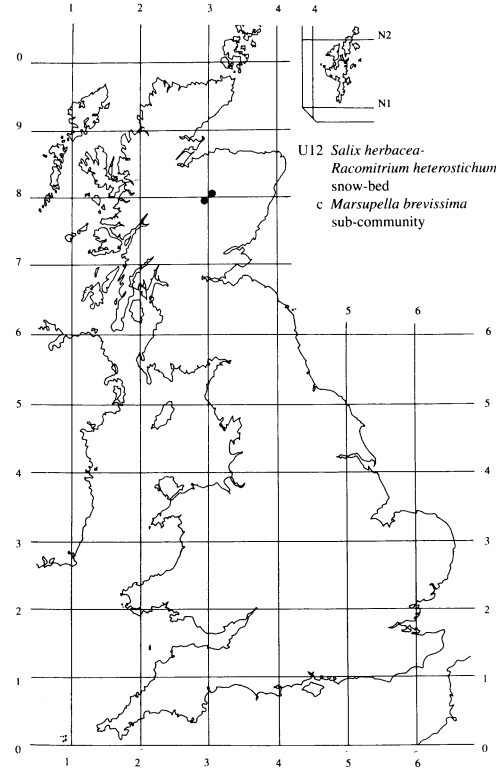

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