

Geographical and temporal distributions of *Alyssum alyssoides* and *Berteroa incana* (Brassicaceae) in the British Isles and the relationship to their modes of introduction

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ABSTRACT

Alyssum alyssoides and *Berteroa incana* are closely related crucifers which have been introduced to the British Isles, and whose distributions can be explained in terms of their modes of introduction. Both species have been recorded predominately in lowland England, but are also scattered in Scotland, Wales and Ireland. *A. alyssoides* is strongly associated with fields, especially clover fields, and to a lesser extent with railways. *B. incana* is less commonly recorded from fields (but where it does occur it too is mostly in clover fields), and is also associated with roads and railways, waste ground and docks. *A. alyssoides* began to be frequently recorded from the 1830s onwards, peaking about the turn of the century, and then declining to a general low level with very few recent records. *B. incana* began to be frequently recorded from the 1860s onwards, peaking before the First World War and declining thereafter and has since occurred at a relatively low but stable frequency. The increase in both species was probably associated with seed imports following the introduction of the crop rotation system of farming, and their declines are probably associated with introduction of quality control and regulation of agricultural seed sales. Neither species is particularly persistent in Britain, possibly due to sub-optimal climate and/or habitats.

KEYWORDS: Cruciferae, Hoary Alison, introduced species, Small Alison, weed.

INTRODUCTION

Alyssum alyssoides (L.) L. (*A. calycinum* L.), Small Alison, and *Berteroa incana* (L.) DC. (*Alyssum incanum* L.), Hoary Alison, are closely related crucifers which have been introduced to the British Isles (Dunn 1905; Rich 1991). When *Crucifers of Great Britain and Ireland* (Rich 1991) was prepared, T.C.G.R. was aware that the occurrence of these two species in the British Isles was relatively poorly researched. There are also many historical records in herbaria and the literature which have not been included in the most recent maps in Preston *et al.* (2002). As there are some striking similarities in the patterns of occurrence of both species, we have investigated the records available, and tried to place both species in the context of their native European ranges and relate their patterns of occurrence in Britain to their origin and modes of introduction.

Alyssum alyssoides (hereafter *Alyssum* unless otherwise stated) was first recorded in the British Isles in 1817 at Port Marnock, v.c. H21 Dublin (TCD; Moore & More 1866), and first recorded for Britain in 1829 near Arbroath, v.c. 90 Forfar (E). Rich (1991) described it as a casual of fields and arable land, waste ground, docks and tracks, and noted that it was rarely persistent except sometimes on sandy ground. It was often introduced with foreign seed, and sometimes as a wool alien (Remington 1928; Clement & Forster 1994). It is a winter annual, germinating in the autumn, over-wintering as rosettes, and coming into flower early the next summer (Baskin & Baskin 1972). It is probably native throughout much of Europe but is introduced in the north (Jalas *et al.* 1996). It also occurs as a native eastwards to Afghanistan and the Near East and North Africa, and has been widely introduced elsewhere in the world.

Berteroa incana (hereafter *Berteroa* unless otherwise stated) was first recorded in Britain in 1766 at Weymouth, v.c. 9 Dorset (Good 1948) and was later also reported in Ireland from Port Marnock in 1869 (More 1872). Rich (1991) noted it was a casual of waste ground, arable fields, clover and recently sown grass, docks, rubbish heaps, etc., and was sometimes persistent on sandy ground. Like *Alyssum*, it was often introduced with foreign seed, and may have also been introduced associated with different modes of transportation such as canals, railways, etc. (Dunn 1905; Remington 1928; Clement & Foster 1994). It is often reported as a biennial though experimental evidence shows that it can be both a summer annual and a biennial (Reichman 1988). Biennial plants over-winter as rosettes and then produce stems the following spring which flower from June onwards. Annual plants germinating in the spring or early summer produce weak rosettes which may develop stems and flower rapidly. It is morphologically variable across its range, and the variation observed in British material may reflect multiple introductions. It is native from central to eastern Europe to East Asia (Jalas *et al.* 1996), and has been widely introduced in western and northern Europe and North America.

METHODS

Records were abstracted systematically from the literature, herbaria (**BEL, BIRA, BRISTM, BM, CGE, E, GLAM, K, LTR, NMW, OXF, RNG** and **TCD**, with a few extra records from **ABRN, GTM, HAMU, HDD, HIWNT, HWB, IPS, LCN, LEI, LES** and **LTR**; herbarium abbreviations following Kent & Allen 1984) and the Biological Records Centre (B.R.C.).

T. C. G. Rich determined most, but not all, the herbarium records. Although a number of species of *Alyssum* have been recorded in the British Isles (Clement & Foster 1996), most are distinctive and are unlikely to be confused with *A. alyssoides*, though a few examples were found (a record from Newbury, v.c. 22 Berkshire in 1895 which was actually *A. montanum* L.; **BM**). *Berteroa incana* is also a distinctive species and all herbaria specimens were correctly identified with the exception of a specimen from Nunney, v.c. 6 Somerset in 1913, G. B. Milne-Redhead, which was actually *B. mutabilis* (**OXF**). Literature records have generally been accepted at face value for both species.

The records were compiled on standard individual record cards ('pink cards') and collated in a spreadsheet (493 records of *Alyssum*, 448 of *Berteroa*). 10 × 10 km square grid references were allocated using the Ordnance Survey gazetteer. Copies of the records have been deposited at the BRC.

A reductionist approach was used to analyse the records. Duplicate records were eliminated, and apparent duplicates, which varied in the completeness of the records, were assumed to be the same unless there was obvious reason to maintain them as separate records. A number of BRC records consisting of a 10-km square and no date or with summary date class (e.g. 1950+) were not included (hence the omission of some records plotted in Preston *et al.* 2002). Literature records were correlated against herbarium records wherever possible. Records cited for localities with the same name are assumed to be from the same site.

RESULTS

National distribution maps for the species are shown in Figures 1 and 2, distinguishing pre- and post-1950 records. The maps show that both species have been predominantly recorded in lowland England, but are also scattered more rarely in lowland Scotland, Wales and Ireland. *Alyssum* is generally widespread, with no particular concentrations of records other than in parts of south-east England. *Berteroa* is probably less frequent over all, but has a very strong concentration of records in Surrey and London. The post-1950 records for *Alyssum* are scattered in eastern and northern England (Fig. 1). The post-1950 records for *Berteroa* are scattered throughout its wider distribution with a particular concentration in south-east England and East Anglia (Fig. 2).

The numbers of records for the different habitats in which they have been recorded are shown in Figure 3. 64% of the records for *Alyssum* were from fields, and of those which had the type of field stated, 63% were from clover fields, reflecting the areas where short term rotation crops were

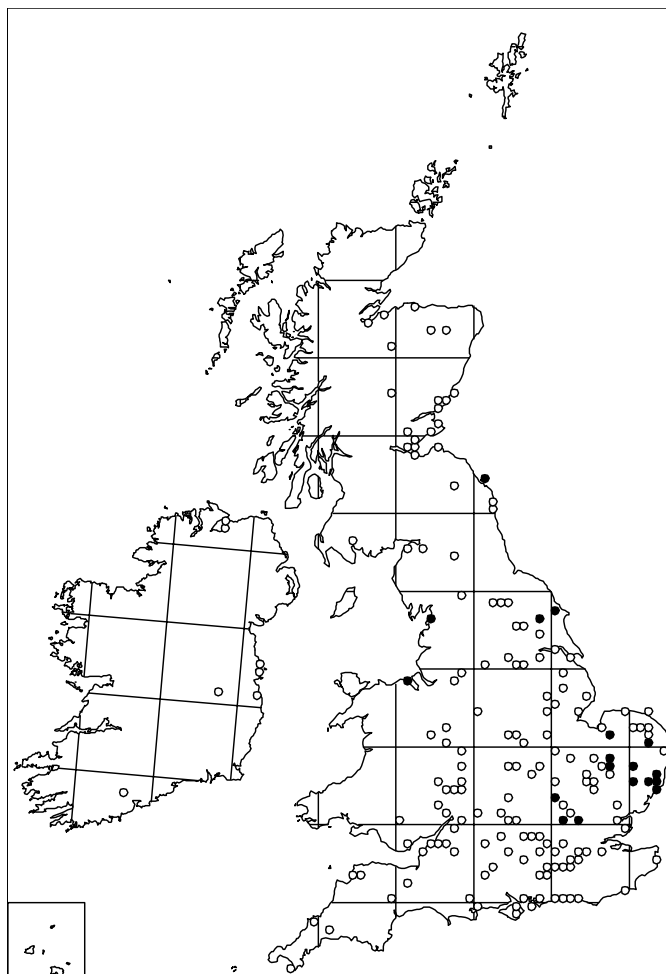


FIGURE 1. Distribution map of *Alyssum alyssoides*. ○, pre-1950. ●, 1950 onwards. Undated records are not included.

grown. 11% of the records were associated with railways. In contrast only 28% of the records of *Berteroa* were from fields, 72% of which were stated to be from clover fields, and these also occurred in areas where short term rotation crops were grown. 8% of its records were associated with railways, but these are mostly from SE England. *Berteroa* is also frequently recorded on waste ground and docks (17% and 16% of records respectively), the latter resulting from where imported seed was stored and sorted before being shipped to agricultural areas. The differences in frequencies in different habitats may be partly related to their different life cycles, the annual *Alyssum* perhaps being more favoured under short-term cultivation than the annual to biennial *Berteroa*, which probably prefers open but less frequently disturbed habitats.

As virtually all records are based on flowering and/or fruiting material, the main reproductive seasons for each species were investigated to see how they relate to the native range. *Alyssum* was mainly recorded in May to July, as expected for a winter annual, and *Berteroa* was mainly recorded from July to September, as expected from its known flowering/fruiting period in Europe. Both species thus behave in the same manner in Britain as they do in Europe; this contrasts with some other annuals at the edge of their range such as *Filago gallica* which behaves as a winter annual in Europe and a summer annual in Britain (Rich *et al.* 1999).

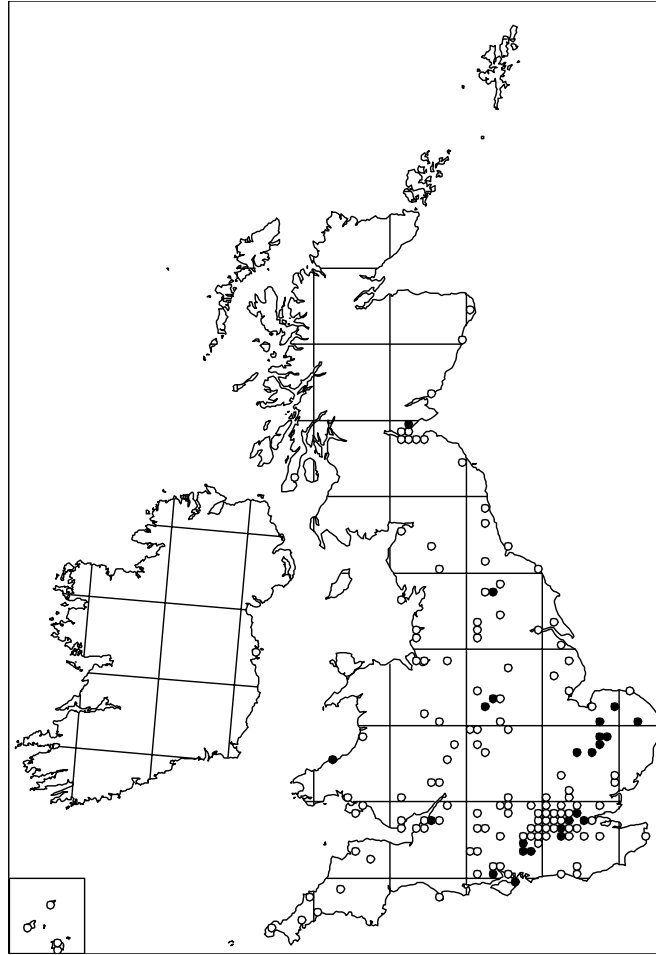


FIGURE 2. Distribution map of *Berteroa incana*. ○, pre-1950. ●, 1950 onwards. Undated records are not included.

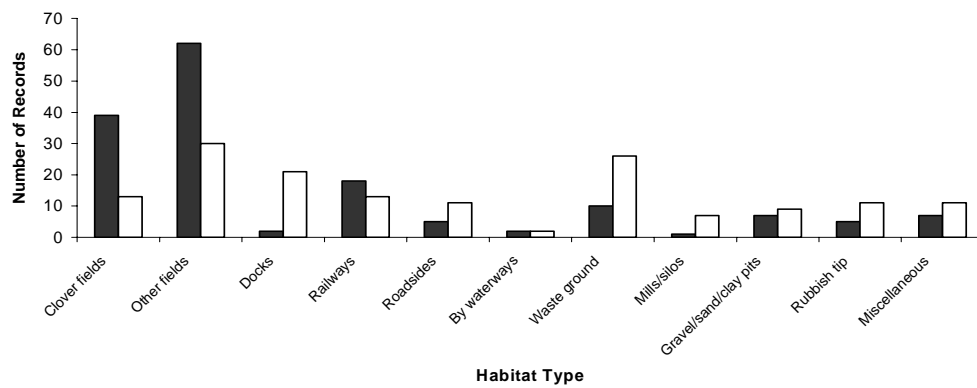


FIGURE 3. Number of records for each habitat for *Alyssum alyssoides* (■; n=158) and *Berteroa incana* (□; n=154). Repeat records for the same sites are not included.

The numbers of records for each species for each year are shown in Figures 4 and 5 with a smoothed 10 year running average. The number of records for both species varies markedly from year to year, probably due to random recording variation. The running averages smooth some of the variation in recording, and are used here to interpret the temporal changes. *Alyssum* was only rarely recorded until the 1830s and thereafter increased, peaking about the turn of the century, and then declining to a general low level with a brief resurgence after the Second World War. It then declined further with very few records; the rise in the 1990s is due to intensive recording of the last two remaining sites. *Berteroa* shows a different pattern, only really becoming established in the 1860s, and peaking before the First World War. Immediately thereafter it declined rapidly until a brief resurgence in the 1920s–1930s. It has occurred at a relatively low but stable frequency since.

An indication of how persistent each species has been at each site was assessed from the time between the first and last records. In many cases the records are solitary, and it is impossible to know if the plants were casual for one year only, or were persistent but unrecorded both before and

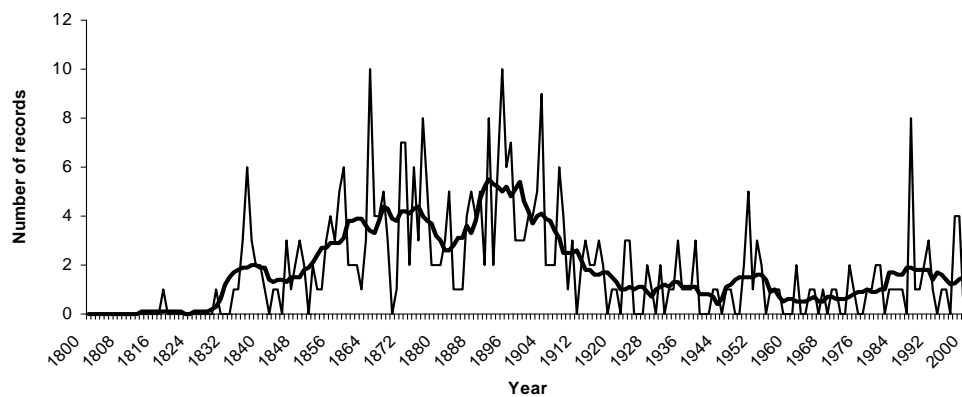


FIGURE 4. The number of records/year of *Alyssum alyssoides* 1800–2000 showing both the actual number of records (thin line) and the 10 year running average (thick line).

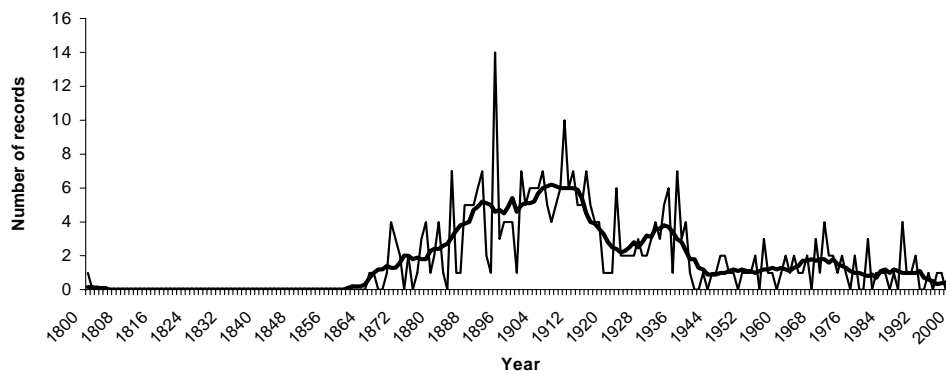


FIGURE 5. The number of records/year of *Berteroa incana* 1800–2000, showing both the actual number of records (thin line) and the 10 year running average (thick line).

after the record. Similarly, either species could have been repeatedly reintroduced at some sites (e.g. docks). The vast majority of records of both species are for one year only (85% for *Alyssum* and 83% for *Berteroa*). They persisted for more than 10 years at 5.8% of the sites for *Alyssum* and 8% for *Berteroa*. There was a slight tendency for *Berteroa* to be more persistent in the London area, which has the warmest summer climate in Britain and may be the most suitable for its growth.

DISCUSSION

The distribution of both species in space and time can be largely explained in terms of introduction with foreign agricultural seed, though they both have also been introduced by other mechanisms too.

The introduction of seed may have begun in association with import of foreign seed required for the crop rotation system of roots - corn - seeds/rotation grass - corn in the 19th Century, which was widely established throughout lowland Britain and at its peak by the 1870s (Stoate 1995). *Alyssum* and *Berteroa* are both noted as occurring in fields, pastures and fallows in eastern Europe (Komarov 1970; Hegi 1986), and we assume both species occurred as weeds in the parent agricultural seed crops of grass and clover, and were harvested and re-sown with them in Britain, resulting in the observed association of records with sown grass and clover crops. Agricultural statistics given by Rothero (1917) between 1871 and 1911, the time of peak occurrence of both species, show that approximately 10% of the cultivated land in England and Wales had 'clovers, sainfoin and artificial and other grasses under rotation'. The records have no information on which grass crops they occurred in (though *Lolium perenne* was the species usually sown with clovers), and only one record of *Alyssum* states it was associated with Dutch clover, a cultivated form of *Trifolium repens* L.. *Trifolium pratense* L. was widely cultivated from the 18th Century onwards, with much seed imported from southern and eastern Europe and North America (Salisbury 1961; Syme 1902). *T. repens* was widely cultivated by 1777, with seed imported from many countries including Holland, Denmark, Germany, Czech Republic, Slovakia, Poland, Russia, North America and New Zealand (Erith 1924). *T. incarnatum* L. seed was imported from eastern Europe from the 1840s (Syme 1902, Dunn 1905, Salmon 1931, Druce 1932); as the records for *Alyssum* begin to increase markedly about this time it may have been especially associated with it.

The decrease in frequency of *Alyssum* and *Berteroa* in the British Isles must be largely due to cleaner agricultural seed imports which lack their seeds as contaminants. Up until development controls were implemented in the 19th Century in Europe clean seed was exceptional, the percentage germination (excepting a number of species including clovers) was poor, and mis-naming of species was widespread (C. P. Jacobsen, cited in Remington 1928). Testing seeds for germination quality was first begun in 1869 in Denmark, and was fairly soon widely established in Europe. In Britain a Commission was appointed by the Board of Agriculture to inquire into the sale of agricultural seed in 1900, and the first Government seed testing station was established in 1920 in Cambridge (Remington 1928). The sale of agricultural seeds was first regulated by the Seeds Act, 1920 and by the Seeds Regulations, 1922. These required any seed merchant to declare certain particulars as to the quality of the seeds when selling or offering seeds for sale, such as the percentage purity, percentage germination, presence of injurious weeds, etc. The marked declines in both species is probably due to implementation of this and foreign legislation, as a drop in the number of records for *Berteroa* is especially noticeable in the 1920s, though the decline in *Alyssum* occurred somewhat earlier. Remington (1928) listed the principal weed seeds found in samples of clover and grass seed, and noted that *Alyssum* was very common in seed of European white clover and was also frequently found in other clovers and grass from the same source, and that *Berteroa* was common in clovers and small grass seeds from east Central Europe. By the 1950s, Lousley (1953) noted that imported seed for cultivation contained far fewer aliens than formerly, which he attributed to improved seed cleaning methods and the vigilance of the seed testing stations. Further reasons for the decline before the Second World War were the more widespread use of artificial fertilisers, resulting in the lack of need for rotation, and the import of cheap American wheat with the consequential increase in dairy farming and decrease in cereals and the need for rotation (Stoate 1995).

The habitats of *Alyssum* in the British Isles contrast strongly with its natural habitats in Europe. In central Europe, it is described as a calcicolous therophyte of nutrient-deficient, dry soils mostly on chalk and limestone in fully sunlit situations (Hegi 1986; Ellenberg 1988). It is a characteristic species of the *Alyssum-Sedum albi* warmth-loving calcareous rock community with species such as *Cerastium brachypetalum* Pers., *Minuartia hybrida* (Vill.) Schischk., *Thlaspi perfoliatum* L., *Veronica praecox* All. and *Trifolium scabrum* L.. This type of community is often found on shallow ledges and rocks, and probably indicates its natural habitat.

In the British Isles, *Alyssum* is mainly an arable weed or casual of railway lines, waste ground etc. and does not seem to have colonised equivalent natural habitat. It occurs on a range of soil types, especially sandy soils, and the records show no particular relationship to calcareous soils. It does not seem to have established itself in any quantity in Britain, with a few local exceptions, despite widespread and repeated re-introductions. Dunn (1905) did not regard it as a wild or even naturalised species, though he noted it was capable of producing lots of seed in a remarkably short period of time in light sandy soils, which gave it a degree of permanence in some cultivated areas. It is possible that both the habitats that it has occurred in here and the British climate are sub-optimal for its long-term survival. In contrast, Baskin & Baskin (1972) noted *Alyssum* was naturalised in North America on shallow soil on limestone outcrops, a very similar situation to its natural habitat in Eurasia.

In central Europe, *Berteroa incana* is also characterised as a therophyte of dry soils and fully sunlit situations; it has a broad soil pH tolerance though it prefers lime-poor, light sandy and gravelly substrates (Hegi 1986; Ellenberg 1988). Hegi (1986) and Ellenberg (1988) differ in their assessment of its nitrogen requirements, the former suggesting it occurs preferentially on nutrient-rich and nitrogen-rich soils, the latter in average to deficient nutrient conditions. It is difficult to know what its original natural habitat would have been in eastern Europe, but it may possibly have been open sandy steppes. In Britain, its habitats tend to be similar to those from which it is currently reported in Europe (Hegi 1986). In Europe it is the character species of the *Berteroetum incanae* ruderal community of roadsides and embankments etc., of which Mucina & Brandes (1985) describe two geographical variants. Indeed, in sites in Suffolk and Middlesex where it is well established, the vegetation types it occurs in are very similar to those reported by Mucina & Brandes (1985) (pers. obs. T. Rich).

Berteroa has established itself to a greater extent than *Alyssum*, and is currently more widely found. Dunn (1905) noted it had a tendency to establish itself along railways and roads, and he assumed 'traffic' was the cause of its introduction and its means of dispersal and permanence in Britain. However, in the light of evidence from seed testing (Remington 1928) it is more likely that its seeds were introduced in foreign grain, and that railways and roadsides simply offered suitable habitats in which it could establish itself. Although its British habitats are similar to those in Europe, the British climate, as with *Alyssum*, may be sub-optimal for its long-term survival.

In Britain, the strong decline of *Alyssum* indicated by the map in the *Atlas of the British flora* (Perring & Walters 1962) prompted it to be included in the British Red Data Book (Perring & Farrell 1977). It was subsequently given full statutory protection on Schedule 8 of the Wildlife and Countryside Act, 1981. It has now been excluded from the third edition of the Red Data Book (Wigginton 1999) but is still listed on Schedule 8 of the Wildlife and Countryside Act 1981, from which we strongly suggest it should now be removed. However, given its historical occurrence in Britain, there is no reason why populations should not be locally conserved as part of our cultural heritage.

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