W3
Salix pentandra-Carex rostrata woodland

Synonymy
Alder wood Rankin 1911*b*; Open carr Pearsall 1918; Closed carr Pearsall 1918 *p.p.*; *Salix* carr Ingram *et al.* 1959; Fen carr Proctor 1974; Willow carr Adam *et al.* 1975 *p.p.*; *Crepido-Salicetum pentandrae* Wheeler 1980*c*; *Sphagno-Salicetum atrocinereae* Birse 1984 *p.p.*

Constant species
Salix cinerea, *S. pentandra*, *Angelica sylvestris*, *Cardamine pratensis*, *Carex rostrata*, *Caltha palustris*, *Filipendula ulmaria*, *Galium palustre*, *Geum rivale*, *Valeriana dioica*, *Calliergon cuspidatum*, *Mnium hornum*, *Rhizomnium punctatum*.

Rare species
Salix nigricans, *Carex appropinquata*, *Carex diandra*, *Corallorhiza trifida*, *Lysimachia thyrsiflora*, *Pyrola rotundifolia*.

Physiognomy
The *Salix pentandra-Carex rostrata* woodland is a very distinctive woodland type, fairly constant in its overall composition and structure and with clear northern European affinities in its flora. The canopy is always low, though often uneven-topped and invariably dominated by bushy Salices, most commonly *Salix pentandra* and/or *S. cinerea*. Although the former Northern Montane willow can be found occasionally in other kinds of wet woodland in northern Britain, only in this community does it make more than a local contribution to the canopy. When it is abundant here, its typical spreading habit, with branches reaching down to the ground and often re-rooting, gives stands a very characteristic appearance. Mature individuals of *S. cinerea* can open up with age, too, so that, even where the cover of bushes of these species is dense, the canopy can be somewhat open. Other Salices are rare, though they can be locally abundant. Most distinctive among these are two other Northern Montane species, *S. nigricans* and *S. phylicifolia* which, when they occur together, frequently hybridise to produce a perplexing range of intermediates (*S.* × *tetrapla*: Meikle 1975) among which the identity of the parents can be lost (e.g. Proctor 1974, Adam *et al.* 1975, Lock & Rodwell 1981). *S. aurita* also occurs in some stands and, more rarely, the osiers *S. viminalis* and *S. purpurea* and these, too, may hybridise among one another and with the other Salices.

The only other woody species to occur with any frequency in the community is *Betula pubescens* and even this is only occasional. *Alnus glutinosa* is rare and the associates of the canopy of southern fen woods like *Frangula alnus*, *Rhamnus catharticus* and *Viburnum opulus* are typically absent. Neither does an underscrub of Rubi or *Ribes* spp. ever play a prominent part here.

In the field layer, there is no consistent pattern of dominance. Indeed, many stands have no single herbaceous dominant at all but the assemblage of species typical of the community is nonetheless very distinctive. The most prominent component generally comprises taller dicotyledons, though the mixture of species here is rather different from that characteristic of southern fen woods. The commonest species are *Filipendula ulmaria*, *Angelica sylvestris*, *Valeriana dioica*, *V. officinalis*, *Geum rivale* and *Cirsium palustre*. Most of these can be locally abundant and, under the frequently light shade of the canopy, they often flower. *Equisetum fluviatile* is common too, its stems growing tall and often branching. *Urtica dioica* is notably infrequent and species such as *Eupatorium cannabinum*, *Lysimachia vulgaris*, *Lythrum salicaria* and *Iris pseudacorus* are usually absent.

Herbs of shorter stature form a patchy lower tier to the vegetation. The most notable among these are *Cardamine pratensis* and the Northern Montane *Crepis paludosa* but also frequent are *Caltha palustris*, *Mentha aquatica*, *Lychnis flos-cuculi*, *Ranunculus repens*, *Poa trivialis*, *Dactylorhiza fuchsii* and *Equisetum palustre*. *Menyanthes trifoliata* and *Potentilla palustris* also occur commonly and are especially conspicuous in wetter areas where they can form large patches. Then there is

almost always some *Galium palustre* trailing over the ground and other plants. Ferns are not a prominent feature but *Dryopteris dilatata* is occasionally found on drier areas. Three rare Northern Montane species which have been recorded in this woodland type are *Lysimachia thyrsiflora* (in Scotland: Birse 1984), the saprophytic orchid *Corallorhiza trifida* (Wheeler 1980*c*, Birse 1984) and *Pyrola rotundifolia*, which seems to favour the more open margins of the stands where it occurs (Wheeler 1975).

Bulkier monocotyledons are very variable in their abundance, though a number can assume local dominance. The commonest of these is *Carex rostrata*, which is constant and which can exceptionally form an extensive cover in the field layer; usually, though, it occurs as rather sparse scattered shoots. Other Carices recorded less frequently are *C. diandra*, *C. lasiocarpa*, *C. appropinquata*, *C. paniculata*, *C. laevigata*, *C. vesicaria*, *C. nigra* and *C. curta*. *C. acutiformis* is not found and *Phragmites australis* occurs only very occasionally and rarely with any abundance. There are sometimes prominent tussocks of *Juncus acutiflorus* or *J. effusus*.

The remaining striking feature of the community is the abundance of bryophytes which, in some stands, form a virtually complete carpet over the ground. Most conspicuous and distinctive of the commoner species are *Calliergon cuspidatum*, *Climacium dendroides* and various of the larger Mniaceae, usually *Rhizomnium punctatum* but, in some stands, *Plagiomnium affine*, *P. ellipticum*, *P. rostratum* or *P. elatum*. There is frequently a little *Mnium hornum* too, especially over the drier tree bases, and also some *Eurhynchium praelongum*. More occasionally, *Brachythecium rutabulum* and *Hypnum cupressiforme* can be found and some stands have locally prominent patches of Sphagna, usually *S. recurvum*, *S. squarrosum* or *S. palustre*. *Drepanocladus uncinatus*, *Ptilidium pulcherrimum*, *Douinia ovata* and *Nowellia curvifolia* have been recorded in this woodland on shrub boles, branches and decaying wood and there can be an abundance of Usneion barbatae lichens festooning the shrub bark.

Habitat

The *Salix-Carex* woodland is most typical of peat soils kept moist by moderately base-rich and calcareous ground water in open-water transitions and basin mires in northern Britain. It can develop as a primary woodland cover with the increased terrestrialisation of such sites or by secondary colonisation of peat-cut surfaces. In drier situations, grazing can be an important factor inhibiting its development.

The general geographical limits of the community are undoubtedly influenced by climate. Shrubs such as *Salix pentandra*, *S. nigricans* and *S. phylicifolia* and herbs like *Crepis paludosa*, *Menyanthes trifoliata*, *Potentilla palustris* and the rarer *Carex diandra*, *C. lasiocarpa*, *C. appropinquata*, *Lysimachia thyrsiflora*, *Corallorhiza trifida* and *Pyrola rotundifolia* are all species which, to varying degrees, are confined to the cooler, more northerly parts of Britain or are commoner there (Matthews 1955). Conversely, a number of woody and herbaceous species prominent in communities like the *Salix-Betula-Phragmites* woodland and the *Alnus-Carex* woodland become very much sparser towards the north or increasingly restricted to the coast.

Within this general range, the *Salix-Carex* woodland probably has a potentially widespread distribution within the sub-montane zone: the altitudinal range of the available samples is from 45–370 m (Ingram *et al.* 1959, Proctor 1974, Adam *et al.* 1975, Wheeler 1975, Birse 1984). It is, however, a distinctly local vegetation type because of the scarcity of suitably base-rich and calcareous situations within the northern uplands. Such conditions are most extensively developed in the region within often fairly small and isolated basins set in calcareous bedrocks or drift, as at Semerwater (Ingram *et al.* 1959) and Malham Tarn (Proctor 1974, Adam *et al.* 1975) in North Yorkshire, in the Eden valley in Cumbria, in southern Scotland (Wheeler 1975, 1980*c*, 1983) and north-east Scotland (Birse 1980, 1984). Other basins, such as Esthwaite in Cumbria (Pearsall 1918, Tansley 1939, Pigott & Wilson 1978) and Crag Lough in Northumberland (Lock & Rodwell 1981), show a more localised development of similar conditions. It is in such sites that the most well-developed stands of the *Salix-Carex* woodland are to be found, growing on fen peats or peaty gleys, irrigated with waters with a pH of 5–7 and dissolved calcium levels in the order of 10–90 mg l^{-1} (Proctor 1974, Wheeler 1983).

In general, the community occupies tracts of such substrates which are sufficiently free from surface waterlogging to allow shrub colonisation to take place. On solid peats, such a condition will arise where autochthonous accumulation of litter raises the surface above the usual upper limit of the flood. In the rather cool climate of the region and with the often low level of nutrients in the waters, such accumulation may be slow (e.g. Spence 1964). Furthermore, some of the basins in which the community is typically found are prone to sudden and dramatic unseasonal fluctuations in water-level after heavy rain (e.g. Ingram *et al.* 1959, Lock & Rodwell 1981) and this may be inimical to the permanent establishment of a shrub cover on the marginal fens. Where expanses of such vegetation develop as a floating mat, a not uncommon feature of these basins, the effect of this may be obviated: then the raft of vegetation, bound together below by the stout, interweaving rhizomes of species such as *Carex rostrata*, *Menyanthes trifoliata* and *Potentilla palustris*, will rise and fall with the waters, keeping the surface free from

inundation (e.g. Lock & Rodwell 1981). Where drier baulks of peat remain after cutting of the surface, these may provide centres for initial invasion (Proctor 1974, Wheeler 1983).

Occasionally, stands of the *Salix-Carex* woodland can be found in other situations where this balance of base-richness and moisture level is maintained. It may occur, for example, in the lagg of raised mires, where marginal seepage ameliorates the ombrotrophic conditions developed on the higher peats (e.g. Rankin 1911*b*). It is also probably a potential woodland cover on soligenous mires and small flushes where seepage of base-rich and calcareous waters results in the development of humose gleys. Almost invariably, however, such areas are set within tracts of upland pasture and then grazing repeatedly sets back any shrub colonisation. Even on the drier parts of basin mires, such grazing (usually by sheep or deer) may be an important factor in delaying invasion: at Crag Lough, for example, a stand of the community is very sharply delimited from fen vegetation by a fence which has prevented access by stock (Lock & Rodwell 1981).

The isolation of many of the sites on which this woodland can develop may have some influence on the composition of the canopy. Although all the common Salices of the community produce large quantities of light, readily wind-dispersed fruits, the relative proximity of seed-parents of the different species may play some part in the rather striking site-specific variation sometimes found in the canopy. The isolation of the established stands will also influence the complex and varied patterns of hybridisation that occur among the Salices at different sites. It may play a part, too, in the scarcity of *Alnus glutinosa* in the community: although the climatic and edaphic conditions characteristic of the *Salix-Carex* woodland are generally within the range favourable to this species, it may not be able to migrate readily into sites which are distant from seed-parents (McVean 1953, 1956*b*). Interestingly, it does play some part in colonisation at Esthwaite North Fen where it is common in adjacent woodlands (Pigott & Wilson 1978).

The composition of the field layer of this woodland is closely related to that of the preceding herbaceous vegetation. Quite a wide range of rich and poor fens seem to be potential precursors to the *Salix-Carex* woodland and some of these are marked by considerable physiognomic variety. Thus, even young stands of the community often lack the fairly standard patterns of dominance found in the field layers to communities like the *Salix-Betula-Phragmites* woodland and the *Alnus-Carex* woodland. Many of the potential dominants of the fens are also somewhat shade-tolerant, so, under the relatively open canopy, they do not show such a striking sequential demise as is typical of the *Salix-Betula-Phragmites* woodland. This is true also of the dicotyledonous component of the field layer, most of the species of which persist from the invaded fens. Indeed, there is very little about the herbaceous element of the *Salix-Carex* woodland that is peculiar to it alone though, with increasing age, many species become more confined to the more open and wetter parts of the woodland, the drier areas around the tree bases having but a sparse cover of *Dryopteris dilatata* and patches of *Mnium hornum*.

Zonation and succession

At some sites, the *Salix-Carex* woodland occupies a clear position in open-water transitions running from the woodland on the driest peats through fen and swamp to aquatic vegetation. At Crag Lough, for example, the community has a fringing front of very wet *Potentillo-Caricetum* fen which gives way, in turn, to the *Caricetum rostratae*, the *Equisetetum fluviatile* or related societies of *Potentilla palustris* and *Menyanthes trifoliata* (Lock & Rodwell 1981). A similar pattern is found in Esthwaite North Fen, though here, the *Phragmitetum* and *Scirpetum lacustris* also play a part in the swamp sequence (Pearsall 1918, Tansley 1939, Pigott & Wilson 1978).

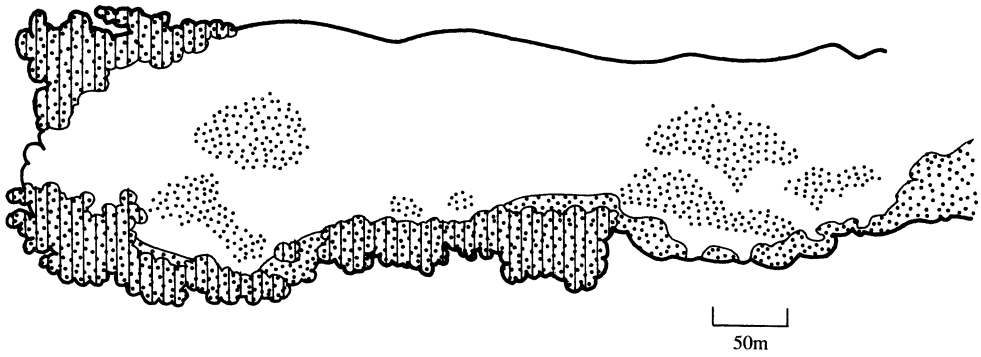
In more fully terrestrialised basin mires, the community characteristically occurs in complex patchworks of vegetation that involve a variety of rich and poor fens related to local variations in seepage and through-put of waters of different pH and calcium content. Again, the *Potentillo-Caricetum* can play a part in such mosaics but, more often, it is some kind of *Carex rostrata-Calliergon* mire that provides the bulk of the herbaceous vegetation around the *Salix-Carex* woodland with a more local development of poor fens like the *Carex rostrata-Sphagnum squarrosum* community. If there is some deposition of alluvium alongside inflow streams, Filipendulion communities may complicate the pattern. This kind of mosaic is seen very clearly at Malham Tarn (Proctor 1974, Adam *et al.* 1975; Figure 17).

At this site and in some other basin mires, the *Salix-Carex* woodland can also be found forming a marginal belt around areas of *Sphagnum*-dominated mires with patchy *Betula-Molinia* woodland. Such situations approach those found in raised mires where, likewise, the community can occur in the lagg giving way sharply towards the mire centre to acidophilous bog and woodland (e.g. Rankin 1911*b*).

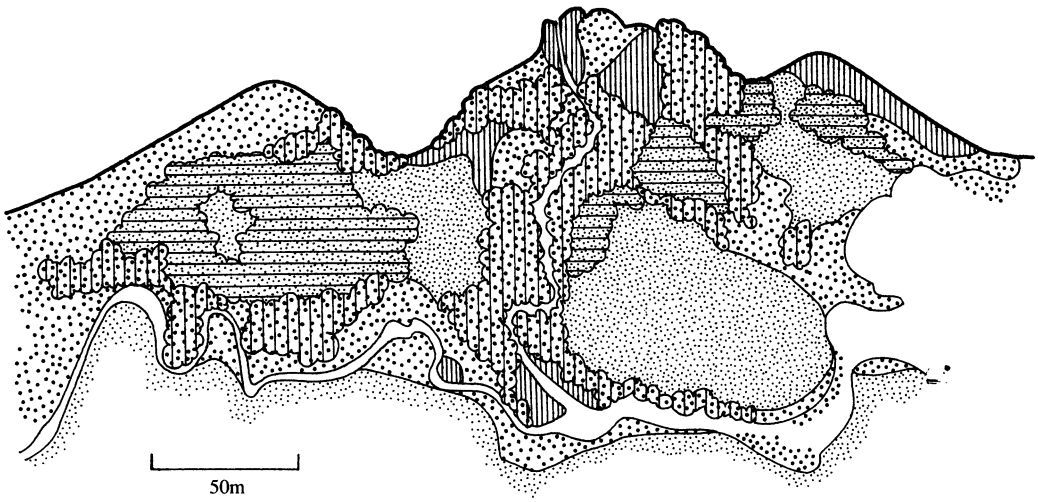
The small amount of stratigraphical data available from mires such as these (Lock & Rodwell 1981, Webb & Moore 1982) suggests that the *Salix-Carex* woodland has developed from fens such as the *Potentillo-Caricetum* and the *Carex-Calliergon* mire though the exact relationship of such successions to natural changes in the habitat has not been monitored. Nor do we know how rapidly such developments proceed under normal circumstances, though photographic evidence from

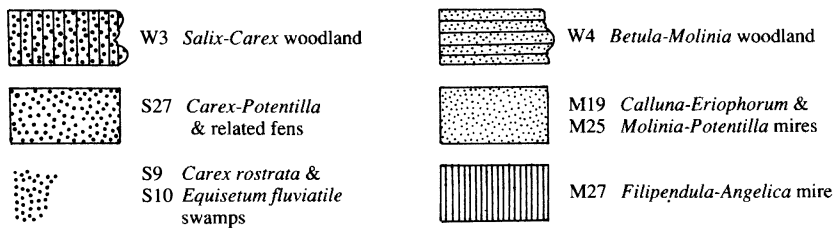
Figure 17. Simple and complex mosaics in mires with *Salix-Carex* woodland.

(*a*) Crag Lough, Northumberland



(*b*) Malham Tarn Fen, North Yorkshire (after Proctor 1974)





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Crag Lough (Lock & Rodwell 1981) suggests that a good cover of this woodland had formed there within a century or so. At Esthwaite, too, colonisation has been quite rapid since the early surveys (Tansley 1939, Pigott & Wilson 1978). But both these sites have moderately eutrophic waters and, in more impoverished basins, change may be much slower. The eventual fate of such successions is unknown but it seems unlikely that the *Salix-Carex* woodland progresses to, say, *Alnus-Urtica* woodland except where stands are drained and disturbed. It is possible, too, that sinking of the fen mat under the weight of the developing canopy sets back further succession in some cases.

One other possibility is that the community is a prelude to the development of more ombrotrophic vegetation as terrestrialisation isolates the mire surface from the ground-water. In this respect, the occasional occurrence of patches of Sphagna within the field layer of the *Salix-Carex* woodland is of interest. Further sampling may permit the characterisation of a distinct sub-community of this woodland in which Sphagna are more prominent, with a decreased representation of some of the dicotyledons and certain Carices, as in the southern *Salix-Betula-Phragmites* woodland. The progression of such vegetation to herbaceous bog (perhaps with an intervening stage with the *Betula-Molinia* woodland) would then leave the *Salix-Carex* woodland persisting only on the marginal fen peat (Walker 1970, Proctor 1974, Wheeler 1983). As on southern floodplain mires, the conditions for such a development might well be initiated within the herbaceous fen before any shrub invasion had taken place.

Distribution

The *Salix-Carex* woodland occurs locally throughout the sub-montane zone of northern Britain. Although no stands have been encountered in Wales, its natural range probably extends there and further sampling may reveal its presence.

Affinities

The distinctive floristic features of northern British fen woods were noted by Proctor (1974) and this vegetation type given association status by Wheeler (1975, 1980*c*) as the *Crepido-Salicetum pentandrae*. Although woodlands with *Salix pentandra* have been described from parts of Europe (e.g. Passarge 1961, Westhoff & den Held 1969), their overall composition is very different to that of the *Salix-Carex* woodland. Its nearest relative among Continental communities seems to be the montane scrub described by Dahl (1956) as the *Mnieto-Salicetum phylicifoliae*.

The community can be considered as the northern counterpart of the *Salix-Betula-Phragmites* woodland within the Salicion cinereae (Wheeler 1975, 1980*c*) and its closest affinities outside woodlands are with the rich fens of the Caricion davallianae.

Floristic table W3

Salix pentandra	IV (4–10)	*Menyanthes trifoliata*	III (1–5)
Salix cinerea	IV (3–8)	*Equisetum fluviatile*	III (1–3)
Betula pubescens	II (2–6)	*Eurhynchium praelongum*	III (1–4)
Alnus glutinosa	I (3–6)	*Poa trivialis*	III (1–4)
Salix nigricans	I (4–9)	*Crepis paludosa*	III (1–3)
Salix phylicifolia	I (4–9)	*Equisetum palustre*	III (1–3)
Salix aurita	I (9)	*Climacium dendroides*	III (1–5)
Salix viminalis	I (4)	*Valeriana officinalis*	III (1–5)
Cardamine pratensis	V (1–4)	*Mentha aquatica*	III (1–5)
Galium palustre	V (1–6)	*Potentilla palustris*	III (1–5)
Caltha palustris	V (1–8)	*Ranunculus repens*	II (1–7)
Filipendula ulmaria	V (1–6)	*Lychnis flos-cuculi*	II (1)
Calliergon cuspidatum	V (1–5)	*Ranunculus acris*	II (1–3)
Angelica sylvestris	IV (1–2)	*Cirsium palustre*	II (1–3)
Valeriana dioica	IV (1–5)	*Brachythecium rutabulum*	II (1–4)
Rhizomnium punctatum	IV (1–7)	*Ajuga reptans*	II (1–4)
Mnium hornum	IV (1–4)	*Holcus lanatus*	II (1–3)
Carex rostrata	IV (1–6)	*Phragmites australis*	II (1–4)
Geum rivale	IV (1–6)	*Molinia caerulea*	II (1–3)
		Dactylorhiza fuchsii	II (1–3)

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Floristic table W3 *(cont.)*

Plagiomnium affine	II (1–3)
Dryopteris dilatata	II (1–3)
Juncus acutiflorus	II (1–6)
Urtica dioica	II (1–5)
Juncus effusus	I (1–5)
Carex paniculata	I (3–4)
Sphagnum recurvum	I (1–3)
Hypnum cupressiforme	I (1–4)
Sphagnum squarrosum	I (4–9)
Viola palustris	I (1–2)
Plagiomnium rostratum	I (1–6)
Phalaris arundinacea	I (1–4)
Sphagnum palustre	I (1–4)
Chrysosplenium oppositifolium	I (1–8)
Lophocolea bidentata s.l.	I (1–3)
Hedera helix	I (2–3)
Galium uliginosum	I (1–3)
Galium aparine	I (1–3)
Carex nigra	I (2–7)
Ranunculus flammula	I (1–2)
Epilobium palustre	I (1–2)
Agrostis stolonifera	I (2–6)
Succisa pratensis	I (1–3)
Lycopus europaeus	I (1–3)
Myosotis scorpioides	I (1–2)
Lophocolea cuspidata	I (1–3)
Drepanocladus uncinatus	I (2–3)
Lophocolea heterophylla	I (1–3)
Plagiomnium ellipticum	I (4–8)
Solanum dulcamara	I (1)
Cardamine flexuosa	I (1–3)
Hydrocotyle vulgaris	I (1)
Galeopsis tetrahit	I (1)
Lysimachia vulgaris	I (3)
Callitriche stagnalis	I (4)
Lemna minor	I (1)
Rubus fruticosus agg.	I (1)
Veronica beccabunga	I (3)
Calliergon cordifolium	I (4)
Athyrium filix-femina	I (1)
Myosotis laxa caespitosa	I (4)
Oenanthe crocata	I (2)
Scutellaria galericulata	I (2)
Chiloscyphus polyanthos	I (1)
Deschampsia cespitosa	I (1)
Eupatorium cannabinum	I (4)
Veronica scutellata	I (1)
Crataegus monogyna seedling	I (3)
Pellia endiviifolia	I (1)
Plagiochila asplenoides	I (1)
Chiloscyphus pallescens	I (1)
Fissidens adianthoides	I (1)
Aulacomnium androgynum	I (2)
Plagiomnium elatum	I (8)
Carex appropinquata	I (4)
Parnassia palustris	I (1)
Trollius europaeus	I (1)
Conocephalum conicum	I (2)
Dicranoweissia cirrata	I (1)
Carex echinata	I (1)
Potamogeton polygonifolius	I (2)
Alnus glutinosa seedling	I (1)
Salix cinerea seedling	I (1)
Carex laevigata	I (4)
Saccogyna viticulosa	I (3)
Marchantia polymorpha	I (1)
Cephalozia bicuspidata	I (1)
Jungermannia obovata	I (2)
Calliergon giganteum	I (1)
Douinia ovata	I (2)
Carex vesicaria	I (4)
Eurhynchium speciosum	I (1)
Pyrola rotundifolia	I (1)
Number of samples	18
Number of species/sample	28 (20–38)
Shrub height (m)	5 (3.5–7)
Shrub cover (%)	93 (80–100)
Herb height (cm)	52 (20–100)
Herb cover (%)	60 (5–90)
Ground height (mm)	15 (10–35)
Ground cover (%)	42 (10–90)
Altitude (m)	267 (45–380)

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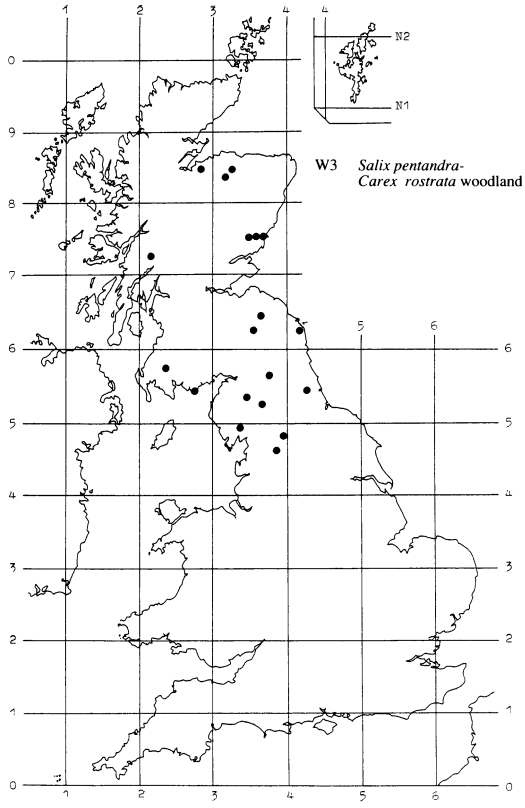

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