MG3
Anthoxanthum odoratum-Geranium sylvaticum grassland

Synonymy
Trisetetum flavescentis Beger 1922; Hay meadows Pigott 1956*a*, Bradshaw 1962, Bradshaw & Clark 1965, Ratcliffe 1978; Dales hay meadows Duffey *et al.* 1974; Northern hay meadows Ratcliffe 1977; *Helictotricho-Trisetetum* Jones 1984 *p.p.*; *Dactylo-Geranietum* Jones 1984.

Constant species
Agrostis capillaris, *Alchemilla glabra*, *Anthoxanthum odoratum*, *Cerastium fontanum*, *Conopodium majus*, *Dactylis glomerata*, *Festuca rubra*, *Geranium sylvaticum*, *Holcus lanatus*, *Plantago lanceolata*, *Poa trivialis*, *Ranunculus acris*, *Rumex acetosa*, *Sanguisorba officinalis*, *Trifolium repens*.

Rare species
Alchemilla acutiloba, *A. glomerulans*, *A. monticola*, *A. subcrenata*, *A. wichurae*.

Physiognomy
The *Anthoxanthum odoratum-Geranium sylvaticum* community has a dense growth of grasses and herbaceous dicotyledons up to 60–80 cm high. Among the former, *Anthoxanthum odoratum*, *Dactylis glomerata*, *Festuca rubra*, *Holcus lanatus*, *Agrostis capillaris* and *Poa trivialis* are constant with *Cynosurus cristatus*, *Trisetum flavescens*, *Poa pratensis*, *Alopecurus pratensis* and *Festuca pratensis* occurring throughout though less frequently. Some of these grasses may attain local abundance (especially the constant species) and there is also some phenological variation with fine-leaved species such as *F. rubra*, *P. trivialis* and *A. odoratum* prominent early in the season but later being overtopped by the more tussocky coarse-leaved species such as *H. lanatus* and *D. glomerata*. However, it is a feature of the community that no single grass species is consistently dominant. Indeed, grasses as a whole commonly comprise a relatively small proportion of the herbage and the most obvious physiognomic feature of the vegetation is generally the variety and abundance of dicotyledons. In summer, the vegetation presents a colourful spectacle and has earned itself the local name of 'herbie meadow'.

Among the constant dicotyledons, *Geranium sylvaticum* is usually the most prominent and exceptionally may account for 90% of the cover. *Sanguisorba officinalis*, *Conopodium majus*, *Alchemilla glabra* and *A. xanthochlora* are also occasionally abundant and by the end of June these five species generally comprise the bulk of the herbage. Beneath, *Plantago lanceolata*, *Rumex acetosa*, *Ranunculus acris*, *Cerastium fontanum* and *Trifolium repens* are constant components with *Taraxacum officinale* agg., *Lathyrus pratensis*, *Bellis perennis* and *Ranunculus bulbosus* frequent. Tall herbs are generally uncommon, although *Heracleum sphondylium* is occasionally conspicuous. Among the low-frequency associates are *Cardamine pratensis*, *Anemone nemorosa*, *Cirsium helenioides*, *Trollius europaeus*, *Leucanthemum vulgare*, *Euphrasia montana*, *Polygonum viviparum*, *Trifolium medium*, *Dactylorhiza fuchsii*, *Coeloglossum viride*, *Orchis mascula*, *Gymnadenia conopsea*, *Leucorchis albida* and *Listera ovata*. Three ancient introductions, *Rumex longifolius*, *Polygonum bistorta* and *Peucedanum ostruthium* occur locally, sometimes in dense patches.

There is sometimes a hazy mosaic in stands of the community with areas tending towards calcifugous grassland or mires. In the former, *Anthoxanthum odoratum* may be locally abundant with *Viola lutea* and even *Deschampsia flexuosa* and *Vaccinium myrtillus*. In the latter, *Crepis paludosa* and *Carex panicea* are often conspicuous with occasional records for *Filipendula ulmaria*, *Geum rivale*, *Cochlearia alpina*, *Lychnis flos-cuculi*, *Potentilla palustris*, *Valeriana dioica*, *Pedicularis palustris*, *Dactylorhiza incarnata* and *D. majalis* ssp. *purpurella*.

We do not have systematically collected bryophyte data for all the available samples but mosses are frequent throughout. The most common species are

Brachythecium rutabulum, *Eurhynchium praelongum* and *Rhytidiadelphus squarrosus* and each of these may be locally abundant.

Sub-communities

***Bromus hordeaceus* ssp. *hordeaceus* sub-community:** *Helictotricho-Trisetetum*, *Lolium perenne* Subassociation Jones 1984. In general, this sub-community is characterised by the replacement of species indicative of lack of improvement by those typical of re-seeded grasslands, e.g. *Lolium perenne* and *Phleum pratense* ssp. *pratense*, and attendant weeds, among which *Bromus hordeaceus* ssp. *hordeaceus* is the most conspicuous. Many of the occasionals of the *Briza* sub-community are much rarer or absent here and the vegetation is poorer and less diverse. Although the dicotyledons may remain conspicuous, grasses are generally more abundant and *Dactylis glomerata* and *Poa trivialis* sometimes share dominance. *P. trivialis* is often particularly noticeable early in the season when young plants appear on areas of bare soil. In more extreme cases, *Geranium sylvaticum* and *Sanguisorba officinalis* show greatly reduced vitality and may persist only as isolated patches. *Alchemilla xanthochlora* and (especially) *A. glabra* may remain more abundant but, in some stands, these too are much less conspicuous than usual.

***Briza media* sub-community:** Hay meadows Bradshaw 1962, Bradshaw & Clark 1965; *Helictotricho-Trisetetum*, *Lathyrus pratensis* Subassociation Jones 1984. This is the richest and most diverse of the sub-communities. It is characterised partly by the markedly preferential frequency of species common in unimproved grasslands, e.g. *Briza media*, *Lotus corniculatus*, *Luzula campestris*, *Rhinanthus minor*, *Centaurea nigra* and *Leontodon hispidus*, and the virtual absence of species associated with improvement and/or re-seeding. There is also a wide variety of occasionals, some of which reflect the occurrence of undisturbed transitions to mires and other grassland types which are more common in this sub-community.

Others, however, belong to the meadow vegetation proper and include some species of local or very restricted national distribution. Most prominent among these are various of the microspecies within the *Alchemilla vulgaris* aggregate (Walters 1949, 1952) which have been the subject of ecological study by Bradshaw (1962). Three are Northern Montane species (Hultén 1950, Matthews 1955) confined in Britain to the Teesdale/Weardale area of Durham and almost always found in this sub-community of the *Anthoxanthum-Geranium* grassland. *Alchemilla monticola* and *A. acutiloba* are both fairly widespread in this area: the former occurs in varying degrees of abundance in meadow stands and, towards the fringe of its distribution, on or near to roads; the latter is more frequent along verges, often in dense patches. *A. subcrenata* is a further, much rarer, Northern Montane species occurring here. Two other members of the aggregate, the Arctic-Subarctic *A. wichurae* and the Arctic-Alpine *A. glomerulans*, are more widely distributed in northern Britain and, though sometimes conspicuous in this sub-community, also occur in calcicolous grasslands and ledge vegetation. *A. filicaulis* ssp. *filicaulis* is another Arctic-Alpine taxon but it is much rarer here than in calcicolous grassland. The much more widespred *A. filicaulis* ssp. *vestita* is also frequent and occasionally abundant in this sub-community but it occurs, too, in the meadows and pastures of the *Centaureo-Cynosuretum*. In exceptional cases, samples have been recorded with four or five of these species in addition to *A. glabra* and *A. xanthochlora*.

***Arrhenatherum elatius* sub-community:** *Dactylo-Geranietum* Jones 1984. In the coarser sward of this sub-community, tussock grasses such as *Arrhenatherum elatius*, *Dactylis glomerata* and *Avenula pubescens* are more abundant, though they rarely dominate. In general, the vegetation resembles that of the poorer *Bromus* sub-community but *Geranium pratense*, *Cruciata laevipes* and *Holcus mollis* are preferential here and there are sometimes dense patches of *Alchemilla acutiloba* and, more rarely, *A. monticola*.

Habitat

The *Anthoxanthum-Geranium* community is an upland grassland confined to areas where traditional hay-meadow treatment has been applied in a harsh submontane climate. It is most characteristic of brown soils on level to moderately sloping sites and is now almost entirely restricted to a few valley heads, between 200 and 400 m, in northern England. Many stands are still used as hay-meadows but the community also occurs on river banks and road verges, in churchyards and in woodland clearings.

The climate of the sites is cold, wet, windy and cloudy (Manley 1936, 1942) and the major effects on the vegetation are felt through temperature and precipitation. Winters are bitter and stormy with up to 50 days observed snow or sleet (Manley 1940) and a long spring snow-lie. The growing season starts later and is shorter than in any other agroclimatic area of England and Wales (Smith 1976). Growth normally begins in late April to early May but late frosts are frequent and, in the brief cloudy summer, temperatures may be below the critical mean for plant growth for more than half the time (Pigott 1956*a*). The autumn is windy and very wet.

Annual precipitation ranges from 900 to 1800 mm (*Climatological Atlas* 1952) with 180–200 wet days yr^{-1} (Ratcliffe 1968), but the effect of this high rainfall is modified by the physical and chemical properties of the soils. Although these may occur over permeable sandstones and limestones, they are frequently derived from superficial deposits: alluvium, head, glacio-fluvial material or, most commonly, till, often laid down in moraines or as drumlins. Such material usually has a very substantial fine sand fraction which, especially when compacted, has little pore space (Pigott 1978*b*). In this region, such soils show an early autumn return to field capacity (Smith 1976) and poor to impeded drainage throughout the year with gleying below. Where the soil parent material is more free-draining, the predominant direction of soil water movement is downwards and there is a superficial removal of any free calcium carbonate and a fall in pH and even the development of an illuvial horizon (Pigott 1956*a*). Generations of the traditional application of lime and farmyard manure (see below) have tended to offset the loss of minerals by such leaching (and by the annual removal of the hay crop).

The chemical composition, especially the calcium content, of the soil parent material further influences the effect of the soil water on the vegetation. On material derived from siliceous rocks, especially where this is permeable, soils tend to a typical brown earth profile and it is in such situations that the vegetation has species characteristic of calcifugous grasslands. On more calcareous material, the typical profile is of the brown calcareous earth type and, where this is impermeable below, high calcium content and base-status may be maintained by flushing with ground water from adjacent limestones. It is around the springs which develop in such circumstances that the *Anthoxanthum-Geranium* community attains its greatest richness and diversity with occasional records for a wide variety of species of poor fens and base-rich mires. In general, this kind of heterogeneity is most characteristic of situations where mixed till in a complex morainic topography abuts on to limestone exposures.

Most of the differences between the three sub-communities are, however, attributable directly to variations in the treatment of the vegetation. The *Anthoxanthum-Geranium* community is essentially a hay-meadow and comprises part of the 'in-by' land of Pennine and Lakes hill farms. These valley fields are grazed in winter, mainly by sheep, except in very unfavourable weather when the stock are kept indoors. In late April to early May, the meadows are shut up for hay and the stock, apart from animals in poor condition, transferred to the 'out-by' summer grazing on the open moorland. Mowing takes place generally in late July to early August though, in unfavourable seasons, it may be delayed as late as September. The aftermath is then grazed once more until the weather deteriorates.

Traditionally, the meadows have been given a light dressing of farmyard manure after being shut up and it is this, together with liming, which has helped maintain the richness and diversity of the *Briza* sub-community. In some areas, the old practice of stacking the hay in a mound within the meadows (in a different place each year) has probably contributed to the local abundance of particular species seeding in from the cut material (Bailey 1810, Bradshaw 1962). Traditional methods of seeding in from barn-sweepings or with seed collections from rich meadows or by the transplanting of turfs (Bradshaw 1962) have probably also helped maintain the frequency and abundance of a wide range of species.

Such long-continued practices have been abandoned at an increasing rate in recent years. It is now commonplace to use chemical fertilisers, especially nitrogen, to increase hay yield and this, more than any other factor, is responsible for the widespread conversion of the *Briza* sub-community to the much poorer *Bromus* sub-community. Many of the stands described as recently as the 1960s have shown such a floristic impoverishment and, in some areas, only substantial subsidies maintain the traditional methods of treatment (Ratcliffe 1978).

Ploughing and subsequent abandonment and/or re-seeding have also contributed to the loss of the richer *Briza* sub-community in some areas. In the Lake District, many meadows were ploughed up for potato cultivation during the Second World War and afterwards reverted to the *Bromus* sub-community. More systematic and repeated ploughing and re-seeding, especially when combined with application of artificial fertilisers, has the more drastic effect of converting the *Anthoxanthum-Geranium* community to other more productive types of grassland. However, both *Geranium sylvaticum* and *Sanguisorba officinalis* are remarkably persistent after ploughing alone and can regenerate from buried rhizome fragments. *Alchemilla glabra* and *A. xanthochlora* also seem able to reappear rapidly from dormant seed. Even some of the rare *Alchemilla* spp. may spread on to road verges and along disturbed paths; indeed, *A. acutiloba* is particularly associated with such habitats in Durham (Bradshaw 1962).

Stands of the community along road verges are a valuable supplement to the enclosed grazing of upland farms and may be used for irregular winter pasturing. Even in summer, sheep may escape from the out-by land over the cattle grids and graze the verges lightly. Many verges are not cut and this enables more of the dicotyledons to set seed, thus helping to maintain the richness of adjacent meadows. However, where such stands remain ungrazed, they may be converted to the coarser

Arrhenatherum sub-community which can persist even with annual cutting.

Zonation and succession

Stands of the *Anthoxanthum-Geranium* community occur most frequently in fields bounded by walls or fences and each subject to a more or less uniform treatment regime. Spatial zonations between the sub-communities are therefore infrequent, although neglected corners and margins of fields with either the *Briza* or the *Bromus* sub-community may show a narrow transition to the *Arrhenatherum* sub-community. The blue-violet flowers of *Geranium pratense* often mark out this sub-community in summer. On verges which have a less systematic treatment such transitions are more common and irregular.

The local appearance of mire species in stands of the *Anthoxanthum-Geranium* community may form part of a transition to flush vegetation where drainage of soil water is strongly impeded. The types of mire involved in such sequences depend on the calcium status and pH of the ground water and include the *Pinguiculo-Caricetum* and the *Molinia-Crepis* fen. Along stream sides where there is seasonal inundation a tall-herb Filipendulion mire may terminate the sequence.

The striking floristic similarity between the *Anthoxanthum-Geranium* community and the field layer of open stands of the *Fraxinus-Sorbus-Mercurialis* and *Alnus-Fraxinus-Lysimachia* woodlands strongly suggests that this meadow vegetation has developed by canopy clearance and is maintained by annual mowing which excludes tall dominants (Pigott 1956*a*, Bradshaw 1962). Zonations between the community and such woodland are rare but occasionally the two vegetation types occur contiguously on identical sites separated only by a boundary wall. In Scandinavia, very similar meadow vegetation is mown in the clearings of such open woodland (Nordhagen 1928, Sjörs 1954; see 'Affinities' below).

Traditional treatment has maintained the community in all its richness but the vegetation of the *Bromus* sub-community represents one stage in a process of increasing the productivity and decreasing the floristic diversity of hay-meadows in response to various combinations of fertiliser application, ploughing and re-seeding. This seems eventually to convert the vegetation to the *Holcus-Trifolium* sub-community of *Festuca-Agrostis-Galium* grassland or the *Anthoxanthum* sub-community of the *Lolio-Cynosuretum*.

Distribution

This is a northern sub-montane community now almost entirely restricted to a few upland valleys in northern England, notably Teesdale and Weardale in Durham, Swaledale and Wensleydale in North Yorkshire and parts of the Lake District. We have no Scottish samples but fragments of the community survive along river banks in Tayside. It was undoubtedly more widespread in the past and, in areas of agricultural improvement, verge stands provide a valuable reserve.

Affinities

The *Anthoxanthum-Geranium* community has long been recognised for its distinctive richness but its exact floristic affinities are unclear. On the one hand, it shares many species with the 'Park Meadow' communities described from Norway (Nordhagen 1928, 1936, 1943), Sweden (Sjörs 1954) and Greenland (Böcher 1954). These have traditionally been placed in the Cicerbition alpini which comprises vegetation approached most closely in Britain by the tall-herb communities of mountain ledges. On the other hand, there are clear affinities with other meadow types in the Arrhenatheretalia allocated to the Polygono-Trisetion, which replaces the Arrhenatherion at higher altitudes in Europe (Beger 1922, LeBrun *et al.* 1949). A further difficulty is that complexities of treatment styles have served to blur the boundary between this alliance and the pastures of the Cynosurion in Britain.

Floristic table MG3

	a	b	3
Plantago lanceolata	V (2–5)	V (2–4)	V (2–5)
Rumex acetosa	V (1–5)	V (1–3)	V (1–5)
Ranunculus acris	V (1–5)	V (1–3)	V (1–5)
Geranium sylvaticum	V (2–9)	IV (1–4)	V (1–9)
Anthoxanthum odoratum	IV (1–5)	V (3–6)	V (1–6)
Conopodium majus	IV (2–7)	V (2–6)	V (2–7)
Cerastium fontanum	IV (1–3)	V (1–3)	V (1–3)
Dactylis glomerata	V (1–7)	IV (1–5)	IV (1–7)
Alchemilla glabra	V (1–4)	IV (1–4)	IV (1–4)

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Trifolium repens	V (1–4)	IV (1–3)	IV (1–4)
Poa trivialis	V (1–7)	IV (1–3)	IV (1–7)
Festuca rubra	IV (2–7)	IV (3–8)	IV (2–8)
Agrostis capillaris	IV (1–7)	IV (1–5)	IV (1–7)
Holcus lanatus	IV (2–6)	III (1–5)	IV (1–6)
Sanguisorba officinalis	IV (1–6)	III (1–3)	IV (1–6)
Bromus hordeaceus hordeaceus	III (1–5)		II (1–5)
Lolium perenne	III (1–5)	I (2–6)	II (1–6)
Phleum pratense pratense	II (2–3)	I (1–2)	I (1–3)
Ranunculus repens	II (1–4)		I (1–4)
Arrhenatherum elatius	I (2–3)		I (2–3)
Vicia sativa nigra	I (2)		I (2)
Veronica serpyllifolia	I (1)		I (1)
Myosotis discolor	I (1)		I (1)
Stellaria media	I (1)		I (1)
Rhinanthus minor	II (1–6)	IV (2–3)	III (1–6)
Bellis perennis	III (1–4)	IV (1–4)	III (1–4)
Cynosurus cristatus	III (1–6)	IV (2–5)	III (1–6)
Ranunculus bulbosus	III (1–4)	IV (1–3)	III (1–4)
Leontodon hispidus	II (1–5)	IV (1–4)	III (1–5)
Luzula campestris	I (1–4)	IV (1–3)	III (1–4)
Trifolium pratense	II (1–3)	IV (1–4)	II (1–4)
Hypochoeris radicata	I (1–2)	III (1–3)	II (1–3)
Lotus corniculatus	I (1–4)	III (1–3)	II (1–4)
Centaurea nigra	I (1–3)	III (1–3)	II (1–3)
Briza media		III (2–3)	I (2–3)
Alchemilla filicaulis vestita		II (1–4)	I (1–4)
Alchemilla monticola		II (1–4)	I (1–4)
Succisa pratensis		II (1–3)	I (1–3)
Orchis mascula		II (1)	I (1)
Alchemilla acutiloba		I (3–6)	I (3–6)
Alchemilla subcrenata		I (2–3)	I (2–3)
Alchemilla filicaulis filicaulis		I (3)	I (3)
Alchemilla glomerulans		I (1–5)	I (1–5)
Alchemilla wichurae		I (1–4)	I (1–4)
Caltha palustris		I (1)	I (1)
Primula veris		I (1–2)	I (1–2)
Thymus praecox		I (2)	I (2)
Viola riviniana		I (1)	I (1)
Viola lutea		I (1)	I (1)
Saxifraga granulata		I (1–2)	I (1–2)
Senecio jacobaea		I (1)	I (1)
Crepis paludosa		I (1)	I (1)
Alchemilla xanthochlora	II (1–5)	III (1–3)	III (1–5)
Taraxacum officinale agg.	III (1–3)	III (1–2)	III (1–3)
Lathyrus pratensis	III (1–3)	III (1–2)	III (1–3)
Poa pratensis	II (2–6)	II (3–6)	II (2–6)
Heracleum sphondylium	II (1–5)	III (1–5)	II (1–5)
Alopecurus pratensis	II (1–7)	II (1–3)	II (1–7)

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Floristic table MG3 (*cont.*)

	a	b	3
Cardamine pratensis	II (1–3)	II (1–2)	II (1–3)
Anemone nemorosa	I (2–4)	II (1–3)	II (1–4)
Trisetum flavescens	II (1–3)	II (1)	II (1–3)
Leucanthemum vulgare	II (1–3)	I (1)	I (1–3)
Festuca pratensis	II (1–4)	II (1–3)	II (1–3)
Achillea millefolium	I (1–3)	II (1–2)	I (1–2)
Potentilla erecta	I (3–4)	II (1–2)	I (1–4)
Carex panicea	I (3)	II (1–3)	I (1–3)
Carex caryophyllea	I (2)	II (1)	I (1–2)
Deschampsia cespitosa	I (1)	II (1–3)	I (1–3)
Filipendula ulmaria	I (3–4)	II (1–2)	I (1–4)
Geum rivale	I (1)	II (1–3)	I (1–3)
Euphrasia officinalis agg.	I (1–2)	II (1–3)	I (1–3)
Trollius europaeus	I (4)	II (1–2)	I (1–4)
Avenula pubescens	I (2–4)	II (3)	I (2–4)
Leontodon autumnalis	I (1–3)	I (2–3)	I (1–3)
Prunella vulgaris	I (1–6)	I (2–3)	I (1–6)
Campanula rotundifolia	I (2)	I (1)	I (1–2)
Cirsium helenioides	I (1)	I (1–2)	I (1–2)
Lathyrus montanus	I (3)	I (1)	I (1–3)
Equisetum arvense	I (3–4)	I (1)	I (1–4)
Ajuga reptans	I (1)	I (1)	I (1)
Trifolium medium	I (2)	I (1–2)	I (1–2)
Anthriscus sylvestris	I (4)	I (1–2)	I (1–4)
Vicia sepium	I (4)	I (1)	I (1–4)
Brachythecium rutabulum	III (1–5)		
Eurhynchium praelongum	III (1–5)		
Rhytidiadelphus squarrosus	III (1–7)		
Calliergon cuspidatum	II (1–3)		
Mnium hornum	II (1–3)		
Plagiomnium cuspidatum	I (2–4)		
Number of samples	34	40	74
Number of species/sample	23 (12–33)	35 (19–43)	26 (12–43)

a *Bromus hordeaceus hordeaceus* sub-community
b *Briza media* sub-community
3 *Anthoxanthum odoratum-Geranium sylvaticum* grassland (total)

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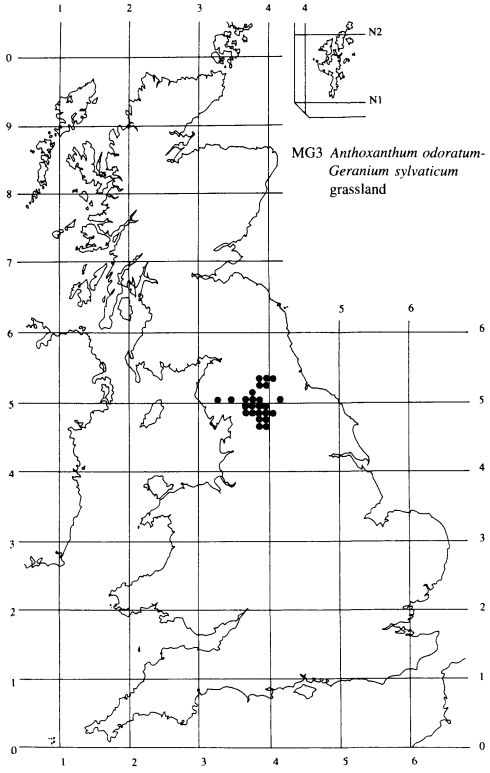

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