

***Cotula alpina* (Asteraceae) naturalised in the British Isles**

Kevin J. Walker^{1*}, Linda Robinson² & Duncan Donald³

¹BSBI, Harrogate, UK; ²Penrith, Cumbria, UK; ³Poolewe, Wester Ross, UK

*Corresponding author: kevin.walker@bsbi.org

This pdf constitutes the Version of Record published on 26th February 2020

Abstract

Cotula alpina (Hook f.) Hook f. is an Australian herb that has been naturalised in Britain since the 1970s and is now locally abundant in parts of northern England and northwest Scotland. Its method of arrival is unknown but it is likely to have originated from gardens and perhaps also from wool shoddy. It appears to be spreading rapidly due to high seed production and effective dispersal by sheep, humans and vehicles and is now locally abundant on moorland tracks and in adjacent acid grassland and heather moorland managed for grouse. Due to its evergreen and mat-forming habit it can outcompete community dominants such as *Agrostis capillaris* and *Festuca ovina* in areas where levels of grazing are high. It appears to be well suited to the British climate and is therefore likely to spread into similar habitats in other regions where it could pose a threat to localized species associated with short grassland on acidic soils. Its overall abundance and ability to regenerate rapidly from seed means it is unlikely to be easily controlled or eradicated, although exclusion of grazing may help to reduce its abundance in some areas.

Keywords: acid grassland, ecology, habitats, heather moorland, invasive non-native.

Introduction

Cotula (Asteraceae, tribe Anthemideae) is a small genus of diminutive herbs of open habitats in Australia, New Zealand, South Africa and South America (Lloyd & Webb, 1987; Himmelreich et al., 2012). Many species are cultivated for ornament or amenity and this has resulted in them becoming established outside their native range. Fourteen species have been recorded in the British Isles, six of which have become naturalised (Clement & Foster, 1994; Wilmore, 2000; Stace & Crawley, 2015; Stace, 2019): *C. australis*, *C. dioica*, and *C. squalida* have been recorded in arable, waste ground and lawns, whereas *C. coronopifolia* appears to be restricted to freshwater and saline marshes. In recent years both *C. sessilis* (syn. *Soliva pterosperma*) and *C. australis* have been found in the trampled turf of campsites in southern and eastern England where they are likely to have been introduced by tourists (Pope & Stanley, 2018). In comparison *C. alpina*, the subject of this paper, is confined to moorland tracks and roadsides and adjacent grassland and heathland in upland regions. Both *C. coronopifolia* and *C. squalida* are widely naturalised whereas *C. australis* and *C. dioica* have only been

recorded in a few places mainly as wool-shoddy casuals in the past (Preston et al., 2002). *C. alpina*, *C. coronopifolia* and *C. squalida* are occasionally grown in rockeries or, as in the case of *C. squalida*, as an alternative for grass in lawns.

Cotula alpina (Hook. f.) Hook. f., Alpine Cotula, appears to have been overlooked by British botanists until its discovery by Linda Robinson on a roadside in Upper Nidderdale, North Yorkshire in June 2009, where its abundance suggested that it had been present for some time (Robinson, 2009). The species did not match any of the descriptions in Stace (1997) but appeared very close to photographs of *C. alpina* on a number of Australian websites. Specimens were sent to Eric Clement, the BSBI's alien plant referee, and Brendan Lepschi, the curator of the Australian national herbarium in Canberra, who both confirmed that LR's determination was correct. Remarkably, *C. alpina* was found in northwest Scotland later the same year (White, 2009). These are the first confirmed British records for *C. alpina*, although a few earlier records have recently come to light (Robinson, 2009; Walker & Robinson, 2012; Donald, 2013).

In this paper, we describe the distribution, origin, habitats and ecology of *C. alpina* in Britain and its likely impacts on native habitats and species. Nomenclature follows Stace (2019) for vascular plants and Rodwell (1991-2008) for British Plant Communities.

Taxonomy

Cotula alpina was first collected by Ronald Campbell Gunn in Marlborough, Tasmania, in 1841 and described as *Ctenosperma alpinum* by Joseph Dalton Hooker on his return to Britain following the Ross Antarctic expedition of HMS Erebus and HMS Terror (Hooker, 1847). This name was changed to *Cotula* after a 'more extended examination of the species' published in Hooker's full account of the Tasmanian flora (Hooker, 1855-57). The following taxonomic description is based on Curtiss (1963), Welsh & Entwisle (1999), Costin et al. (2000) and Thompson (2007), supplemented by measurements of British material.

Glabrous, scapose, annual or short-lived perennial, to 5 cm tall (-10 cm in Australia; Thompson, 2007). Spreading by short rhizomes and stolons that root at each node (Fig 1.); leaves evergreen, alternate or loosely clustered at each node, ± oblong, usually 2–4 cm long, 4–6 mm wide, 1-pinnatifid with occasional secondary teeth; 4-6 pairs of ± ovate, acute pinnae with pale ± mucronate apices; lamina minutely glandular-punctate with the base tapered into broad-winged petiole, c. 10 mm long, broadly clasping the stem. Scapes stout, hollow, axillary, 1-3 mm broad, only slightly narrowed distally at maturity (unlike other *Cotula* species); glabrous and much shorter than leaves at anthesis (usually c. 15 mm) but lengthening to 3-5 cm at maturity (usually to c. 3 cm in British Isles); receptacle convex. Capitula 4 mm across (to 5.5 mm when in fruit), phyllaries dull green, 1.5-2.0 mm diameter, oblong, obtuse, glabrous, with hyaline and ± purple margins. Florets dull yellow; the outer (ray) c. 30-40, female, oblong, c. 1 mm long, 3- to 4-seriate, with ciliate wings but lacking corollas and pedicels; styles c. 1.5 mm long, stigma weakly divided at the apex. The inner (disc) florets fewer (c. 8-16), sessile, four-toothed, functionally male (with abortive stigmas) and usually sterile, with the corolla c. 1-1.5 mm long with the limb yellow-green; styles truncate, undivided, usually shorter than the corolla. Achenes of the outer-florets

chestnut-brown, 1.5–2 mm long, laterally compressed with a thick, rounded wing undifferentiated from the seed, and scattered papillose hairs near top and apical margins. Flowering in December to March in Australia; late June to August in Britain, exceptionally from May to November.

Stace (2019) provides a key to six species of *Cotula* naturalised in the British Isles in which he differentiates *C. alpina* as having a strongly creeping habit with stems rooting at the nodes, a lack of hairs, and small dull yellow capitula that lack spines (Fig. 1).

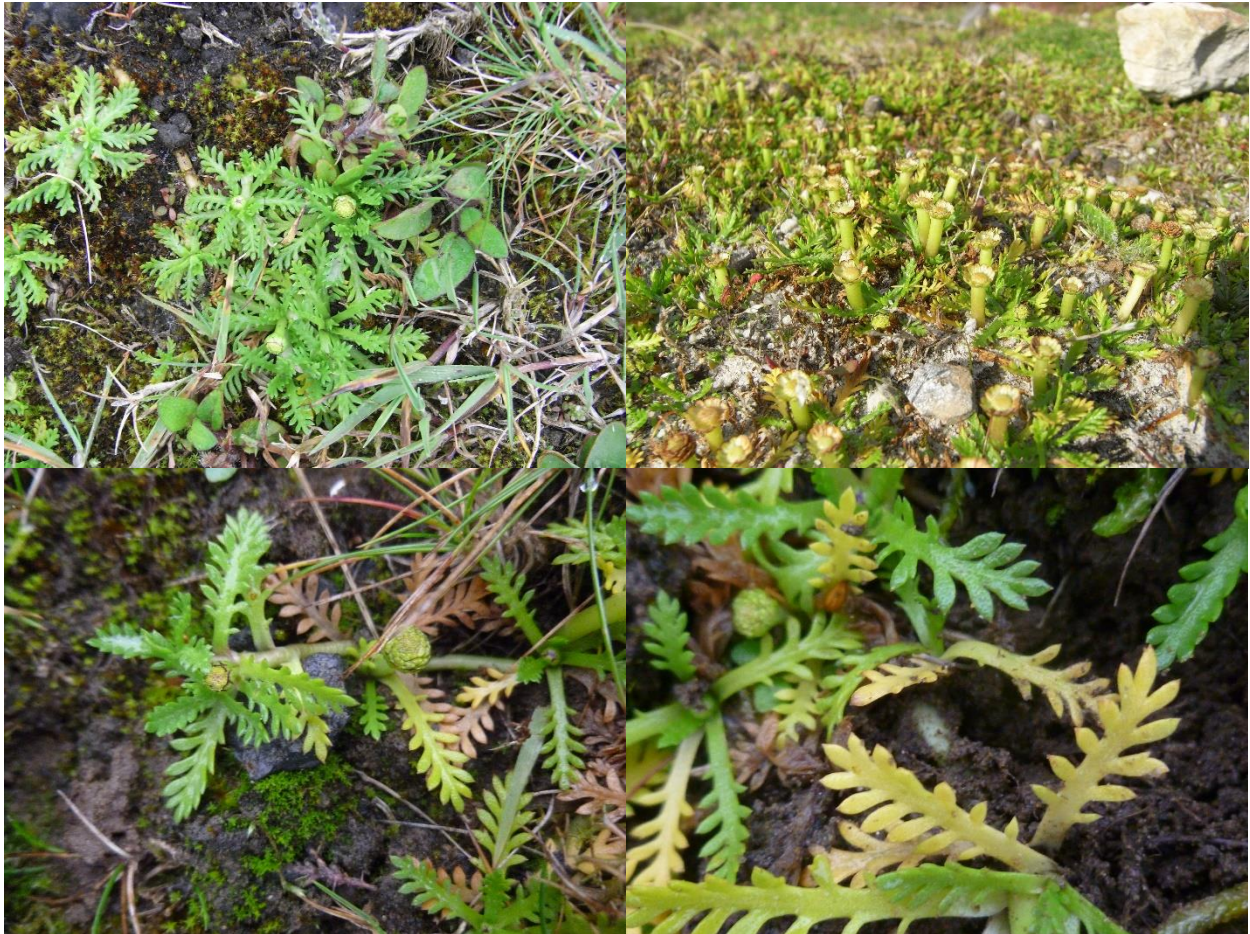


Figure 1. *Cotula alpina* in Upper Nidderdale, North Yorkshire; coming into flower (top left), in seed (top right), and showing stoloniferous shoots (bottom left) and exposed rhizome (bottom right).

Distribution

Cotula alpina is endemic to southeastern Australia where it is confined to upland regions of southeastern New South Wales, eastern Victoria and Tasmania. In Victoria it is locally common at moderate to high altitudes (579 to 1191 m) on a variety of substrates including basalt-derived loams. In New South Wales, it is found in the Snowy Mountains, alongside the road over Mount Kosciuszko, the highest point in Australia, where the

climate and terrain are similar to upland regions of northern England and Scotland with an annual rainfall of between 850 to 1500 mm and a temperature range of between -1 to 26 °C (Costin et al., 2000). Equivalent figures for the hectads in which *C. alpina* occurs in GB are 1137 ± 74 mm (inter-quartile range 945-1395 mm) with a mean January and July temperature of 3.3 ± 0.4 °C and 14.4 ± 0.3 °C respectively.

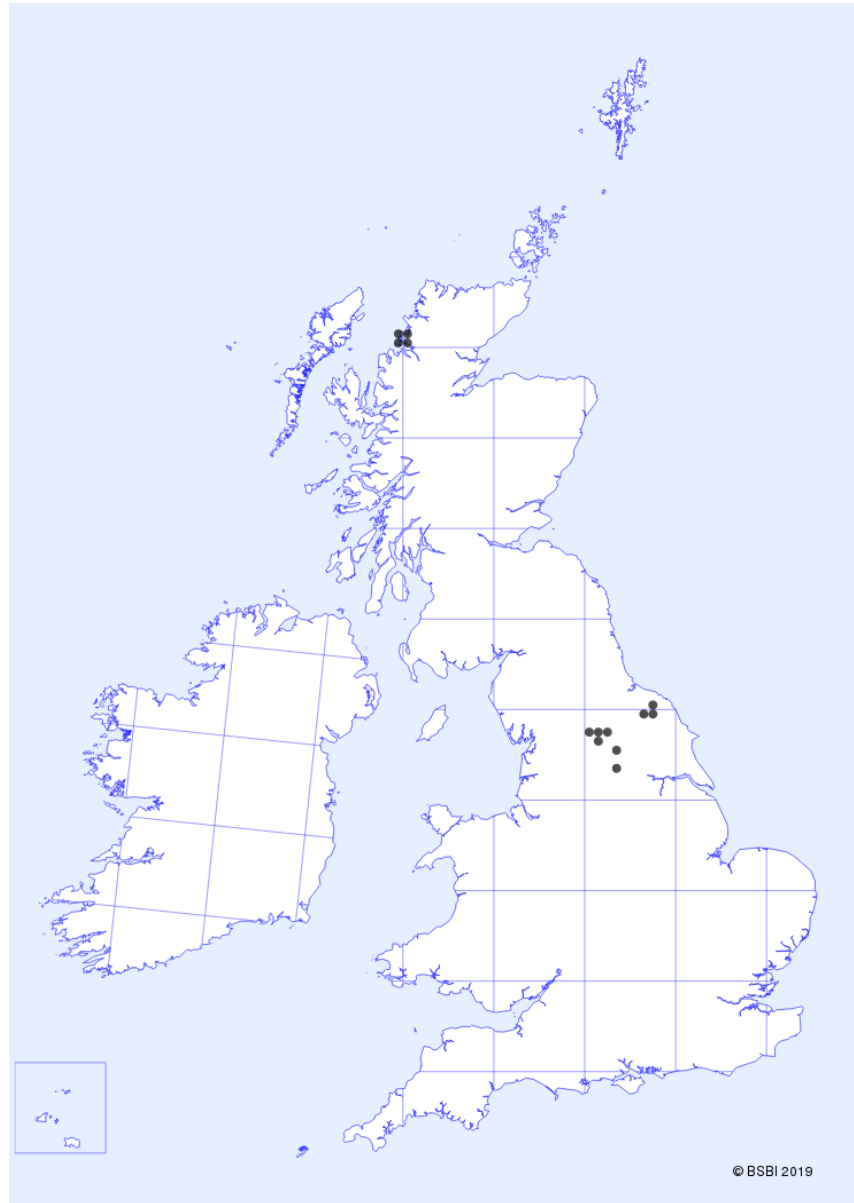


Figure 2. The known distribution of *Cotula alpina* in Britain and Ireland.

In Great Britain *C. alpina* has been recorded in nine 10 × 10 km grid squares (hectads) in England and four in Scotland (Fig. 2). As stated above it was first identified in Upper Nidderdale (v.c.64/65) in June 2009 (Robinson, 2009; Walker & Robinson, 2012) although earlier records for *C. coronopifolia* and *C. squalida* from the same area

almost certainly refer to it (Robinson, 2009). The earliest record so far traced is from 1975 on a 'metalled track' above Gouthwaite Reservoir incorrectly determined as *C. coronopifolia* (Walker, 1976) – this is likely to be the track above Dallowgill that supports one of the largest populations of *C. alpina* today. It was also mistakenly recorded as *C. coronopifolia* on a different track re-surfaced with limestone above Lofthouse in 1980 (Jowsey, 1980) and as *C. squalida* in two different locations on Dallow Moor in 1995 and 2005 (Phyl Abbott, pers. comm.).

Since its discovery in 2009 the authors have surveyed potential habitats for *C. alpina* on the eastern side of Upper Nidderdale and confirmed its presence in 38 monads, all on or near tracks crossing grouse moors between Pateley Bridge and Lofthouse (Fig.3). In these squares *C. alpina* occurs more or less continuously along ca 25 km of moorland tracks and roadsides, often dominating the grassy or heathy margins that are heavily grazed by sheep and rabbits. The altitudinal range of these populations is 230-430 m.

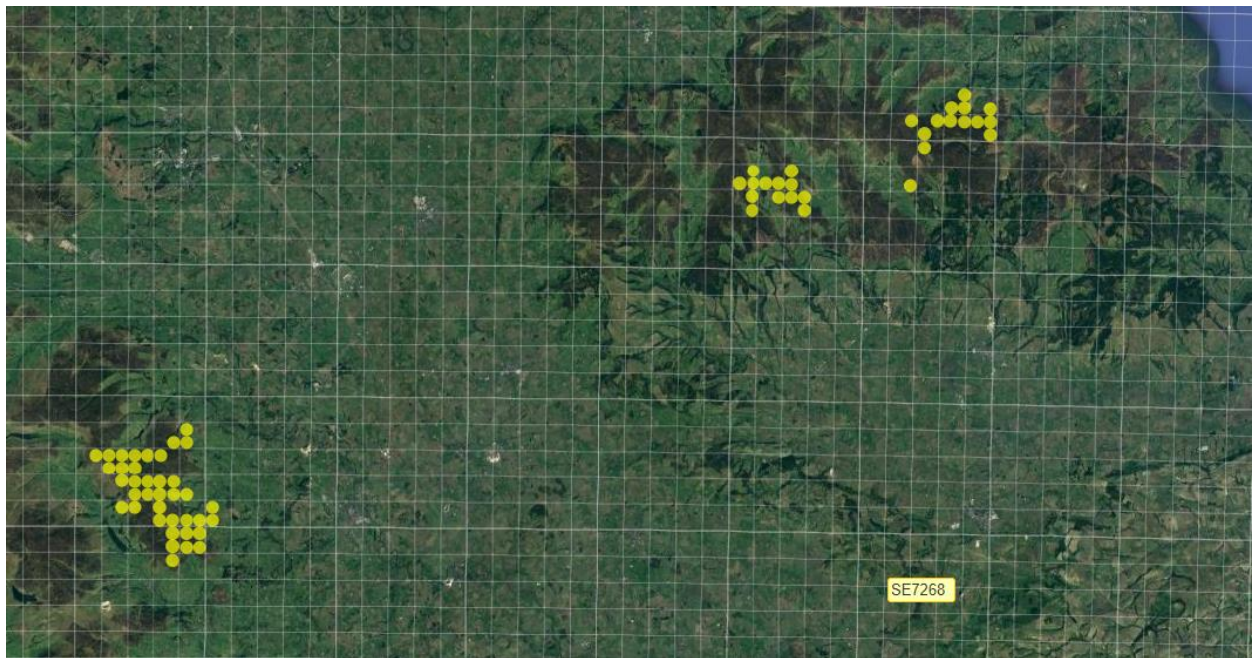


Figure 3. The distribution of *Cotula alpina* in Upper Nidderdale in the Yorkshire Dales (west) and on the North Yorkshire Moors (east). Yellow dots represent presence within 1 ×1 km grid squares.

In North-east Yorkshire (v.c.62) *C. alpina* was first discovered on Rudland Rigg in November 2006, growing along moorland tracks. As in Nidderdale, it was initially identified as *C. squalida* (Denney, 2007) and not confirmed as *C. alpina* until 2009 (Robinson, 2009). In 2010, further discoveries were made on moorland roadsides and tracks between Glaisdale and Rosedale (Vince Jones, pers. comm.). Subsequent surveys have shown it to be much more widespread with records from at least 27 monads with notable populations in Bransdale and on Rudland Rigg, Glaisdale Moor, Egton High Moor and Heygate Bank (Fig. 3). The altitudinal range of these populations is 240-370 m.

Elsewhere in Yorkshire *C. alpina* has been found naturalised in closely mown lawns in formal gardens and parkland in Roundhay Park, Leeds (Kevin Walker, pers. obs.) and in the lawn of a private garden nearby (Phyl Abbott, pers. comm.). It has also occurred on an urban roadside in central Harrogate where it did not persist (Kevin Walker, pers. obs.).

Remarkably *C. alpina* was first encountered in Scotland in August 2019 just two months after its original discovery in England [although an earlier specimen collected by Tim Rich from Old Dornie in 2005 has recently been confirmed as *C. alpina* (Donald, 2013)]. When originally discovered it was scattered along about a mile of a coastal roadside grassland near to Polbain on the Coigach Peninsula, Wester Ross (White, 2009), but subsequent surveys have shown it to be much more widespread with records from roadsides in around 25 monads (Donald, 2013; 2014), suggesting it may have been well-established for several decades (Fig. 4). The altitudinal range of these populations is from just above sea-level to 140 m on Meall an Fheadain.

There are no other confirmed records for Scotland although Kent (1972) listed *C. squalida* as naturalised in turf under bracken above a beach near Gairloch: this may have been *C. alpina* but it has not been re-found despite recent searches.



Figure 4. The known distribution of *Cotula alpina* on the Coigach Peninsula, Wester Ross. Yellow dots represent presence within 100 ×100 m grid squares.

Origin

How *Cotula alpina* came to be naturalised in the wild in Britain is not known. In England its association with moorland tracks has led to the suggestion that it may have been introduced in aggregates used in their construction or resurfacing, although how the

seed could have contaminated these aggregates in the first place is not clear, unless recycled rockery stone had been used. Possibly a more plausible explanation is that *C. alpina* escaped from a garden, as it has occasionally been grown in alpine rockeries in the past (David Pearman, pers comm.) [although it does not appear to be available for sale today]. For example, it is widely naturalised within lawns within a large formal garden (Coronation Gardens, now Tropical World) adjacent to Roundhay Park in Leeds. Alternatively, seed may have been introduced with wool imported from Australia, either as a raw material or by-products from its cleaning process ('shoddy') (Donald, 2014). In the past these waste products were used to improve rough pasture or arable soils prior to planting crops (Shimwell, 2006), and this seems a much more probable explanation in the croftland of Coigach where gardening has always been a relatively marginal pursuit. We can only speculate as to whether these introductions occurred independently in each region or whether seed was transported between them following an initial colonisation event. The latter would seem plausible in northern England where vehicles and possibly also livestock are moved between grouse moors in the Yorkshire Dales and the North York Moors on a regular basis.

Habitats

In Australia *Cotula alpina* is confined to short herb or bryophyte-rich communities with a range of moisture regimes in the subalpine and alpine zones. In the Australian Alps and adjacent ranges as far north as the Brindabella Range (Australian Capital Territory, Eastern Highlands of Victoria) it is locally common in subalpine herb-fields, and occasional in *Sphagnum* bogs, wet areas in tall alpine herb-fields and sod tussock grassland above the tree line (Burbridge & Gray, 1970; Walsh & Entwisle, 1999; Costin et al., 2000). In the Eastern and Central Highlands of Tasmania it is a local plant in montane habitats including bolster heath, heath, alpine sedgefields, short alpine herb-field and tussock grassland (Kirkpatrick, 1997). It also occurs in moist grassland at lower altitudes (Curtiss, 1963).

In northern England, the majority of *C. alpina* populations occur in acid grassland on or adjacent to gravelly tracks that provide vehicle access to driven grouse shooting infrastructure on heather moorlands (e.g. shooting butts, shooting lodges) (Robinson, 2009). More rarely it is found in 'lawns' around shooting lodges, on bare peat or mosses in road/trackside ditches or heather moorland recovering from burning (for red grouse) adjacent to tracks. *C. alpina* is most abundant in very short, relatively species-poor *Festuca ovina-Agrostis capillaris-Rumex acetosella* (U1) acid grassland which occurs as fragmentary stands in the middle of tracks and more extensively along the edges of tracks and roads and on adjacent moorland (Table 1a; Fig. 5). More locally it grows in *Festuca ovina-Agrostis capillaris-Thymus praecox* (CG10) calcareous grassland on the edge of tracks, possibly where soils are slightly more basic owing to re-surfacing of tracks with calcareous rocks (e.g. limestone chippings). On heavily disturbed tracks and severely burnt heather moorland it occurs within species-poor *Poa annua-Sagina procumbens* open vegetation (OV20).

Table 1. Vegetation and habitat characteristics of *Cotula alpina* in northern England. The figures are based the species composition of 34 0.25 m² quadrats recorded in three main habitats: 'Track' = moorland tracks, 'Grassland' = track and roadside grassland; and 'Heathland' = heathland regenerating after burning for red grouse.

	Track	Grassland	Heathland	All
<i>a) Vegetation types¹</i>				
U1 acid grassland	10	9	4	23
U5 acid grassland	1		1	2
H1 heathland			1	1
CG10 calcareous grassland	1	4		5
OV20 open vegetation	2		1	3
<i>b) Vegetation composition</i>				
% cover <i>Cotula alpina</i>	25 (4)	30 (5)	27 (7)	27 (3)
% cover bare ground	29 (7)	3 (1)	23 (8)	18 (4)
Species richness	11.3 (0.8)	11.6 (0.7)	10.6 (1.5)	11.3 (0.5)
Shannon diversity	1.5 (0.1)	1.4 (0.1)	1.2 (0.1)	1.4 (0.1)
<i>c) Habitat conditions²</i>				
Nitrogen (N)	3.7 (0.2)	3.3 (0.1)	3.1 (0.4)	3.5 (0.1)
Reaction (R)	4.4. (0.2)	4.3 (0.1)	3.5 (0.3)	4.2 (0.1)
Light (L)	6.8 (0.1)	6.7 (0.1)	6.8 (0.1)	6.7 (0.1)
Moisture (F)	5.2 (0.1)	5.2 (0.1)	5.8 (0.3)	5.4 (0.1)
Soil pH	6.6 (0.5)	7.3 (0.1)	5.5 (0.4)	6.7 (0.3)

Notes:

1 - 'Vegetation types' follow British Plant Community types (Rodwell, 1991-2008) and were assigned using Tablefit (Hill, 2015): U1 acid grassland = *Festuca ovina-Agrostis capillaris-Rumex acetosella* acid grassland; U5 = *Nardus stricta-Galium saxatile* acid grassland; H1 = *Calluna vulgaris-Festuca ovina* heathland; CG10 = *Festuca ovina-Agrostis capillaris-Thymus praecox* calcareous grassland; OV21 = *Poa annua-Sagina procumbens* open vegetation.

2 - The mean cover-weighted Ellenberg indicator values for soil moisture, fertility, reaction and light were calculated for each quadrat and then summarized for each habitat type. Ellenberg values were taken from Hill et al. (2004). Soil pH was measured on surface soil samples taken from 20 quadrat locations from Upper Nidderdale using a handheld temperature calibrated pH meter in a mixture of 1:1 soil and deionized water.

The number of species growing with *C. alpina* in these habitats was relatively low (11.3 ± 0.5 0.25 m²; inter-quartile range 9-13.3) with species diversity being highest on tracks and lowest on regenerating heathlands (Table 1b). The most frequently recorded associates across all habitats were (in descending order) *Agrostis capillaris*, *Festuca ovina* and *Prunella vulgaris*, whereas species with high constancy in specific habitats included *Plantago major* on tracks, *Calluna vulgaris* and *Sagina procumbens* in heathlands and *Taraxacum officinale* and *Trifolium repens* in grassland (Table 2).



Figure 5. Habitats of *Cotula alpina* in Britain: acid grassland bordering a track, Potts Moor, Nidderdale (top left); regenerating heather moorland near Ouster Bank, Nidderdale (top right); acid grassland bordering a moorland track, Rudland Rigg, North York Moors (bottom left); acid grassland on storm beach adjacent to the road between Achiltibuie and Polbain, Wester Ross (bottom right).

On tracks and in regenerating heathland *C. alpina* is usually associated with very open vegetation with lots of bare ground whereas in grasslands the turf was almost completely closed with less than 5% bare ground (Table 1b). In northern England *C. alpina* grows exclusively on shallow peats over acidic millstone grits and consequently the soils have low pH with heather moorland having the lowest pH (5.5) and trackside grassland the highest pH (7.3) presumably due to the influence of limestone chippings used for track construction or resurfacing (Table 1c). The associated species indicate that the soils are infertile and moist, as shown by the relatively low mean cover weighted Ellenberg N and F scores (Table 1c), although with heathland soils having the lowest and highest scores respectively reflecting the very low fertility and high water retention capacity of peaty soils. All the habitats have high mean cover weighted Ellenberg L scores, reflecting the very open nature of all three habitat types.

Table 2. The most frequent associates of *Cotula alpina* in Northern England. Values are constancy in 34 0.25m² quadrats: 1 = 1-20%; 2 = 21-40%; 3 = 41-60%; 4 = 61-80%; 5 = 81-100%.

Species	Track	Grassland	Heathland	All
<i>Agrostis capillaris</i>	5	5	4	5
<i>Festuca ovina</i>	4	5	3	4
<i>Prunella vulgaris</i>	4	4	3	4
<i>Plantago major</i>	5	2	2	3
<i>Calluna vulgaris</i>	3	2	5	3
<i>Sagina procumbens</i>	3	2	4	3
<i>Taraxacum officinale</i>	3	4	1	3
<i>Poa annua</i>	3	2	2	3
<i>Trifolium repens</i>	2	4	1	2

In Scotland, most populations occur close to sea-level in very short, sheep- and rabbit-grazed coastal grassland on roadside banks, storm beaches, and occasionally in damp coastal flushes. Unlike in Australia it shows a distinct preference for drier soils, often on sloping ground, where the turf is more open due to disturbance, soil depth and high grazing pressure, although in a few sites it grows in flushes where soils are permanently moist. Although we have no quadrat data for Scottish sites the photos included in Donald (2012, 2013) show *C. alpina* achieving its greatest abundance in *Agrostis-capillaris-Festuca ovina* acidic grassland with only a few plants having colonized the adjacent damp rush pasture.

Ecology

Cotula alpina is a low-growing rosette-forming herb that can spread vigorously by both rhizomes and short stolons which root at the nodes (Fig. 1). Although Australian floras describe it as an annual or short-lived perennial we suspect that most individuals in Britain behave as perennials given its abundance in closed grassland turf where it often forms extensive carpets at the expense of grassland dominants such as *Agrostis capillaris* and *Festuca ovina*. It appears to be intolerant of shade or competition from taller plants and is conspicuously absent from taller heather moorland, grassland and rush pasture adjacent to trackside populations. Although *C. alpina* shows a preference for free-draining soils in Britain it appears to be indifferent to soil moisture, occurring in wet flushes and on Sphagnum as well as drought-prone gravels on tracks.

C. alpina appears to reproduce prolifically in the British Isles with flowering noted in all months from May through to November. Each rosette produces at least one button-like compound inflorescence on a short, thick scape, which elongates when the plant is in fruit, thereby increasing the height from which seeds are released. The mode of reproduction is unknown but is likely to be at least partly autogamous given the very small, inconspicuous flowers with few rewards for pollinators. Wind pollination would also seem to be likely given the very close proximity of capitula in most populations (Fig. 1). Seed production appears to be high with virtually all capitula producing 30-40 ripe

achenes (see Fig. 1). The seeds are very light and compressed laterally which probably aids dispersal locally by wind. The almost continuous distribution along roads and tracks suggests that the seeds are also dispersed very effectively by adhesion to soil transported on the feet of livestock and humans or on vehicle tyres. Sheep and rabbits probably also disperse seeds in their coats and dung and occasionally it may have colonised new sites through the movement of soil/rubble. Its short lifespan and abundance in open habitats would suggest that it creates at least a short-term seedbank although further work is required to test whether this is in fact the case.

Impact & control

Cotula alpina is now fully naturalised in acid grasslands in northern England and northwest Scotland i.e. it has self-sustaining populations with individuals surviving and reproducing at a significant distance from the original point of introduction. It should therefore be categorized as D2 in Blackburn et al.'s (2011) categorisation of naturalisation states for non-native species.

Despite its small size *C. alpina* spreads vigorously to achieve high cover in short, heavily grazed turf to the detriment of community dominants as well as uncommon associates such as *Botrychium lunaria*, *Omalotheca sylvatica* and *Ophioglossum azoricum* (Donald, 2013). Owing to its long flowering period, copious seed production, dispersal ability and creeping habit it is also a very good pioneer of open ground and can thus spread rapidly into new habitats including recently made-up tracks, burnt heathland and disturbed ground. We would therefore expect it to spread into similar habitats in other 'upland' regions in the near future. Habitats where it is likely to have greatest impact are grazed, sandy, coastal grasslands and heathlands with many notable species associated with bare ground.

C. alpina is likely to be very difficult to eradicate or control easily given its local abundance and ability to regenerate rapidly from seed in heavily grazed or disturbed habitats. However, evidence from Scotland (Donald, 2014) suggests that removal of livestock and a resulting increase in sward height may restrict its spread and reduce its abundance in the longer term although such management is likely to be impractical in many upland areas where grazing is extensive (e.g. on grouse moors or in open crofting townships).

Conclusions

In Britain *Cotula alpina* appears to be a garden escape or wool-shoddy alien that has been naturalised in semi-natural habitats for at least 50 years. It is now present in around 90 monads in three areas where it appears to be spreading rapidly along moorland tracks and roadsides, as a result of seed dispersal by livestock, humans and vehicles. It is likely to spread into similar habitats in other regions where it has the capacity to exclude community dominants and possibly localized species of acid grassland. Our ability to control its spread is likely to be limited owing to its ability to regenerate rapidly in heavily grazed or disturbed habitats. Exclusion of grazing may however help to reduce its abundance in some areas where livestock grazing can be removed or its habitats enclosed.

Acknowledgments

We would like to thank Phyl Abbott for information on *Cotula alpina* in Yorkshire.

References

- Blackburn, T.M., Pyšek, P., Bacher, S., Carlton, J.T., Duncan, R.P., Jarošík, V., Wilson, J.R.U., & Richardson, D.M. 2012. A proposed unified framework for biological invasions. *Trends in Ecology and Evolution*, 26: 333-339.
- Burbridge, N. & Gray, M. 1970. *Flora of the Australian Capital Territory*. Canberra: Australian National University Press.
- Clement, E.J. & Foster, M.C. 1994. *Alien Plants of the British Isles*. London: Botanical Society of the British Isles.
- Costin, A.B., Gray, M., Totterdell, C.J. & Wimbush, D.J. 2000. *Kosciuszko Alpine Flora*, second edition. CSIRO.
- Curtiss, W.M. 1963. *The Students Flora of Tasmania. Part 2. Lathraceae to Epidicraceae*. Tasmania: L.G. Shea, Government Printer.
- Denny, J. 2007. New Zealand daisy found on Rudland Rigg. *Ryedale Natural History Society Annual Report for 2006* (http://www.ryenats.org.uk/rept06_7/report07.htm).
- Donald, D. 2013. Alpine Cotula project, phase 1. Unpublished report. [online] 25 (February 2020) <https://bsbi.org/wester-ross-vc105> [accessed 25 February 2020]. Available at: <<https://bsbi.org/download/18698/>>
- Donald, D. 2014. Alpine Cotula eradication project. Progress report 1, May 2014. Unpublished report [online] 25 (February 2020) <https://bsbi.org/wester-ross-vc105> [accessed 25 February 2020]. Available at: <<https://bsbi.org/download/18701/>>
- Hill, M.O. 2015. *TABLEFIT version 2.0 for the identification of vegetation types*. Wallingford: Centre for Ecology and Hydrology.
- Hill, M.O., Preston, C.D. & Roy, D.B. 2004. *PLANTATT. Attributes of British and Irish Plants: Status, Size, Life History, Geography and Habitats*. Monks Wood: Centre for Ecology and Hydrology.
- Himmelreich, S., Breitwieser, I & Oberprieler, C. 2012. Phylogeny, biogeography, and evolution of sex expression in the southern hemisphere genus *Leptinella* (Compositae, Anthemideae). *Molecular Phylogenetics and Evolution*, 65: 464-481.
- Hooker, J.D. 1847. *Flora Tasmaniae Spicilegium; or Contributions Towards a Flora of Van Diemen's Land. London Journal of Botany*, 6: 106-125.
- Hooker, J.D. 1855-1857 [1860]. *The botany of the Antarctic voyage of H.M. discovery ships Erebus and Terror. III. Flora Tasmaniae* 1(3), 192, t. 51 A. [comb. nov.]
- Kent, D.H. 1972. Observations in West Ross (v.c. 105). *Transactions of the Botanical Society of Edinburgh*, 43: 547.
- Kirkpatrick, J. 1997. *Alpine Tasmania. An illustrated guide to the flora and vegetation*. Oxford: Oxford University Press.
- Jowsey, W.H. 1980. Botanical section. *Harrogate and District Naturalists' Society Report for 1980*, 16-17.

- Lloyd, D.G. & Webb, C.J. 1987. The reinstatement of *Leptinella* at generic rank, and the status of the 'Cotuleae' (Asteraceae, Anthemideae). *New Zealand Journal of Botany*, 25: 99-105.
- Pope, C. & Stanley, P. 2018. Caravan touring sites – an overlooked habitat for introduced species. *BSBI News*, 139: 53-55.
- Preston, C.D., Pearman, D.A. & Dines, T.D. comps. & eds. 2002. *New Atlas of the British and Irish flora*. Oxford: Oxford University Press.
- Robinson, L. 2009. *Cotula alpina* (Hook. f.) Hook. f. (Alpine Cotula) in North-west Yorkshire (v.c.65), Mid-west Yorkshire (v.c.64) and North-East Yorkshire (v.c.62), new to Britain and Europe. *BSBI News*, 113: 52-54.
- Rodwell, J.S. 1991-2008. *British Plant Communities. Volumes 1-5*. Cambridge: Cambridge University Press.
- Shimwell, D.W. 2006. A Shoddy Tale: perspectives on the wool alien flora of West Yorkshire in the twenty-first century. *Watsonia*, 26: 127–137.
- Stace, C.A. 1997. *New Flora of the British Isles*, second edition. Cambridge: Cambridge University Press.
- Stace, C.A. 2019. *New Flora of the British Isles*, 4th ed. Suffolk: C. & M. Floristics.
- Stace, C.A. & Crawley, M.J. 2015. *Alien plants*. London: William Collins.
- Thompson, I.R. 2007. A taxonomic treatment of tribe Anthemideae (Asteraceae) in Australia. *Muelleria*, 25: 51.
- Walker, D.R. 1976. Botanical section. *Harrogate and District Naturalists' Society Report for 1975*: 9-10.
- Walker, K.J. & Robinson, L. 2012. Alpine Cotula (*Cotula alpina*) in Upper Nidderdale: new to Britain and Europe. *Harrogate and District Naturalists' Society Report for 2012*: 16-18.
- Walsh, N.G. & Entwisle, T.J. 1999. *Flora of Victoria. Volume 4. Dicotyledonous Cornaceae to Asteraceae*. Melbourne: Inkata Press.
- White, A. 2009. First known record of *Cotula alpina* in Scotland. *BSBI News*, 113: 54-55.
- Wilmore, G.T.D. 2000. *Alien Plants of Yorkshire*. Leeds: Yorkshire Naturalists Union.

Copyright retained by author(s). Published by BSBI under the terms of the [Creative Commons Attribution 4.0 International Public License](https://creativecommons.org/licenses/by/4.0/).

ISSN: 2632-4970

<https://doi.org/10.33928/bib.2020.02.043>