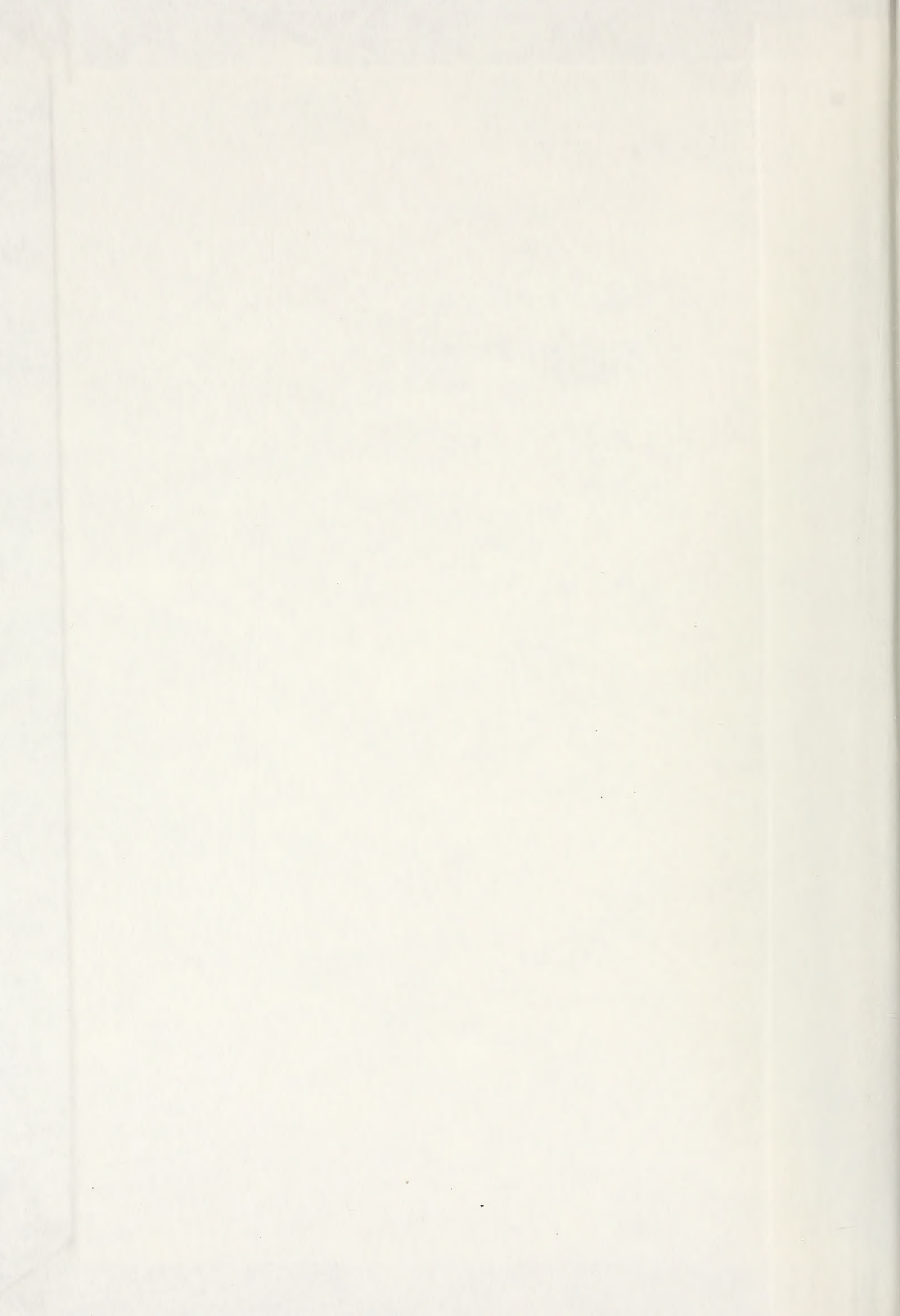




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The cover illustration of *Potentilla anglica* Laich. (Trailing Tormentil) was drawn by Rosemary Wise.

Sorbus whiteana (Rosaceae), a new endemic tree from Britain

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ABSTRACT

Sorbus whiteana T. C. G. Rich & L. Houston, a new endemic tree from the Avon Gorge and Wye Valley, is described. It is distinguished from other members of the *S. aria* (L.) Crantz group in Britain by the obovate, unlobed leaves which are greenish underneath, and the fruits being longer than wide. It is triploid. About 76 plants are known in four populations and a plant from another locality require confirmation. The complex history of its discovery is set out; it has been confused with *S. wilmottiana* E. F. Warb. and *S. hungarica* (Bornm.) Hedl. ex C. E. Salmon.

KEYWORDS: Avon Gorge, Bristol, *Sorbus aria* group, Whitebeam.

INTRODUCTION

The Avon Gorge in Bristol is home to at least nine native and four introduced taxa of *Sorbus*, Whitebeams, and is the richest and most important *Sorbus* site in Britain. Of the rarer species, *S. bristoliensis* Wilm. and *S. wilmottiana* E. F. Warb. are endemic to the Avon Gorge, *S. eminens* E. F. Warb. and *S. porrigentiformis* E. F. Warb. are endemic to England and Wales, and *S. anglica* Hedl. is endemic to Britain and Ireland. The commoner native species in the Avon Gorge are *S. aria* (L.) Crantz *sensu stricto*, *S. aucuparia* L. and *S. terminalis* (L.) Crantz, and the introduced species are *S. croceocarpa* P. D. Sell, *S. decipiens* (Bechst.) Irmisch, *S. intermedia* (Ehrh.) Pers. and *S. latifolia* (Lam.) Pers.

In this paper we describe a ninth native *Sorbus* from the Avon Gorge (the fifth species there that is endemic to Britain). It is a member

of the *S. aria* group, of which four other members also occur in the Avon Gorge (*S. aria sensu stricto*, *S. eminens*, *S. porrigentiformis* and *S. wilmottiana*). It has been known from the Avon Gorge for some time but not differentiated; it has also recently been found in the Wye Valley.

METHODS

Broad leaves from the short vegetative shoots, excluding the oldest and youngest leaf (Aas *et al.* 1994) were measured on herbarium material in NMW. Fruits were measured on fresh material, and the colours matched against the Royal Horticultural Society colour charts (Royal Horticultural Society 1966).

Potential pollen viability was investigated using Alexander's Stain (Alexander 1969) on the three flowering collections available. Anthers were removed from herbarium specimens with tweezers under a low-power binocular microscope, and placed on a slide with a drop of Alexander's Stain, warmed briefly on the hotplate, then broken up with the tweezers. The preparation was then covered with a coverslip and replaced on the hotplate to improve the uptake of the stain. The slides were then examined under a high-power compound microscope for areas of dense pollen grains. Potentially viable grains were counted as those which were large and rounded-triangular with cell walls which stained green and with cytoplasm inside which stained uniformly bright red. Small deformed grains or those staining green only with very little or no red staining inside (i.e. no cytoplasm) were considered infertile.

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Chromosome numbers were determined using standard methods. Tips of actively growing roots were collected mid-morning and pre-treated in 8-hydroxyquinoline solution for 20–24 hours at 4°C. They were then fixed in a 3:1 mixture of absolute ethanol: glacial acetic acid and stored at 4°C until needed. Root tips were then hydrolysed in concentrated 5N HCl for 10 minutes at room temperature, then stored in 70% industrial methylated spirits. Meristems were dissected out in 45% acetic acid, and squashed between a microscope slide and coverslip in 0.1% aceto-orcein stain with brief flame treatment.

The distribution was assessed from herbaria (BIRM, BM, BRISTM, CGE, K, NMW, OXF and UPS; abbreviations following Kent & Allen 1984), and from extensive *Sorbus* field work in South-west England and South Wales between 1996 and 2005.

RESULTS

A small amount of morphological variation was found within and between populations. Some plants from the Avon Gorge have relatively large leaves, and the plant from Lady Park Wood had relatively more veins. Typical leaves from the short shoots are illustrated in Figure 1.

Potential pollen fertilities were found of 43% for one plant on the top northern edge of Great Quarry, Clifton Down (voucher NMW.V.2002.17.189), 68% for another plant in woodland nearby (NMW.V.2004.3.109), and 62% for a plant from the Great Quarry (NMW.V.2003.1.154, = Lemche's *aria*33), giving an overall mean of 58%. A few giant pollen grains (cf. Liljefors 1955) were noted in the latter collection.

Chromosome counts of $2n = 51$ (triploid) have been obtained for a single plant grown from seed collected from the holotype tree in Quarry 3 in the Avon Gorge, and from Ban-ygor cliffs (voucher NMW.V.2002.17.103) (J. Bailey, pers. comm. 2004). The potential pollen fertility is perhaps higher than might be expected for a triploid.

Sorbus whiteana T. C. G. Rich & L. Houston, sp. nov.

HOLOTYPE: Near top centre of Quarry 3, Leigh Woods, Avon Gorge, Bristol, v.c. 6 North Somerset, 21 August 2002, T. C. G. Rich & L. Houston (NMW, accession number V.2002.17.50). **ISOTYPE:** BM.

Vernacular name: White's Whitebeam.

Frutex vel arbor parva ad 10 m ut minimum. Petioli 9–20 mm. Folia lata brachyblastorum (8.5–)9.3–13.6(–14.8) × (5.0–)5.6–8.7(–9.6) cm, (1.3–)1.4–1.9(–2.0) plo longiora quam latiora, obovata vel obtrullata, ad longitudinis suae (53–)55–65(–69) partes centensimas latissima, apice acuto vel obtuso, basi cuneata, plerumque non lobata vel interdum (praecipue in umbra) leniter lobata, marginibus uniserratis vel leniter biserratis, dentes prope apicem extra sed in parte inferiore magis prorsum projectos ferentibus, sed c. 1 cm infimo prope petiolum fere integro; pagina superior glabrescens viridis, pagina inferior cinereo-viridis tomentosa, venarum paribus (7.5–)8.5–11.5(–12.5) ad angulum (24–)26–35(–37)° a costa tentis. Inflorescentia aggregata, tholiformis, ramulis viridialbis tomentosis instructa. Flores ad 17 mm lati. Sepala anguste triangularia, patentia, tomentosa sed ad apicem viridia, eglandulata. Petala (6–)7–10 × 5–7 mm, circularia vel late elliptica ungue brevi, alba, cupulata, pilis effusis ad basin vestita. Stamina c. 20, antheris luteis e roseo suffusis. Styli 2, virides, usque ad basin discreti, basi pilosi. Fructus maximi (9.5–)10–13.5(–14) × (9–)10–13(–14) mm, (0.85–)0.9–1.1(–1.2) plo longiores quam latiores, plerumque aspectu longiore quam latiore, interdum globosi, in medio latissimi, lenticellis sparsis vel satis frequentibus parvis vel mediocribus super superficiem dispersis, interdum ad basin aliquot pluribus, in maturitate rubri.

Shrub or small tree to at least 10 m. Petioles 9–20 mm. Broad leaves of short shoots (8.5–)9.3–13.6(–14.8) × (5.0–)5.6–8.7(–9.6) cm, (1.3–)1.4–1.9(–2.0) times as long as wide, obovate to obtrullate, widest at (53–)55–65(–69)% along leaf length, with apex acute to obtuse and base cuneate, usually unlobed or sometimes (especially in shade) weakly lobed, with margins uniserrate to weakly biserrate, with teeth at the top directed outwards, those below directed more forwards, but with lowest c. 1 cm near petiole nearly entire; upper surface glabrescent, green, lower surface greyish-green tomentose, with (7.5–)8.5–11.5(–12.5) pairs of veins held at an angle of (24–)26–35(–37)° to midrib. Inflorescence crowded, domed, with branchlets greenish-white tomentose. Flowers up to 17 mm across. Sepals narrowly triangular, spreading, tomentose but green at tip, eglandular. Petals (6–)7–10 × 5–7 mm, circular to broadly elliptic with a short claw, white,

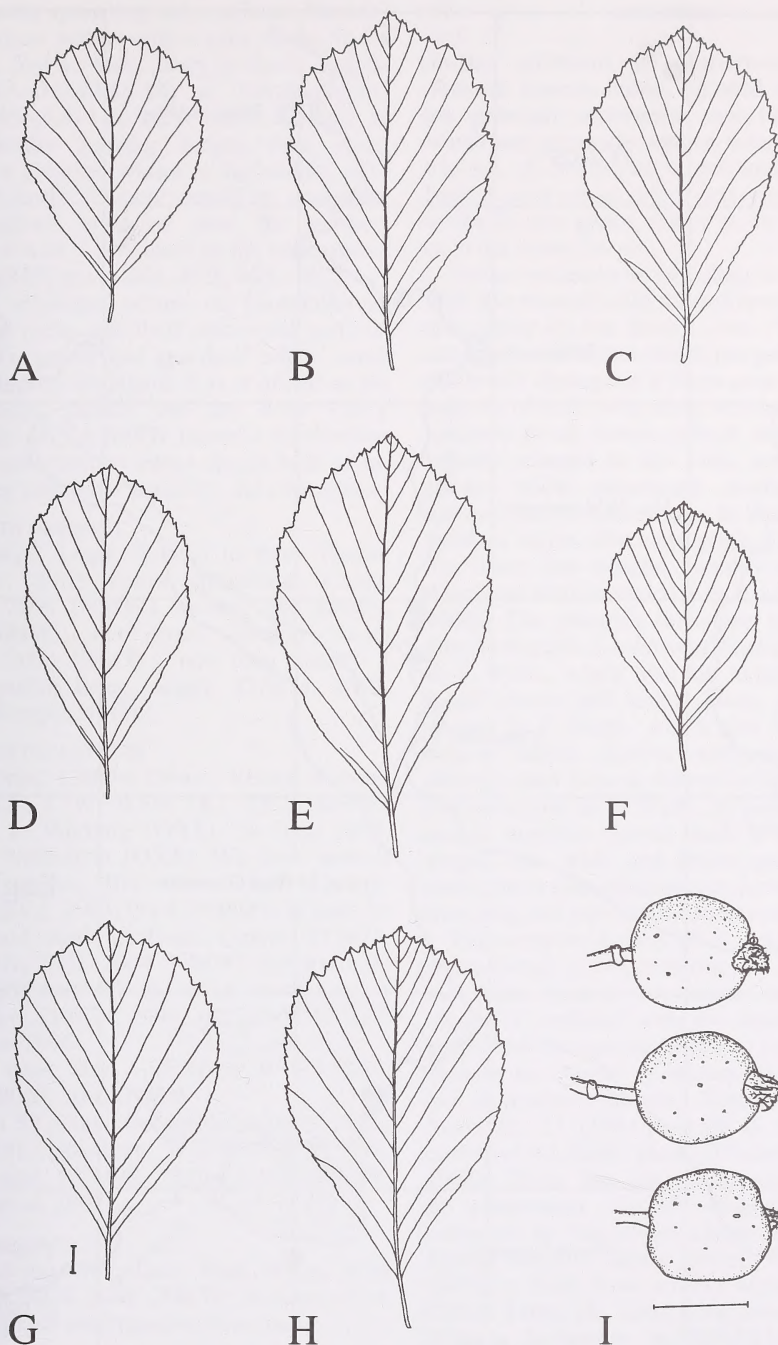


FIGURE 1. *Sorbus whiteana*. A-H, Typical leaves from the short shoots. A, Leigh Woods, Holotype and B-C, Isotype. D, Stokeleigh Camp (NMW.V.2004.26.183). E, Clifton Down, top north edge of Great Quarry (NMW.V.2001.25.240). F, Ban-y-gor (NMW.V.2002.17.103). G, Shorn Cliff (NMW.V.2002.13.164). H, Lady Park Wood (V.2004.11.36). I, Fruits, The Gully (NMW.V.1998.48.21). Scale bars 1 cm.



FIGURE 2. Distribution map of *Sorbus whiteana* in South-west England and Wales. ● Confirmed localities, ○ Provisional identification.

cupped, with spreading hairs at base. Stamens c. 20, anthers yellow with a pink flush. Styles 2, green, free to base, hairy at base. Largest fruits (9.5–)10–13.5(–14) × (9–)10–13(–14) mm, (0.85–)0.9–1.1(–1.2) times as long as wide, usually looking longer than wide, sometimes globose, widest at the middle, with sparse to fairly frequent, small to moderate-sized lenticels scattered over the surface, sometimes with a few more at the base, red at maturity (RHS guide 44A, 45B, 46A, 46C).

Sorbus whiteana occurs on Carboniferous Limestone rocks and their associated soils on open cliffs, screes and grassland edges, scrub and developing woodland. It is confined to the Avon Gorge, Bristol and the Wye Valley (Figure 2). All the NMW material cited below has been collected by either one or both of us, sometimes with other botanists and colleagues.

V.C. 6 NORTH SOMERSET

Avon Gorge, Leigh Woods, in three places: One tree, cliffs below Stokeleigh Camp, ST5673, 2004 (NMW), second tree nearby, 2005 (NMW); two trees, Donkey Slide, ST5673, 2004 (NMW); one tree, Quarry 3 (former police firing range), ST5574, 2002, 2004 (Holotype; NMW).

V.C. 34 WEST GLOUCESTER

Avon Gorge, Clifton Down: Rocky wooded slope, 1920, J. W. White (K). 13 September 1955, E. F. Warburg (OXF). 24 June 1958, P. J. M. Nethercott (OXF). We have seen it in three places: five trees, Great Quarry, ST5674, 2002, 2003, 2004 (NMW); at least 11 trees, wood north of Great Quarry ST5674, 1997, 2001, 2002, 2004 (NMW) and six more trees, 2005; trees 83 and 101x, north side of The Gully, ST5674, 1996, 1997 (NMW; Rich & Houston 1996).

A few trees, Ban-y-gor cliffs, Wye Valley, ST5496, 2000, 2002 (NMW).

At least 53 plants, frequently scattered along Shorn Cliff, Tidenham, Wye Valley ST5398, ST5498 and ST5499, 2001, 2002 (NMW; Houston *et al.* 2002).

V.C. 35 MONMOUTH

One plant on cliffs, Lady Park Wood, Wye Valley, SO5414, 2003 (NMW; Houston *et al.* 2004); requires confirmation from fruit.

Thus at least 76 plants of *S. whiteana* are known in four sites (some with subpopulations) in two vice-counties in England, and it may occur in one site in Wales.

DISCUSSION

Sorbus whiteana is characterised by the obovate, cuneate-based, unlobed leaves which are greenish underneath and the red fruits which are generally longer than wide. Being triploid, *S. whiteana* is presumably derived from *S. aria sensu stricto* and another member of the *S. aria* group, either in the Wye Valley or in the Avon Gorge.

Sorbus whiteana is only likely to be confused with the most closely related species in the *S. aria* group in the British Isles. The obovate, cuneate-based leaves which are greenish underneath will distinguish it from most plants of the very variable *S. aria sensu stricto* which tends to have ovate leaves which are cordate to broadly cuneate at the base, and which are always white underneath. *Sorbus whiteana* differs from *S. wilmottiana* in having obovate, unlobed leaves which are greenish underneath; the latter has elliptic, weakly-lobed leaves which are whitish underneath (Rich & Houston 2004). The greenish underside of the leaves also distinguish *S. whiteana* from *S. leptophylla* E. F. Warb., which also has larger, shallowly-lobed leaves and larger fruits, and from *S. vexans* E. F. Warb., which also has relatively narrow leaves. *Sorbus whiteana* is readily distinguished from *S. hibernica* E. F. Warb., *S. lancastricensis* E. F. Warb., *S. porrigentiformis* and *S. rupicola* (Syme) Hedl. in having fruits longer than wide and leaves greener underneath; these four other species have fruits wider than long and leaves whitish underneath.

The complex history of *S. whiteana* in the Avon Gorge is worth setting out as the taxon has been known for some time. It was originally confused with the central European endemic *S. hungarica* (Bornm.) Hedl. ex C. E. Salmon in *Journal of Botany* 68: 174 (1930) (= *S. hungarica* (Bornm.) Kárpáti in *Borbasia Nova* 25: 23 (1944)) which is related to *S. austriaca* (G. Beck) Hedl. (Warburg & Kárpáti 1968). There has also been confusion with *S. wilmottiana*. *Sorbus whiteana* was first collected in the Avon Gorge by the great Bristol botanist James Walter White (1846–1932), in 1920, from a rocky wooded slope on Clifton Down (K; there is no material in J. W. White's herbarium in BRISTM), and our specific epithet commemorates him. The sheets were labelled '*S. hungarica* (Bornm.) Hedl.' by C. E. Salmon, presumably after matching them with similar material named as such by T.

Hedlund from the Wye Valley (Salmon 1930; see also below). Other botanists attempted to collect White's '*S. hungarica*' but all the material traced so-labelled is *S. aria*, e.g. Mrs C. I. Sandwith & Mrs M. L. Wedgwood, 2 June 1931; Mrs C. I. Sandwith & G. Taylor, 20 September 1931 and perhaps more significantly two sheets from Clifton Down collected by E. F. Warburg no. 135, September 1935 (all **BM**) indicating that Warburg had tried to investigate it during his work on *Sorbus*. Warburg visited Clifton Down on several occasions and on 13 September 1955 collected three sheets of material, of which one is *S. whiteana* and two others with narrower, more acute, more deeply lobed leaves are *S. aria* (**OXF**). These sheets were retained in a separate folder at **OXF** labelled '*S. hungarica*' by Warburg, along with another sheet he had collected from Leigh Woods which may be part of the *S. porrigentifformis* group but which interestingly he had labelled "'hungarica' = ? *wilmottiana*". Indeed it is probable that Warburg first discovered *S. wilmottiana* during his investigation of White's '*S. hungarica*', but Warburg does not appear to have come to any firm conclusion about the '*S. hungarica*' before he died in 1966. Warburg appears to have named at least one other *S. whiteana* collection (Clifton Down, 24 June 1958, P. J. M. Nethercott, **OXF**) as *S. wilmottiana*, but the specimen is mixed on a sheet with two genuine collections of *S. wilmottiana*.

In 1996, English Nature commissioned a survey of *Sorbus* of The Gulley, Durdham Down, Bristol (v.c. 34 West Gloucester) to provide information before conservation work was carried out, as The Gulley was thought to be an important site for *Sorbus* (Rich & Houston 1996). During this survey, two plants of *S. whiteana* were found (another tree may be referable to the *S. latifolia* (Lam.) Pers. group) and were shown to P. D. Sell at Cambridge on 10 October 1996; he agreed they did not match any known species. The plants were given the working name *Sorbus* 'JWWhite' for convenience. Specimens were exhibited at the 1996 BSBI Exhibition Meeting (Rich & Houston 1997), which prompted only one comment, i.e. that they were *S. wilmottiana* by P. J. M. Nethercott (this was not surprising in view of the determination by Warburg cited above). Between 1997 and 1999, L. Houston with others found more *S. whiteana* trees below the *S. wilmottiana* type tree on the edge of Clifton Down and collected further specimens, which were then all considered to be part of the variation in *S. wilmottiana* (**NMW**).

In 1996, Elin Lemche began a PhD on *Sorbus* taxonomy at Cambridge and, guided by L. Houston, collected *Sorbus* from the Avon Gorge for analysis using a variety of methods including DNA techniques (Lemche 1999). Amongst the specimens collected were two trees in secondary scrub from the bottom of the Great Quarry (Lemche nos. *aria*33 and *aria*34, locality incorrectly cited as Leigh Woods) which had at one time been demonstrated by various botanists as *S. wilmottiana*, although more recently they were known not to be that taxon. In her RFLP analysis, Lemche found that these two trees formed an isolated distinct group and *in-situ* hybridisation with *Malus* probes indicated that they were polyploid with one strong and one weak *S. aria sensu lato* band; she suggested that they were candidates for recognition as a new microspecies (Lemche 1999). However, P. D. Sell had named one as *S. rupicola* (a species not currently known from the Avon Gorge) and the other was treated as *S. aria*.

In 2001, T. C. G. Rich began to extend the work of Lemche (1999) on *Sorbus* taxonomy, using more advanced DNA methods (e.g. Fay *et al.* 2002), and requested to see the *aria*33 and *aria*34 trees that L. Houston had shown to E. Lemche. The trees were compared against the type tree of *S. wilmottiana*, and then against the 1996 *Sorbus* 'JWWhite' trees (i.e. *S. whiteana*) and were found to be a good match for the latter. Further samples were collected from other trees in the area. It was then apparent that there had been long-standing confusion between *S. whiteana* and *S. wilmottiana*, at least on the Clifton side of the Gorge (see also Lemche 1999). Further detailed studies of *Sorbus* populations on the Leigh Woods side of the Avon Gorge (V.c. 6 North Somerset) by L. Houston in 2001 also clarified that the *S. whiteana* plants did not fit within *S. wilmottiana*.

In the Wye Valley, the history of *S. whiteana* is somewhat simpler. The recent discoveries stemmed from rope access survey work on the cliffs funded by English Nature. It was found on Ban-y-gor cliffs in 2000 (Houston *et al.* 2001), but was not recognised until 2002 after excellent material had been found at Shorn Cliff, Tidenham (Houston *et al.* 2002). One possible plant was found at Lady Park Wood, Monmouthshire in 2002 but requires confirmation from fruit (Houston *et al.* 2003). It has not been found on searches of the other main cliffs on the English side of the Wye Valley (e.g. around Symonds Yat, The Great Downard, Dennis Grove, Wintour's Leap;

Houston *et al.* 2003, 2004); large areas of the Welsh side remain to be surveyed.

Possibly coincidentally, Salmon (1930) had also cited material of *S. hungarica* named by T. Hedlund collected from cliffs at Pen Moel and Tidenham in the Wye Valley (v.c. 34). Hedlund's determination is surprising given that *S. hungarica* is part of the *S. intermedia* group rather than the *S. aria* group. The *S. hungarica* folder in Hedlund's herbarium in UPS contained no British material in 2004, but one sheet, which probably belongs to the *S. porrigentiformis* aggregate, collected by C. E. Salmon (ref. no. H) on 30 July 1920 from Wye Cliffs, Oakwood, Tidenham had Hedlund's determination as *S. hungarica* subsequently crossed out by Hedlund showing that he had later changed his opinion (the duplicate material from Salmon's gatherings in BM is not *S. whiteana* either). Hedlund was at the time regarded as an authority on *Sorbus*, and although he knew the Scandinavian taxa well, he was inconsistent in determination of material from elsewhere in Europe and came to be considered as unreliable (Kovanda 1961

puts it more strongly!). We consider his determinations of British material of *S. hungarica* as erroneous.

Sorbus whiteana qualifies as 'Endangered' under the IUCN (2001) Threat Criteria. There appear to be no immediate threats to its survival provided care continues to be taken during conservation habitat management work in the Avon Gorge. Seed from Clifton Down has been deposited in the Millennium Seedbank and plants are being grown at the National Botanic Garden of Wales and Bristol University Botanic Garden.

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REFERENCES

- AAS, G., MAIER, J., BALTISBERGER, M. & METZGER, S. (1994). Morphology, isozyme variation, cytology and reproduction of hybrids between *Sorbus aria* (L.) Crantz and *S. torminalis* (L.) Crantz. *Botanica Helvetica* **104**: 195–214.
- ALEXANDER, M. P. (1969). Differential staining of aborted and non-aborted pollen. *Stain Technology* **44**: 117–122.
- FAY, M. F., GERNANDT, D. S., COWAN, R. S., KITCHEN, M. A. R., KITCHEN, C. & RICH, T. C. G. (2002). Parentage of an unknown member of the *Sorbus latifolia* (Lam.) Pers. group. *Watsonia* **24**: 91–100.
- HOUSTON, L., TILLOTSON, A. & CHARLES, C. (2001). *Wye Valley Sorbus project. 1. Ban-y-gor rocks Autumn 2000*. Unpublished contract report to English Nature, Ledbury, March 2001.
- HOUSTON, L., TILLOTSON, A. & CHARLES, C. (2002). *Wye Valley Sorbus project. 2. Shorn Cliff Autumn 2001*. Unpublished contract report to English Nature, Ledbury, March 2002.
- HOUSTON, L., TILLOTSON, A. & CHARLES, C. (2003). *Wye Valley Sorbus project. 3. Upper Wye Gorge Autumn 2002*. Unpublished contract report to English Nature, Ledbury, March 2003.
- HOUSTON, L., TILLOTSON, A. & CHARLES, C. (2004). *Wye Valley Sorbus project. 4. Wintour's Leap and Lady Park Wood Autumn 2003*. Unpublished contract report to English Nature, Ledbury, March 2004.
- IUCN (2001). *IUCN Red List Categories*. Version 3.1. The World Conservation Union, Gland.
- KENT, D. H. & ALLEN, D. E. (1984). *British and Irish Herbaria*. 2nd edition. B.S.B.I., London.
- KOVANDA, M. (1961). Spontaneous hybrids of *Sorbus* in Czechoslovakia. *Acta Universitatis Carolinae, Biologica* **1**: 43–83.
- LEMICHE, E. B. (1999). *The origins and interactions of British Sorbus species*. PhD thesis, Darwin College, Cambridge.
- LILJEFORS, A. (1955). Cytological studies in *Sorbus*. *Acta Horti Bergiani* **17**: 47–113.
- RICH, T. C. G. & HOUSTON, L. (1996). *Sorbus survey of The Gully, Avon Gorge September 1996*. Unpublished contract report to English Nature.
- RICH, T. C. G. & HOUSTON, L. (1997). A new species of *Sorbus* from the Avon Gorge, Bristol. *BSBI News* **75**: 69.
- RICH, T. C. G. & HOUSTON, L. (2004). The distribution and population sizes of the rare English endemic *Sorbus wilmottiana* E. F. Warburg, Wilmott's Whitebeam (Rosaceae). *Watsonia* **25**: 185–191.
- ROYAL HORTICULTURAL SOCIETY (1966). *R. H. S. colour chart*. Royal Horticultural Society, London.
- SALMON, C. E. (1930). Notes on *Sorbus*. *Journal of Botany* **68**: 172–177.
- WARBURG, E. F. & KÁRPÁTI, Z. E. (1968). *Sorbus*, in TUTIN, T. G. *et al.*, eds., *Flora Europaea* **2**: 67–71. Cambridge University Press, Cambridge.

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Sorbus pseudomeinichii, a new endemic *Sorbus* (Rosaceae) microspecies from Arran, Scotland

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ABSTRACT

Sorbus pseudomeinichii Ashley Robertson sp. nov., a new endemic tree from the Isle of Arran, Scotland is described. Its leaf morphology is intermediate between *S. pseudofennica* and *S. aucuparia* and molecular studies support the hypothesis that it was formed by hybridisation between *S. pseudofennica* and *S. aucuparia*. All three hybridogenous taxa endemic to Arran, *S. arranensis*, *S. pseudofennica* and *S. pseudomeinichii*, can be considered endangered. To maximise their chances of long-term survival, all locations and components of this evolutionary complex should be conserved.

KEYWORDS: hybridisation, new species, *Sorbus arranensis*, *Sorbus pseudofennica*.

INTRODUCTION

Recent molecular studies (isozyme, nuclear DNA and chloroplast DNA) have confirmed that the Arran endemics, *Sorbus arranensis* Hedl. and *S. pseudofennica* E. F. Warb., are of hybrid origin, the former originating as *S. aucuparia* L. $\times$ *S. rupicola* (Syme) Hedl., and the latter subsequently as *S. arranensis* $\times$ *S. aucuparia* (Figure 1; Nelson-Jones *et al.* 2002; Robertson *et al.* 2004a). The discovery of an unusual *Sorbus* specimen, in the herbarium of the Royal Botanic Garden Edinburgh, collected by Dr D. McVean in 1949, prompted Lusby (1996) to suggest that further diversity was being produced within the complex in Arran by crosses between *S. pseudofennica* and *S. aucuparia* and, during a detailed study, a small number of trees were found that had a leaf morphology that matched this unusual specimen (Robertson *et al.* 2004b). Molecular marker analyses support the hypothesis that these trees originated as *S. aucuparia* $\times$ *S.*

pseudofennica (Robertson *et al.* 2004b) and they are treated as a new species for consistency with other hybridogenous *Sorbus* taxa in Britain.

***Sorbus pseudomeinichii* Ashley Robertson sp. nov.**

HOLOTYPE: Glen Catacol, main burn, east bank, Arran (v.c. 100), Scotland, 1 June 2004, A. Robertson (NMW, accession number V.2004.017.21). **ISOTYPUS:** BM, CGE, E, UPS.

Arbor ad 4 m ut minimum. Gemmae lanceolatae, hirsutae. Stipulae leniter dentatae, caducae. Ramunculi juvenes petiolique, ut rhachides, modice tomentosi, pilis albis appressis simplicibus vestiti. Petioli 17–38 mm. Folia 75–130 $\times$ 45–105 mm, foliolorum laterali-um 4–5 paribus folioque terminali majore, ambitu generali ovata, pinnarum paribus mediis longissimis. Foliola lateralia ad medium folii 25–55 $\times$ 9–23 mm, oblonga vel oblongolanceolata, rotundata sed ad basin asymmetrica, ad apicem obtusa vel acuta, marginibus propemodo a basi per unum longitudinis trientem serratis, dentibus prorsum flexis acuminatis, supra viridia glabrescentia, infra pallidiora et praecipue secus costam venasque sparsim pubescentia; pinnae infimae sessiles vel manifeste petiolatae, superiores saepe ad rhachin margini proximali adnatae. Foliolum terminale foliolis lateralibus plerumque simile sed multo grandius, 32–60 $\times$ 15–45 mm, ovatum, in parte media cum vel sine uno duobusve lobis profundis vel non profundis fissum (aliquando usque ad costam, in margine saltem distali, sectum), ad basin cuneatum, ad apicem plerumque obtusum. Pedunculi et inflorescentiae rami tomentosi. Inflorescentia

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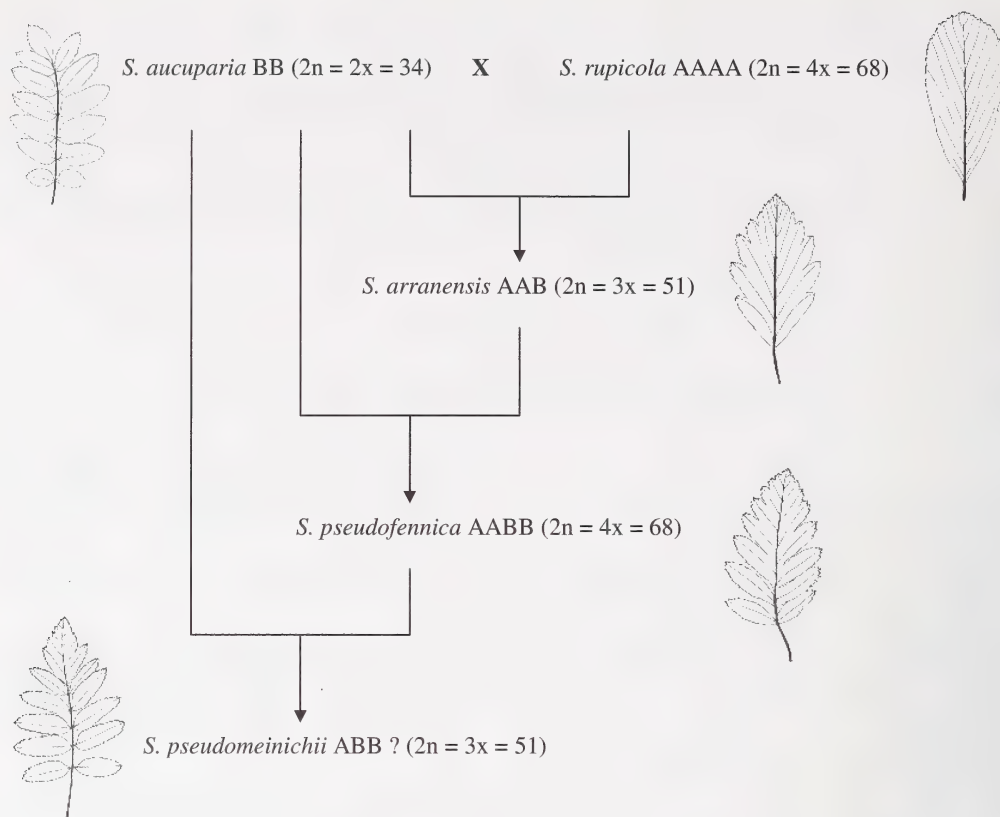


FIGURE 1. Relationships among Arran *Sorbus* taxa. The letters B and A indicate haploid genomes from *S. aucuparia* and *S. rupicola* respectively. Ploidy levels are given in brackets.

corymbosa. Sepala *c.* 1.5–2 mm, triangularia, ad basin sparsim hirsuta, apicem versus glabra, in marginibus glandulosodentata. Petala *c.* 4 mm, orbicularia breviter unguiculata alba cupulata, in facie superiore sparsim pubescentia. Stamina *c.* 20, cremea. Styli 3, usque ad basin discreti. Fructus inter *S. pseudofennicae* et *S. aucupariae* fructus intermedii.

Tree to at least 4 m tall. Buds lanceoloid, hairy. Stipules weakly toothed, deciduous. Young twigs, petioles and rachises moderately tomentose with white, appressed, simple hairs. Petioles 17–38 mm. Leaves 75–130 mm $\times$ 45–105 mm, with 4–5 pairs of lateral leaflets and a larger terminal leaflet, ovate in general outline with the middle pairs of pinnae the longest. Lateral leaflets at middle of leaf 25–55 mm $\times$ 9–23 mm, oblong or oblong-lanceolate, rounded but asymmetrical at the base, obtuse to acute at the apex, with margins serrate from near the base to about one third of the way along the leaf to the apex, with forward-pointing, acuminate teeth, green and

glabrescent above, paler and sparsely pubescent below especially along the midrib and veins; lowest pinnae sessile or clearly stalked, the upper often adnate to the rachis on the proximal margin. Terminal leaflet generally similar to the lateral leaflets but much larger, 32–60 mm $\times$ 15–45 mm, ovate, with or without one or two, deep to shallow lobes at the middle (sometimes cut to the midrib at least on the distal margin), cuneate at the base, usually obtuse at the apex. Peduncles and inflorescence branches tomentose. Inflorescence corymbose. Sepals *c.* 1.5–2 mm, triangular, sparsely hairy at base and glabrous towards tip, glandular-toothed on margins. Petals *c.* 4 mm, orbicular with a short claw, white, cupped, sparsely pubescent on upper side. Stamens *c.* 20, cream. Styles 3, free to base. Fruits intermediate between those of *S. pseudofennica* and *S. aucuparia*.

Endemic to Arran, Scotland. Found beside the main burn in Glen Catacol (two plants), and in the tributary Allt nan Calman (one plant).

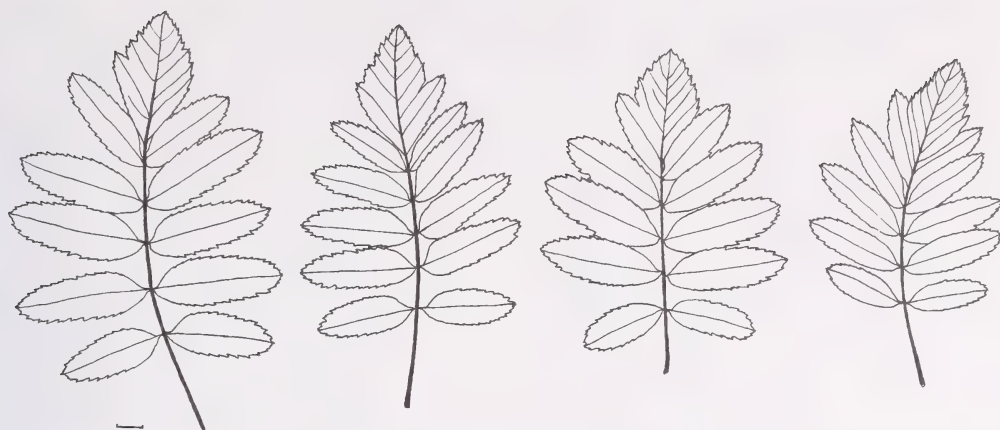


FIGURE 2. Leaves of *Sorbus pseudomeinichii*. Scale bar = 1 cm.

The altitudinal range is c. 150–200 m. One of the Glen Catacol plants, a sapling when first recorded, was not relocated in 2004 and appears to have died. The population of two trees qualifies it as ‘Critically Endangered’ under the IUCN (2001) Threat Criteria.

Sorbus pseudomeinichii (Figure 2) is an example of continuing evolution in *Sorbus*. It differs from *S. aucuparia* in having the terminal leaflet larger than the lateral leaflets (the terminal leaflet is about the same size as the lateral leaflets in *S. aucuparia*). It differs from *S. pseudofennica* in having largely pinnate leaves with 4–5 pairs of pinnae (typically 1–2 pairs of free pinnae in *S. pseudofennica*). *Sorbus arranensis* rarely has any free pinnae and is readily distinguished. The relationships between the taxa are summarised in Figure 1.

DISCUSSION

Isozyme, nuclear DNA and chloroplast DNA studies have shown that, like *S. arranensis* and *S. pseudofennica*, *S. pseudomeinichii* is a *Sorbus* hybrid that has ultimately been derived from the genomes of both *S. aucuparia* and *S. rupicola* (Robertson *et al.* 2004b). These studies also show that two of the trees, one of which is thought to have died, shared the same genetic marker profile, implying that they were members of the same apomictic clone. They are genetically distinct from the third tree. Neither of these two genetic marker profiles has been found before in *S. arranensis* or *S. pseudofennica*. The simplest explanation for the origin of these *S. pseudomeinichii* trees is

that they are the product of sexual outcrossing between *S. pseudofennica* and *S. aucuparia*. This would give a triploid hybrid with a predominance of chromosomes from *S. aucuparia*. The genetic marker evidence is compatible with this hypothesis, as is an examination of pollen grain viability (Table 1), which suggests, in the context of other *Sorbus* species (Liljefors 1955), that *S. pseudomeinichii* is probably triploid (T. Rich, pers. comm. 2004).

The epithet *pseudomeinichii* has been chosen to draw attention to the similarity in origin to the Scandinavian *S. meinichii* (Lindb.) Hedl., thought to be derived from *S. aucuparia* × *S. hybrida* L. (*S. fennica* Kalm ex Fries) (Liljefors 1953; Salvesen 1992; Bolstad & Salvesen 1999). Liljefors’s (1953) experiments revealed that what was then considered *S. meinichii* existed in three forms: a tetraploid apomict (to which the name was originally applied), a triploid apomict and a triploid sexual hybrid. Liljefors (1953) proposed that the name *S. meinichii* should be retained for the tetraploid and a new name *Sorbus teodori* Liljef. given to the triploid forms. Bolstad and Salvesen (1999), using morphometric analysis and cytology, studied the relationships between the *S. meinichii* group, *S. hybrida* and *S. aucuparia*. They agreed with Liljefors (1953) that it was likely the *S. meinichii* forms had been derived from crosses between *S. aucuparia* and *S. hybrida*, but disputed the separation of *S. teodori* from *S. meinichii*. They showed that *S. meinichii* and *S. teodori* are, in reality, at the same ploidy level, which is triploid, not tetraploid as originally thought.

TABLE 1. POTENTIAL POLLEN VIABILITY ASSESSED USING ALEXANDER'S STAIN FOR ARRAN *SORBUS* TAXA HELD IN WELSH NATIONAL HERBARIUM (NMW). DATA COURTESY T. RICH, DECEMBER 2004

Taxon	Locality	Site code	NMW accession number	% viable pollen	No. of grains counted
<i>S. arranensis</i>	Diomhan Burn, east bank	A	V.2004.17.17	2%	85
	Diomhan tributary, north bank	B	V.2004.17.20	0%	100
	Catacol Burn, west bank	E	V.2004.17.12	4%	153
	Allt Easan Biorach, east bank	I	V.2004.17.13	5%	73
	Allt Easan Biorach, east bank	M	V.2004.17.14	1%	133
			Mean	3%	
<i>S. pseudofennica</i>	Diomhan Burn, west bank	A	V.2004.17.8	64%	60
	Diomhan Burn, west bank	A	V.2004.17.2	76%	105
	Diomhan Burn, west bank	A	V.2004.17.1	68%	89
	Diomhan Burn, east bank	A	V.2004.17.7	83%	96
	Catacol Burn, east bank	E	V.2004.17.3	64%	74
			Mean	71%	
<i>S. pseudomeinichii</i>	Catacol Burn, east bank (holotype)	C	V.2004. 17.21	0%	209

TABLE 2. LOCATIONS AND POPULATION SIZES OF ENDEMIC *SORBUS* TREES AT 14 SITES ON ARRAN

Locality	Grid Reference	Site Code	<i>S. arranensis</i> Population size	<i>S. pseudofennica</i> Population size	Most recent Survey
Diomhan Burn	NR925467	A	209	275	Robertson 1997
Diomhan tributary	NR930467	B	32	23	Robertson 1997
Allt nan Calman	NR918454	C	24	33	Robertson 1997
Abhainn Bheag	NR924489	D	0	40	Robertson 1997
Catacol Burn	NR917457	E	33	40	Robertson 1997
Catacol tributary	NR917457	E	8	25	Burlison 1986
Creag na h-Iolaire	NR924475	F	1	0	Burlison 1986
Allt nan Champ	NR936430	G	30	0	Burlison 1986
Garbh Coire Dubh	NR951432	H	24	0	Burlison 1986
Allt Easan Biorach	NR953474	I	11	0	Robertson 1997
Allt Easan Biorach	NR952467	J	3	0	Robertson 1997
Allt Dubh	NR944470	L	27	0	Robertson 1997
Allt Easan Biorach	NR945496	M	4	0	Robertson 1997
North Glen Sannox	NR964457	N	1	0	King 1981
Total			407	436	

Previous surveys have identified 14 sites for *S. arranensis* and *S. pseudofennica* (Fig. 3), with total population sizes in 1997 of 407 and 436 plants respectively (Table 2). They are restricted to steep-sided, granite gorges on strongly acid soils (Table 3). Site K is no longer populated with either taxon due to a local extinction event, possibly a fire or landslide. Trees were last recorded at this site in 1956. Landslides or fire may also account for the lack of *S. rupicola* trees in the area. Competition from other *Sorbus* taxa or simply

that *S. rupicola* has never been in the locality are possible alternative explanations. The nearest known stations for *S. rupicola* are: Gleann Dubh and Holy Island, both Arran and on the mainland, north of Arran, at Ardlamont Point.

High mortality rates and a lack of recruitment for *S. arranensis* and *S. pseudofennica* were used as justifications for the establishment of the Gleann Diomhan National Nature Reserve (McVean 1956; Bignal 1980; Boyd *et al.* 1988). A great deal of research has since

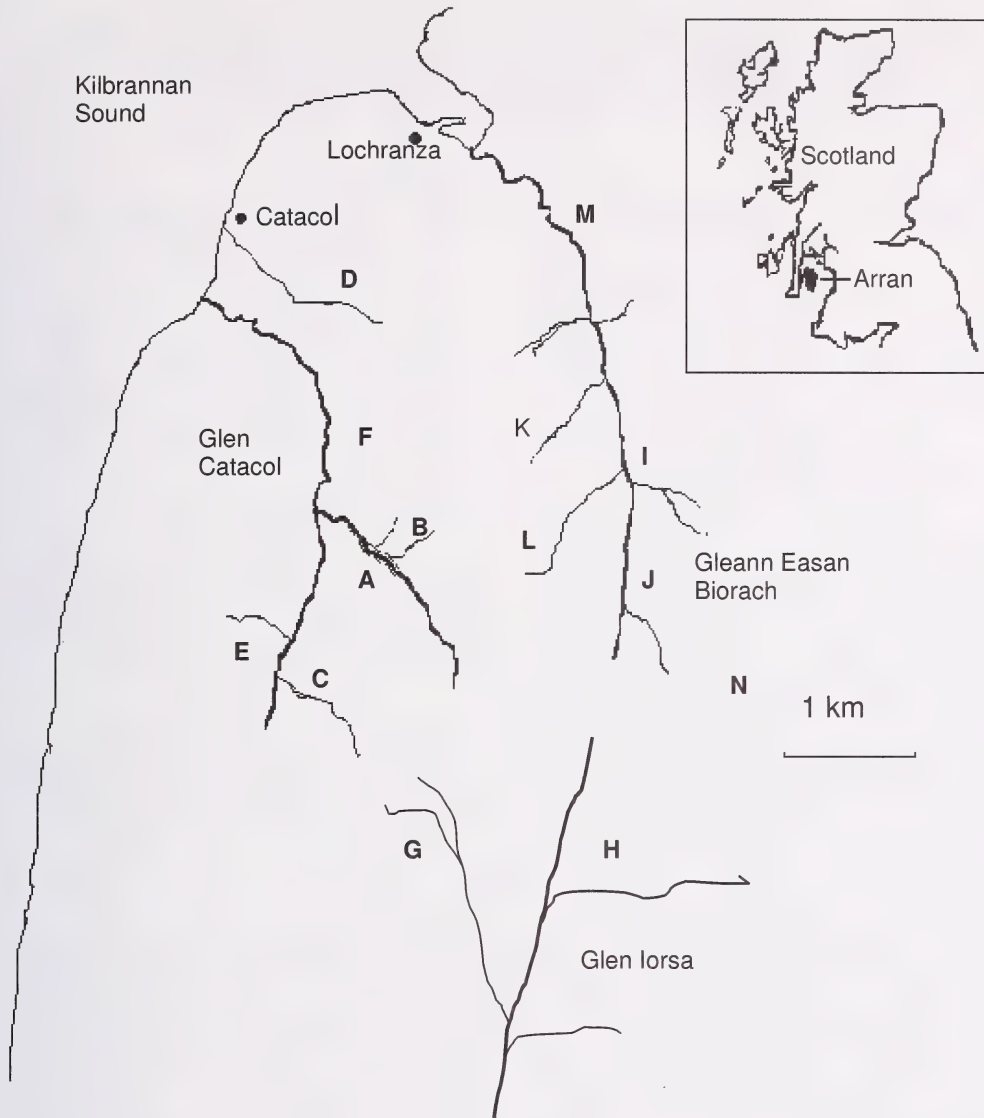


FIGURE 3. Locations of *Sorbus* species on Arran.

been carried out on their ecology and conservation, and although successive surveys have indicated an increase in the populations of both species there is no clear evidence to suggest that successful regeneration is occurring as differences between the survey methods make comparisons difficult (Robertson 2004). A true picture of the population trends will have to await further monitoring, perhaps using a standard protocol as developed for the *Sorbus* taxa at Craig y Cilau, Wales by Rich (2003).

Understanding the population dynamics of the Arran *Sorbus* taxa is central to any conservation plan, especially in the short-term. However, it is equally important to plan for the long-term. Long-term conservation plans should be centred on the processes and potential of the taxa to evolve. If evolution is thought not to be occurring then conservation policy should be aimed at preserving the unique products of hybridisation that are not to be repeated. If on the other hand evolution can be shown to be ongoing then conservation

TABLE 3. SOIL TYPES FOR ROOTING ZONES OF *SORBUS* SPECIES ON ARRAN. SAMPLES WERE AIR DRIED, AND LATER MIXED 50:50 WITH DISTILLED WATER AND PH MEASURED WITH A PHEP2 HANNA POCKET-SIZED PH METER AFTER EQUILIBRATION

Taxon	Locality	Site Code	Soil
<i>S. arranensis</i>	Diomhan Burn, east bank	A	Mixed black organic and grit, pH 3.5
	Diomhan tributary, north bank	B	Mixed black organic and grit, pH 3.5
	Allt Easan Biorach, east bank	I	Black organic peat, pH 3.7
	Allt Easan Biorach, east bank	J	Black organic peat, pH 3.8
	Allt Easan Biorach, east bank	M	Dark grey mixed grit and organic, pH 3.5
<i>S. pseudofennica</i>	Diomhan Burn, west bank	A	Black organic peat, pH 4.1
	Diomhan Burn, west bank	A	Dark, organic, pH 3.7
	Diomhan tributary, south bank	B	Dark grey mixed grit and organic, pH 3.6
	Allt nan Calman, north bank	C	Black organic peat, pH 3.7
	Catacol Burn, east bank	E	Black peat, pH 3.4
<i>S. pseudomeinichii</i>	Catacol Burn, east bank	E	Black organic peat, pH 4.0

policy should aim to ensure that management allows this evolutionary process to continue. The data presented here and in Robertson *et al.* (2004a, 2004b) have shown that the *Sorbus* complex on Arran is an actively evolving entity with new genotypes being generated throughout the range of the endemic taxa; there are now three *Sorbus* species that have evolved there. All three endemics can be considered endangered, and to maximise their evolutionary potential and long-term survival, the

conservation management objective should be to ensure that all the components of the evolutionary complex, *S. arranensis*, *S. aucuparia*, *S. pseudofennica* and *S. pseudomeinichii* are retained in the northern glens of Arran.

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REFERENCES

- BIGNAL, E. (1980). The endemic whitebeams of North Arran. *Glasgow Naturalist* **20**: 59–64.
- BOLSTAD, A. M. & SALVESEN, P. H. (1999). Biosystematic studies of *Sorbus meinichii* (Rosaceae) at Moster, S. Norway. *Nordic Journal of Botany* **19**: 547–559.
- BOYD, W. E., LAING, A. E., STEVEN, G. & DICKSON, J. H. (1988). The history and present management of the two rare endemic trees on the Island of Arran. *Environmental Conservation* **15**: 65–66.
- LILJEFORS, A. (1953). Studies on propagation, embryology and pollination in *Sorbus*. *Acta Horti Bergini* **16**: 277–239.
- LILJEFORS, A. (1955). Cytological studies in *Sorbus*. *Acta Horti Bergini* **17**: 47–113.
- LUSBY, P., WRIGHT, J. & CLARKE, S. J. (1996). *Scottish Wild Plants*. Edinburgh: The Stationery Office.
- IUCN (2001). *IUCN Red List Categories*. Version 3.1. The World Conservation Union, Gland.
- MCVEAN, D. (1954). Notes on the present position of the endemic Arran *Sorbus*. Gleann Diomhan Management plan I. NCC144/MP.
- NELSON-JONES, E. B., BRIGGS, D. & SMITH, A. G. (2002). The origin of intermediate species of the genus *Sorbus*. *Theoretical and Applied Genetics* **105**: 953–963.
- RICH, T. C. G. (2003). *Establishment of a monitoring regime for Sorbus species at Craig y Cilau NNR*. Unpublished contract report to Countryside Council for Wales, January 2003.
- ROBERTSON, A. (2004). *Status review of the Arran endemic whitebeams, Sorbus arranensis and Sorbus pseudofennica*. Unpublished report to Scottish Natural Heritage, February 2004.
- ROBERTSON, A., NEWTON, A. C. & ENNOS, R. A. (2004a). Multiple hybrid origins, genetic diversity and population genetic structure of two endemic *Sorbus* taxa on the Isle of Arran, Scotland. *Molecular Ecology* **13**: 123–143.
- ROBERTSON, A., NEWTON, A. C. & ENNOS, R. A. (2004b). Breeding systems and continuing evolution in the endemic *Sorbus* taxa on Arran. *Heredity* **93**: 487–495.
- SALVESEN, P. (1992). *Sorbus meinichii*. *Plantzman* **13**: 193–198.

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Distinction between the sedges *Carex vulpina* L. and *C. otrubae* Podp. and the potential for identification of hybrids

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ABSTRACT

Carex vulpina and *C. otrubae* are difficult species to distinguish using floral characters. As an alternative, SEM of the nutlet surface, stomatal morphology and isozymes have been used as taxonomic tools to distinguish between the two taxa. The three methods show differentiation along species lines and are suitable to identify hybridisation. Stomatal morphology and isozymes reveal evidence of possible introgression between the two species.

KEYWORDS : False Fox-sedge, True Fox-sedge, hybridisation, isozymes, nutlet morphology, SEM, stomata.

INTRODUCTION

Carex vulpina L. (Fox sedge) and *C. otrubae* Podp. (False Fox sedge) have been recognised as distinct species since separation by Ernest Nelmès (1939). Nelmès identified a broad geographical separation between the two species, considering *C. vulpina* to be a plant predominantly of eastern Europe while *C. otrubae* is more typical of western Europe. However, both species occur in Britain, with *C. vulpina* being a rare plant of wet meadows in southern Britain found in only eleven hectads (Preston *et al.* 2002) while *C. otrubae*, with a wider ecological tolerance, is more common, being found in a variety of damp habitats. The two species are sympatric at some sites. Hence distinction between the two plants is important to allow the ecology of *C. vulpina* to be understood and to allow informed conservation.

The two species have long been considered difficult to separate due to their morphological similarity and the character variability within the two species. The initial separation (Nelmès 1939) was based upon differences in cell morphology, culm shape, leaf colour and character of the inflorescence (bracts, glumes and utricle shape). Subsequent authors have added to the list of supposedly distinguishing morphological features, Erskine & Lambrick

(2000) listed 29 such characteristics. These have typically been qualitative and have included such features as ligule shape (Nelmès 1946), bract shape (Senay 1950) and the timing of utricle fall (Erskine & Lambrick 2000). However Foley & Porter (1999) consider many of these to be of little practical use. Porley (1999), following the pioneering work of Crawford (1910) and Metcalfe (1971) on the distinctiveness of the leaf and stem anatomy of many British *Carex* species, suggested that internal leaf anatomy could be used to discriminate between the two species, although our preliminary investigations using this method have proved inconclusive.

Blurring of the delineation between the two species will result if the species hybridise. Nelmès (1939) suggested that hybrids between *C. vulpina* and *C. otrubae* had been found close to the River Medway, at Tonbridge (v.c. 16) and from Amberley Wild Brooks (v.c. 13), although Stace (1975) noted that these records are unconfirmed. However, Stace (1975) also considers that “hybrids between the two species will be revealed by careful searching”. In Britain crosses have also been reported between *C. vulpina* or *C. otrubae* with members of the *Carex muricata* group and *C. paniculata* (Marshall 1897), although further studies of these specimens is required to substantiate their status (Stace 1975).

Discrimination between other morphologically cryptic Cyperaceae taxa has been undertaken using alternative characters to gross floral morphology. SEM microscopy of the nutlet surface has been successfully used by Schuyler (1971) to distinguish between morphologically similar species of *Scirpus* and *Eriophorum* while Flatberg (1972), among other approaches, utilised differences in stomatal measurements to investigate the occurrence of a new hybrid between *Carex canescens* and *C. chordorrhiza* in central Norway. Starr & Ford (2001) found that SEM of nutlet micromorphology combined with leaf anatomy and morphology (including stomatal

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TABLE 1A. *CAREX VULPINA* SITES AND SAMPLE DETAILS

Site	Map Reference	Vice County	Isozyme Sample Nos.	Stomatal Sample Nos.
Amberley Wild Brooks (AMB)	TQ038136	v.c. 13	1	3
Love Farm East (LF)	TQ066276	v.c. 13	1	1
Besley Farm Wet Meadow	TQ016149	v.c. 13	1	0
Besley Farm (BF)	TQ018149	v.c. 13	1	2
Blackthorne (BMP)	SP636204	v.c. 23	1	1
Otmoor (Nutlets) (OT)	SP578128	v.c. 23	1	4
Asham Meads (AM)	SP590146	v.c. 23	0	2
Ashleworth Ham (AH)	SO828261	v.c. 33	3	5
Hawbridge (HA)	SO849277	v.c. 34	1	1
R. Porley (RP)	Probably Otmoor	v.c. 23	0	1
Stuttgart Bot. Garden (GE)			1	5
Czech Republic (CZR)			0	1
Total			11	26

TABLE 1B. *CAREX OTRUBAE* SITES AND SAMPLE DETAILS

Site	Map Reference	Vice County	Isozyme Sample Nos.	Stomatal Sample Nos.
Ashleworth Ham (AH)	SO828216	v.c. 34	1	5
Coombe Hill (CH)	SO873270	v.c. 34	1	2
Point of Ayr (PA)	SJ122848	v.c. 50	1	1
Donington (D)	TF210355	v.c. 53	1	2
Rixton (RI)	SJ685903	v.c. 59	1	3
Crossens (CR)	SD363214	v.c. 59	1	1
Hesketh Outmarsh	SD425255	v.c. 59	1	0
Gait Barrows (GB)	SD418772	v.c. 60	1	1
Port William (PW)	NX315488	v.c. 74	1	1
Total			8	16

characters) distinguished between members of *Carex* section *Phyllostachys* along traditional taxonomic lines. A number of authors have also used isozymes to address distinctiveness between morphologically similar species (Ford *et al.* 1991; McClintock & Waterway 1993; Ford *et al.* 1998; Reinihammar 1999; Tyler 2003).

This paper aims to investigate the usefulness of using three of the methods outlined above (SEM of the nutlet surface, stomatal morphology and isozymes) to distinguish between *C. vulpina* and *C. otrubae*. In addition we comment on the potential of each method for assessing the presence of hybrids.

METHODS

COLLECTION AND PROPAGATION

Species were identified *a priori* using a range of characters. *C. vulpina* was distinguished by a stout, sharply winged flowering culm, presence

of dark auricles below the inflorescence, the presence of spare, chaffy material around the ligule and the possession of wrinkled leaf sheaths. These are recognised as the most useful diagnostic morphological characters (Rich & Jermy 1998). *C. vulpina* was collected from eight out of the eleven hectads where it is present in England, (Preston *et al.* 2002) in addition to two overseas samples (Table 1a). *C. otrubae* was collected from nine sites across a large part of the range of the species in Britain (Table 1b). At two sites (Amberley Wild Brooks and Ashleworth Ham) the two species were observed growing sympatrically.

All of the *C. otrubae* and most of the *C. vulpina* material were grown from ramets collected from the various sites. From five *C. vulpina* locations (Otmoor, Amberley Wild Brooks, Asham Meads, Germany and the Czech Republic) nutlets, rather than vegetative material, were collected and subsequently germinated.

Successful germination of nutlets was achieved by selecting undamaged, full utricles that were hard to the touch. These were then cleaned of dry debris and stored in paper envelopes at 4 °C. in a jar containing silica gel to ensure a low moisture content. These were collected in late summer/ early autumn. In the following February the utricles were spread on wet filter paper in Petri dishes and kept in the dark at 4 °C. After one month the closed Petri dishes were moved into light in an unheated glasshouse until germination occurred. Throughout these stages drying out was prevented. Within two weeks signs of germination became evident. When the root growth was established and the cotyledons reached about 5 mm in length then the plants were transferred to potting compost in small pots and then grown on outside. Within six weeks from placing the plants in the glasshouse the two species exhibited germination rates between 36–96%. Individuals grown from nutlets were kept until flowering and seed set when identification could be confirmed. Tables showing percentage germination rates for the species in the years 2002 and 2003 are shown in Tables 4a and 4b (see Appendix).

SEM METHODS

Nutlets were prepared for SEM using a method modified from Starr & Ford (2001). The *C. vulpina* material was from Ashleworth Ham (v.c. 34) and the *C. otrubae* material came from Rixton (v.c. 59). The utricles were removed and the nutlets were acetolysed in 1:9 sulphuric acid – acetic anhydride solution using a modified form of Starr & Ford's protocol. Both sets of nutlets were immersed in the solution and placed in an ultrasonic bath at a temperature of 55 °C. *C. otrubae* needed an immersion time of 15 minutes whilst *C. vulpina* required 35 minutes. They were then rinsed in three changes of distilled water and allowed to dry overnight. Two utricles of each species were prepared for scanning. Financial constraints prevented a more extensive sample being taken.

STOMATAL MORPHOLOGY

Using fresh material from the central section of a mature leaf, microscope slides of the abaxial epidermis were prepared using a method modified from Starr & Ford (2001). This involved immersing the leaf in bleach and scraping away unwanted tissue with a scalpel, rinsing in water, dehydrating in ethanol and staining in 1% safranin prior to mounting. Ten randomly selected stomata were then measured

from the prepared slides at 400 × magnification. Two measurements were recorded for each stoma, the maximum length, (the overall length of the stomatal complex running co-axially with the stomatal opening) and maximum width, measured across the outer margins of the guard cells (Fig. 1).

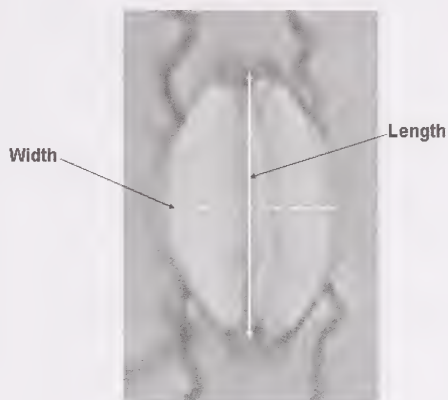


FIGURE 1. Showing the axes from which stomatal measurements were taken.

Dividing the maximum length by the maximum width gave the stomatal index (SI). In all cases the stomatal opening was closed. Stomata from 26 individuals of *C. vulpina* originating from eight English sites plus the two European samples were examined (Tables 1a and 1b). In the case of *C. otrubae* stomata from sixteen individuals from eight British sites were measured. Following checking for homogeneity of variances these data were analysed using one-way ANOVA. *Post hoc* testing was undertaken using the Tukey test.

ISOZYME METHODS

The two species gave regular consistent banding when assayed on three isozyme systems (glucose-6-phosphate isomerase (GPI) E.C. 5.3.1.9, 6-phosphogluconate dehydrogenase (6-PGD) E.C. 1.1.1.44, and menadiol reductase (MNR) E.C. 1.6.99.2.).

These isozymes had previously been shown to be useful in addressing taxonomic questions in *Carex* (e.g. Schell & Waterway 1992; Jonsson & Prentice 2000) and had also been found to exhibit interspecific variation in other *Carex* species during previous work in our laboratory (Blackstock, Smith & Ashton unpub.).

Isozyme methods were modified from Abbott (1993), Ashton (1990) and Soltis (1990). 12% starch gels were used with GPI being run on a discontinuous histidine citrate

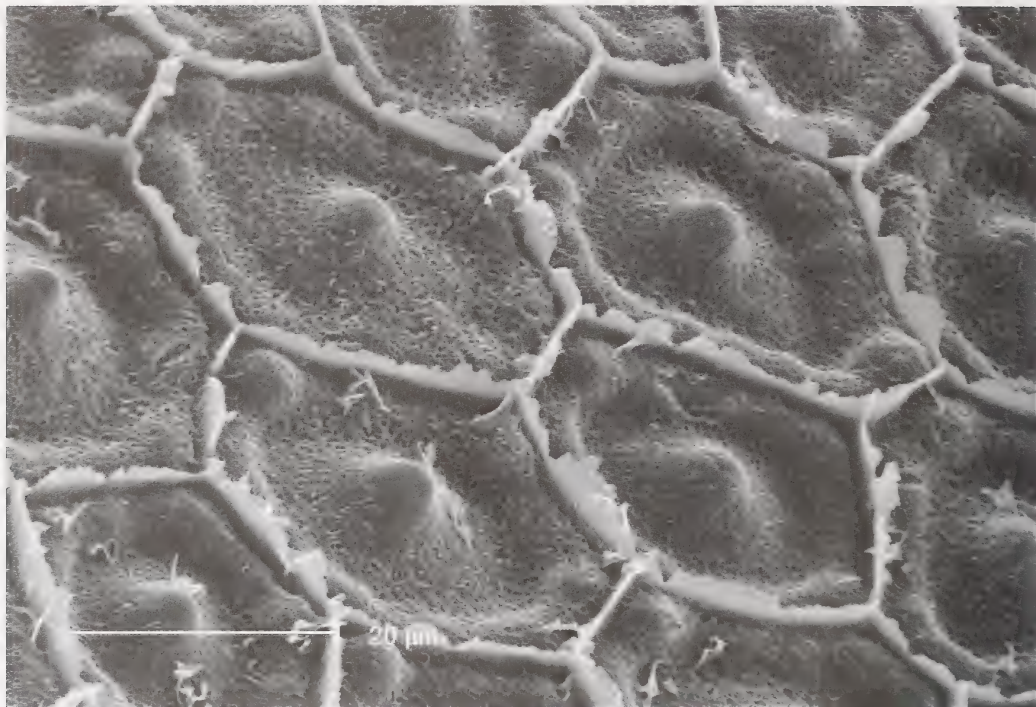


FIGURE 2a. *Carex vulpina* showing rounded central body and prominent satellites.

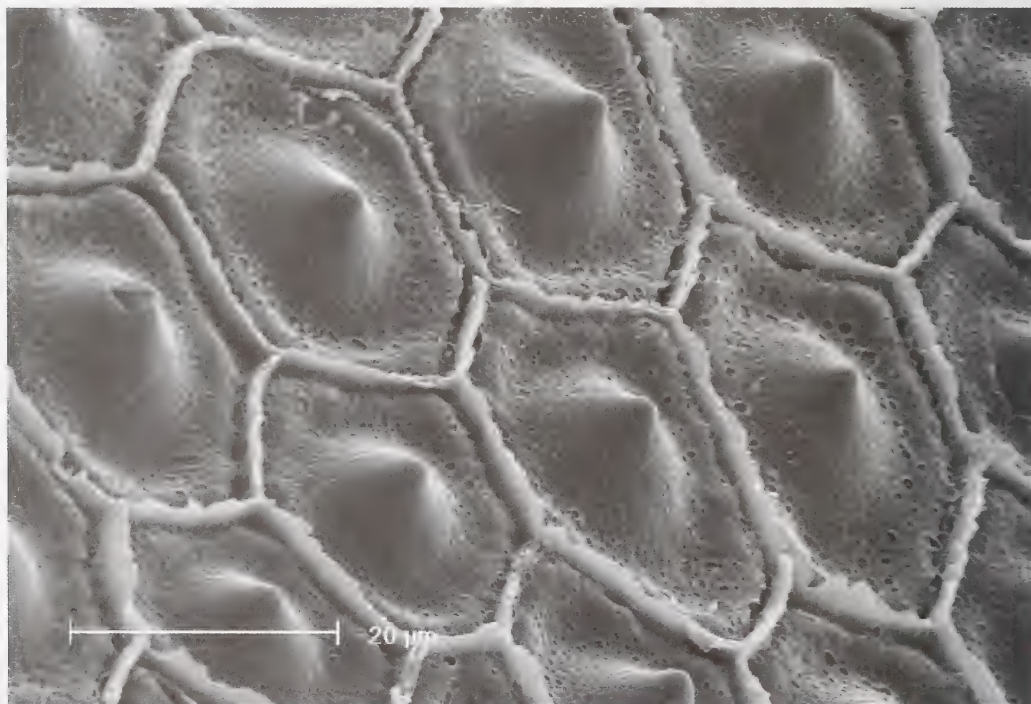


FIGURE 2b. *Carex otrubae* showing pointed central body and less obvious satellites.

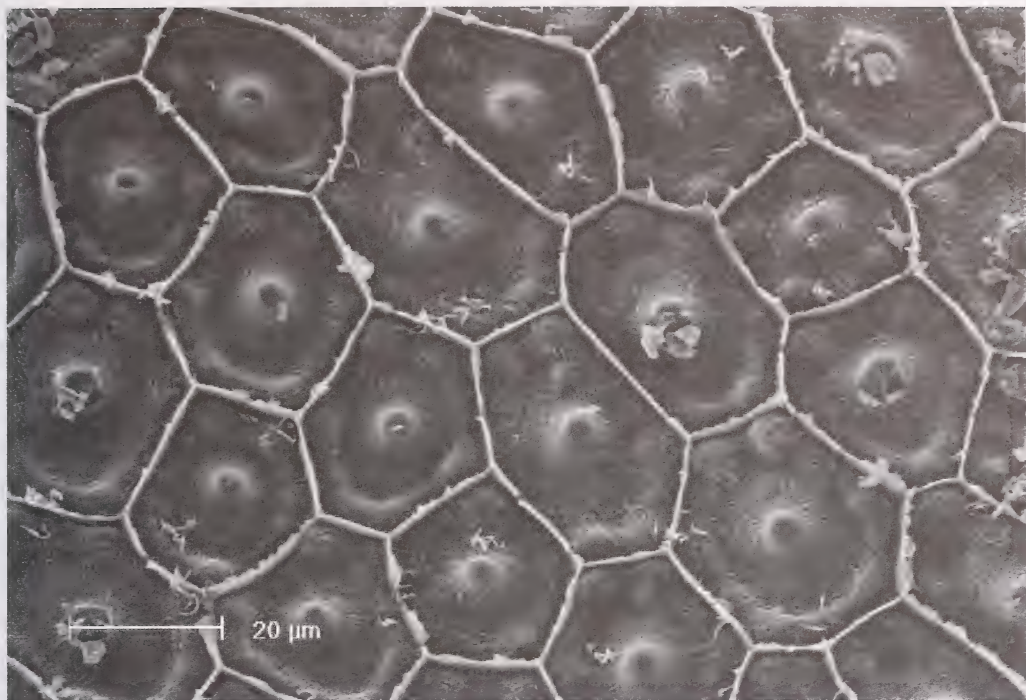


FIGURE 2c. *Carex vulpina* surface cells more orbicular.

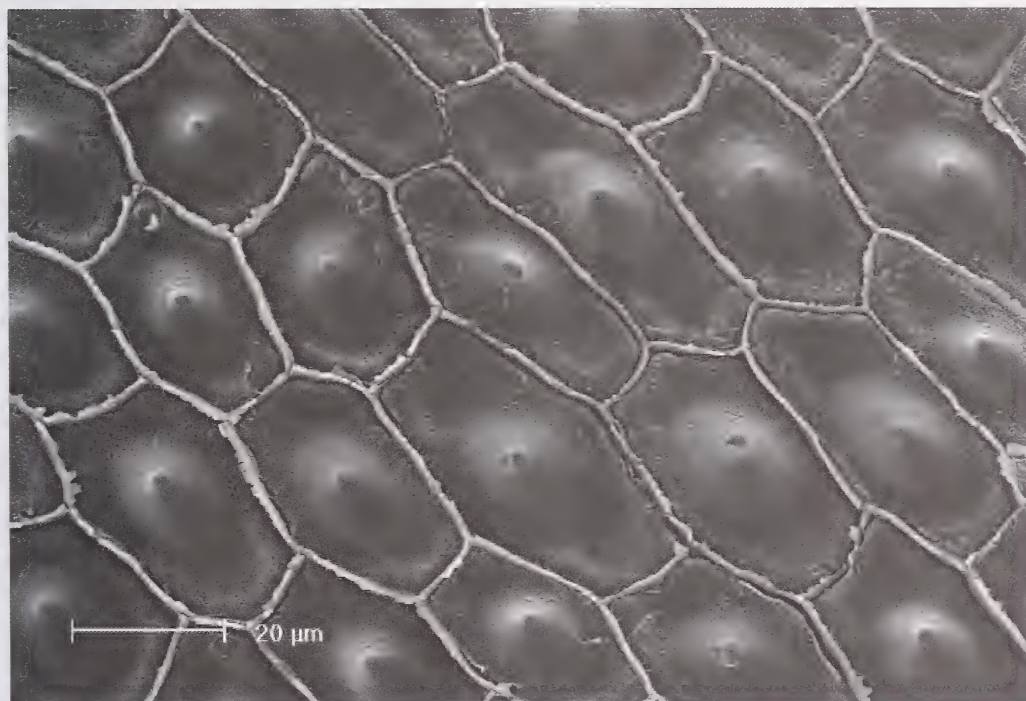


FIGURE 2d. *Carex otrubae* elongate surface cells.

buffer system and 6-PGD and MNR run on a discontinuous tris citrate buffer system (Wendel 1990). Each gel contained samples from both species. The origin of each individual used in each lane is listed in Table 2.

RESULTS

The two plates, Figs. 2a and 2b, show the differences in the outlet surface cell morphology between the two species. The terms used to describe the features follow Schuyler (1971). Note the more rounded central body and the presence of smaller, raised satellite bodies offset towards the cell wall in *C. vulpina* (Fig. 2a). *C. otrubae* has a more sharply pointed central body and less prominent peripheral satellites (Fig. 2b). When viewed perpendicularly surface cells of *C. otrubae* (Fig. 2d) outlets are longer along the axis that passes from the stipe to the beak of the outlet, while in *C. vulpina* these cells are rather orbicular in outline (Fig. 2c).

In all cases the gels were loaded such that lanes 1–11 were *C. vulpina* and lanes 12–20 were *C. otrubae*. The three isozyme systems reveal distinction between the two taxa. GPI shows interspecific variation, *C. vulpina* being monomorphic for the *GPI-1a* allele and *C. otrubae* being monomorphic for the *GPI-1b* allele (Fig. 3a).

A similar pattern is observed in 6-PGD, with *C. otrubae* being monomorphic for the *6-PGD-1c* allele while *C. vulpina* typically possesses the *6-PGD-1b* allele at this locus (Fig. 3b). However two *C. vulpina* individuals possess a different allele. The specimen from Amberley Wild Brooks (lane 2) having the same allele as that found in *C. otrubae* (*6-PGD-1c*) while the specimen from Hawbridge (lane 8) expressed a unique allele (*6-PGD-1a*).

MNR reveals a more complex pattern than in the previous isozymes considered (Fig. 3c). This has been interpreted as consisting of two loci. *C. otrubae* expresses only one of these loci (MNR-1) and is monomorphic.

The full range of variation is observed in *C. vulpina*. In this species some individuals have the same pattern as that found in *C. otrubae* (Amberley Wild Brooks and Hawbridge; tracks 2 and 8 respectively) or they express the slower form of this gene (*MNR-1b*, tracks 5 and 6, Ashleworth Ham). Alternatively the MNR-1 band is absent and individuals exhibit either a single *MNR-2a* band (lanes 9 and 11; Stuttgart

and Besley Wet Meadow) or a two-banded pattern combining either *MNR-2b* and *2c* (lanes 1, 4 and 7; Blackthorne, Ashleworth Ham and Love Farm) or *MNR-2a* and *2b* (Lanes 3 and 10; Ashleworth Ham and Besley Farm).

There is considerable overlap in mean stomatal length in *C. vulpina* and *C. otrubae* and some overlap in stomatal width (Table 3).

Stomatal shape differences between the two species are clearest when both measurements are considered together (Fig. 4). *C. otrubae* stomata are wider than they are long (below the diagonal line in Fig. 4) having a stomatal index (SI) of less than 1. By comparison *C. vulpina* has stomata that are above the diagonal line in Fig. 4, being longer than they are wide (SI > 1). When the mean values of all populations, when $n = 10$, are considered using one-way Anova there is a statistically significant division ($F_{47,432} = 39.97$, $P < 0.05$). The only sample which does not follow this pattern is one of the *C. otrubae* specimens from Ashleworth Ham, which clusters with *C. vulpina*. SI values for each individual surveyed are given in Tables 5a and 5b (in appendix).

DISCUSSION

Discrimination between the two species can be achieved using stomatal shape, isozyme pattern and outlet micromorphology. Within the small sample used for SEM there is consistency within a species and a difference between the two species. *C. otrubae* has a more sharply pointed central body with few, if any, peripheral satellite bodies. *C. vulpina* displays the outer satellite bodies with a blunter central body. Outlet surface cells in *C. vulpina* tend to be orbicular in outline while *C. otrubae* cells have a pronounced longer axis in a line extending from the distal to the proximal end of the outlet. Similarly when stomatal shape is compared *C. vulpina* has elliptical (sub-orbicular) stomata while *C. otrubae* tends to have rounder stomata (orbicular).

The differences in isozyme pattern are slightly less clear cut. The interspecific variation coupled with the absence of intraspecific variation renders GPI the most useful system for delineating between the two taxa. However the patterns observed in 6-PGD and MNR are almost as informative. Despite the apparent complexity of MNR in *C. vulpina*, only 20% of *C. vulpina* expressed the same pattern as that found in *C. otrubae*.



FIGURE 3a. ZYMOGRAM FOR THE ENZYME GPI.



FIGURE 3b. ZYMOGRAM FOR THE ENZYME 6-PGD.



FIGURE 3c. ZYMOGRAM FOR THE ENZYME MNR.

TABLE 2. LANE IDENTIFICATION FOR ISOZYME RESULTS

Lane no.	Site	Lane no	Site	Lane no	Site	Lane no	Site
1	Blackthorne	6	Ashleworth	11	Besley Farm Wet	16	Port William
2	Amberly Wild Brooks	7	Love Farm	12	Donnington	17	Gait Barrows
3	Ashleworth	8	Hawbridge	13	Rixton	18	Crossens
4	Ashleworth	9	Germany	14	Ashleworth	19	Hesketh Marsh
5	Ashleworth	10	Besley Farm	15	Coombe Hill	20	Point of Ayr

Tracks 1–11 inclusive are *Carex vulpina*, LANES 12–20 are *Carex otrubae*.

TABLE 3. STOMA MEASUREMENT RANGES FOR *CAREX VULPINA* AND *C. OTRUBAE*

Character	Data	<i>C. vulpina</i>	<i>C. otrubae</i>
Stomatal length (um)	Sample size <i>n</i>	260	160
	Mean	29.9	29.28
	Range	(22.15–41.13)	(22.15–39.97)
Stomatal width (um)	Mean	24.18	31.88
	Range	(18.95–31.64)	(25.94–37.87)
Stomatal index	Mean	1.24	0.92
	Range	(1.07–1.5)	(0.71–1.31)

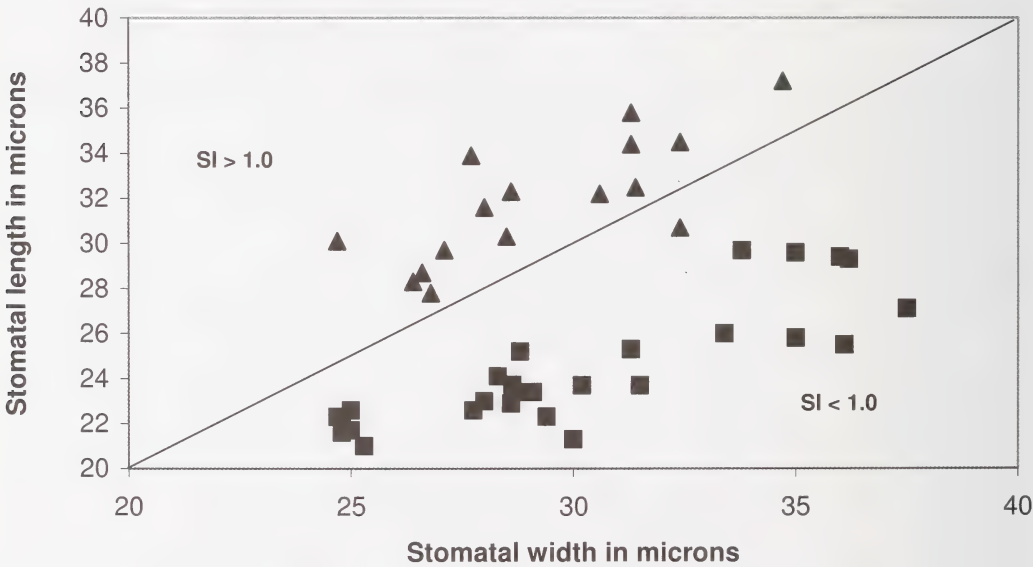


FIGURE 4. Comparison of stomatal index (SI) between *Carex otrubae* (▲) and *C. vulpina* (■).

The interspecific variation in nutlet surface features revealed by SEM coupled with an absence of intraspecific variation, if confirmed across a wider population range, suggests that this method would be a useful tool in identifying hybrids. Schuyler (1971) has used such an approach within morphologically

similar *Scirpus* and *Eriophorum*, hybrids revealing intermediate morphology, although some hybrids such as those between *Scirpus atrovirens* and *S. hattorianus*, proved difficult to evaluate due to the absence of viable seeds. The pattern of variation found in *C. vulpina* and *C. otrubae* avoids the problem of

insufficient variation found by Olgun & Beyazoglu (1997) among Turkish members of *Carex* section *Mitratae* where nutlet micromorphology is uniform and thus of little use in delineating between the three species of the section. However the small sample size makes it difficult to confirm if nutlet micromorphology in these species avoids the problem of too much variation, as recorded by Salo *et al.* (1994), whose study of the *Carex flava* complex revealed a high level of intraspecific variation with no fidelity of characters within taxa.

The patterns of stomatal shape and isozyme banding are not universal within the two species. One of the *C. otrubae* individuals from Ashleworth exhibits the stomatal shape of *C. vulpina* and two of the *C. vulpina* plants display at least one isozyme pattern typical of *C. otrubae*. These are from Amberley Wild Brooks (6-PGD and MNR) and Hawbridge (MNR only). It is unlikely that this is due to initial mis-identification as the other characters examined in this study in these individuals are consistent with the original identification. The presence of isozyme bands in *C. vulpina* that are much more common in *C. otrubae* may be part of the variation present in *C. vulpina* which will be revealed by a more extensive sample. However this is less likely in the stomatal survey which is already extensive. Moreover the different stomatal shape found in the Ashleworth individual of *C. otrubae* is absent in the other four individuals surveyed from this site, indicating that this is not simply interpopulational variation in this species.

It is notable that two of the three locations yielding anomalous results are sites where the two species were observed to be clearly sympatric. At Ashleworth Ham the two species grow less than 50 m apart and at Amberley Wild Brooks they are immediately adjacent. It is also likely that the two species are sympatric at Hawbridge, the third site showing anomalous results. It is therefore possible that hybridisation between the two species has occurred followed by backcrossing and introgression. The resultant transfer of genes may then result in individuals expressing characters more commonly associated with the other species.

Flatberg (1972) utilised differences in stomatal measurements between *Carex canescens* and *C. chordorrhiza* to confirm the occurrence of a new hybrid between these two species, *C. xlidii*, in Central Norway. However, *C. xlidii* is a sterile F1 hybrid with no record of

introgressants and it is approximately intermediate across a range of characters. This is in contrast to the individual at Ashleworth that has *C. otrubae* characteristics but with *C. vulpina*-shaped stomata.

The best indication of ongoing introgression may be the presence of alleles that are close to fixation in one species but very rare in another (Tyler 2003), such as were observed here with 6-PGD and MNR. Isozymes have been used to detect local introgression between *Carex pallens* and *C. ornithopoda* or *C. digitata* in Scandinavia (Tyler 2003). Moreover the position of *C. vulpina* in England, consisting of small populations at the edge of the species' distribution in Europe may increase the likelihood of introgression. Choler *et al.* (2004) showed that ecologically marginal populations of *Carex curvula* exhibited considerable introgression whereas there was no introgression recorded in those in typical habitats.

CONCLUSION

An extensive survey has shown stomatal shape to be a reliable quantitative method for distinguishing between *C. vulpina* and *C. otrubae*. The data have been found to be statistically robust and show a clear and unambiguous division along species lines. It is by no means a field test but reliable results can be had within half an hour. It is achieved at low cost and with equipment found in most laboratories. Where anomalies have been found it is on sites where the species grow sympatrically. From this preliminary study isozymes and SEM of nutlet surface also allow distinction between the two species. In addition the methods and pattern of variation described here provide the tools for a fuller investigation into the extent and nature of hybridisation and introgression between *C. otrubae* and *C. vulpina*.

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REFERENCES

- ABBOTT, R. J. (1993). Genetic diversity in *Primula scotica* Hook. Unpublished SNH report number SNH/030B/93/IBB.
- ASHTON, P. A. (1990). Multiple Origins of *Senecio cambrensis* Rosser, and related evolutionary studies in British *Senecio*. Unpublished Ph.D. thesis. St. Andrews University.
- CRAWFORD, F. C. (1910). *Anatomy of the British Carices*. Oliver and Boyd, Edinburgh.
- CHOLER, P. *et al.* (2004). Genetic introgression as a potential to widen a species' niche: Insights from *Carex curvular*. *Proc. Ntl. Acad. Sci. USA* **101**:171–176.
- ERSKINE, S. E. & LAMBRICK, C. L. (2000). True Fox Sedge, *Carex vulpina*, in Oxfordshire in 2000. Ashmolean Natural History Society of Oxfordshire, Rare Plants Group, Oxford.
- FLATBERG, K. I. (1972). *Carex* × *lidii* Flatb. = *C. canescens* L. × *chordorrhiza* Ehrh., a New Hybrid. *Norwegian Journal of Botany* **19**: 91–106.
- FOLEY, M. J. Y. & PORTER, M. S. (1999). *Carex vulpina* L. – morphological differentiation from *Carex otrubae* Podp. *BSBI News* **81**:74.
- FORD, B. A., BALL, P. W. & RITLAND, K. (1991). Allozyme diversity and genetic relationships among North American members of the short-beaked taxa of *Carex* sect. *Vesicariae* (Cyperaceae). *Systematic Botany* **16**: 116–131.
- MARSHALL, E. S. (1897). A new British hybrid sedge from Surrey. *The Journal of Botany, London* **35**: 491–492.
- MCCLINTOCK, K. A. & WATERWAY, M. J. (1993). Patterns of allozyme variation and clonal diversity in *Carex lasiocarpa* and *C. pellita* (Cyperaceae). *American Journal of Botany* **80**: 1251–1263.
- METCALFE, C. R. (1971). *Anatomy of the Monocotyledons. vol. V. The Cyperaceae*. Oxford University Press, Oxford.
- NELMES, E. (1939). Notes on British Carices – IV. *The Journal of Botany, London* **77**: 259–266.
- NELMES, E. (1946). Plant Notes. *Bot. Soc. and Exchange Club of the British Isles*. 692.
- PORLEY, R. D. (1999). Separation of *C. vulpina* and *C. otrubae* Podp. (Cyperaceae) using transverse leaf sections. *Watsonia* **22**: 431–432.
- PRESTON, C. D., PEARMAN, D. A. & DINES, T. D. (2002). *New Atlas of the British and Irish Flora*. Oxford University Press, Oxford.
- REINHAMMAR, L. G. (1999). Allozyme differentiation between the lowland *Carex capitata* and the alpine *Carex arctogena* (Cyperaceae) in Scandinavia. *Biological Journal of the Linnean Society* **67**: 377–389.
- SCHUYLER, A. E. (1971). Scanning electron microscopy of achene epidermis in species of *Scirpus* (Cyperaceae) and related genera. *Proc. Acad. Nat. Sci. Phila.* **123**: 29–52.
- SENAY, P. (1950). Le *Carex Vulpina* et ses Allies. *Bull. Mus. Hist. Nat.* **Second series**, 332–339.
- SOLTIS, D. E. S., P.S. (1990). *Isozymes in Plant Biology*, vol. 1 (ed. T. R. Dudley). Chapman & Hall., London.
- STACE, C. A. (1975). *Hybridization and the Flora of the British Isles*. Academic Press., London.
- STARR, J. R. & FORD, B. A. (2001). The taxonomic and phylogenetic utility of vegetative anatomy and fruit epidermal silica bodies in *Carex* section *Phyllostachys* (Cyperaceae). *Can. J. Bot.* **79**: 362–379.
- WENDEL, J. F. (1990). Visualisation and interpretation of plant isozymes, in SOLTIS, D. E. S., P.S. (1990). *Isozymes in Plant Biology*, vol. 1, pp. 5–45. Chapman & Hall, London.

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APPENDIX

TABLE 4A. GERMINATION RATES FOR *CAREX VULPINA* YEAR 2002

Population	Species	Start date	Completion date	% Germination
Hawbridge	<i>C. vulpina</i>	12/02/2002	05/04/2002	53%
*R. Porley	<i>C. vulpina</i>	12/02/2002	05/04/2002	70%
Ashleworth	<i>C. vulpina</i>	12/02/2002	05/04/2002	62%
		AVERAGE % GERMINATION		61.70%

* This material was supplied by the named person and probably came from Otmoor.

TABLE 4B. GERMINATION RATES FOR *CAREX VULPINA* FOR YEAR 2003

Population	Species	Start date	Completion date	% Germination
Besley Farm	<i>C. vulpina</i>	28/01/2003	24/03/2003	36%
Hawbridge	<i>C. vulpina</i>	28/01/2003	24/03/2003	90%
Asham Meads	<i>C. vulpina</i>	28/01/2003	24/03/2003	54%
*R. Porley	<i>C. vulpina</i>	28/01/2003	24/03/2003	62%
Ashleworth	<i>C. vulpina</i>	28/01/2003	24/03/2003	96%
		AVERAGE % GERMINATION		67.60%

TABLE 5A. STOMATAL INDEX OF *CAREX OTRUBAE* SAMPLE SIZE N = 10

Site	AH Ot1	AH Ot2	AH Ot3	AH Ot4	AH Ot5	CH Ot1	CH Ot2	CR Ot1
Mean	0 934	0 887	1 064	0 968	0 913	0 826	0 942	0 823
SED	0 067	0 07	0 132	0 071	0 054	0 098	0 066	0 059
Variance	0 005	0 005	0 018	0 005	0 003	0 01	0 004	0 004
Site	D Ot1	D Ot2	GB Ot1	PA Ot1	PW Ot1	RI Ot1	RI Ot2	RI Ot3
Mean	0 913	0 962	0 929	0 888	0 932	0 954	0 943	0 876
SED	0 034	0 055	0 056	0 066	0 041	0 09	0 06	0 042
Variance	0 001	0 003	0 003	0 004	0 002	0 008	0 004	0 002

TABLE 5B. STOMATAL INDEX OF *CAREX VULPINA* SAMPLE SIZE N = 10

Site	AH V1	AH V2	AH V3	AH V4	AH V6	AM V1	AM V2	AMB V1
Mean	1 13	1 108	1 111	1 157	1 231	1 208	1 231	1 292
SED	0 072	0 08	0 134	0 131	0 061	0 054	0 076	0 108
Variance	0 005	0 006	0 018	0 017	0 004	0 003	0 006	0 012
Site	AMB V1	AMB V2	BF V1	BF V2	BMP V1	CZR V1	GE V1	GE V2
Mean	1 224	1 24	1 146	1 391	1 25	1 14	1 277	1 243
SED	0 118	0 089	0 054	0 113	0 088	0 073	0 071	0 106
Variance	0 014	0 008	0 003	0 013	0 008	0 005	0 005	0 011
Site	GE V3	GE V4	GE V5	HA V1	LF V2	OT V1	OT V2	OT V3
Mean	1 329	1 155	1 415	1 214	1 417	1 178	1 248	1 323
SED	0 089	0 074	0 154	0 077	0 07	0 047	0 098	0 097
Variance	0 008	0 006	0 024	0 006	0 005	0 002	0 01	0 009
Site	OT V4	RP V2						
Mean	1 219	1 259						
SED	0 062	0 113						
Variance	0 004	0 013						

Epitypification of *Carex vulpina* L. (Cyperaceae)

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ABSTRACT

The designated lectotype of *Carex vulpina* is an immature plant, misleading in respect to the correct application of the name, since important taxonomic characters are undeveloped. Also, the specimen is found to be partly in conflict with the protologue. Other elements cited by Linnaeus have been examined but fail to clarify the application. To assist in this, an epitype is designated.

KEYWORDS: *Carex otrubae* Podp., epitype, lectotype, Linnaeus, nomenclature, protologue.

INTRODUCTION

Carex vulpina L. was originally described in *Species plantarum* (Linnaeus 1753) with the diagnosis “*Carex spica supradecomposita inferne laxiore: spiculis androgynis ovatis sessilibus glomeratis: superne masculis*”, i.e. a species of *Carex* with the spike very many times [decompoundly] divided, laxer below: spikelets androgynous, ovate, sessile, collected close together in a head, male above.

In the Linnaean herbarium (LINN) there is a sheet (1100.22) bearing part of a plant, which comprises a single inflorescence and upper culm but lacks leaves, ligules, lower culm and rhizome and roots. The sheet is annotated in Linnaeus's hand “7 *vulpina*”, the “7” equating to his species number in *Species plantarum*. At the end of his protologue, Linnaeus stated that the plant occurred in Europe in “*paludibus nemorosis*” (wooded marshes). This specimen was selected as the lectotype by Nelmès (1939) and recently accepted as such on photographic evidence by Egorova (1999) but is difficult to reconcile with the current concept and usage of *C. vulpina* and could even be of another taxon. Indeed, Nelmès himself (Nelmès 1939) noted that the lectotype and diagnosis were in some conflict. Despite this, there appears to have been no subsequent discussion regarding his designation.

About 50 years after Linnaeus' publication, Rebutisch (1804) described a new species, *Carex nemorosa* Rebut. However, for long afterwards that name was only applied at infraspecific rank to plants with an interrupted,

long-bracteate inflorescence, common in western and southern Europe and not thought to be specifically distinct from the rarer *C. vulpina*. The latter has a more compact inflorescence with only a few short or vestigial bracts (Hess *et al.* 1967; Schultze-Motel 1968; Chater 1980; Stace 1991; Egorova, 1999).

Eventually however, Haussknecht (1877), who knew *Carex vulpina*, essentially a plant of eastern and northern Eurasian distribution, progressively less frequent to the west and largely replaced there by the commoner *C. nemorosa* of Rebutisch, recognised the latter at specific rank. Despite this, it was only following the work of Nelmès (1939) that its existence as a separate species was more widely acknowledged. The western taxon was now accepted as such, but under the later-published name of *Carex otrubae* Podp. (Podp. 1922) since the name *Carex nemorosa* Schrank had been previously validly published (Schrank 1789) for a different species of *Carex*.

CHARACTERS USEFUL IN DISTINGUISHING *C. VULPINA* FROM *C. OTRUBAE*

Carex otrubae, principally a western European and Mediterranean plant, occurs eastwards to the Middle East, whereas *C. vulpina* is rare in western Europe but much more frequent to the east, especially in Russia and western Asia and as far east as the Altai. As both species occupy the same type of wet, sometimes shaded habitat such as ditch margins and other marshy ground, their identities have often been confused and, in western continental Europe and the British Isles, this has resulted in many erroneous records for *C. vulpina*. Both species can be remarkably similar in general facies although *C. otrubae* is often less robust and this close morphological similarity is reflected in recent molecular work by Hendrichs *et al.* (2004) who were unable to separate the two species by ITS sequence data. Stature and the presence of a large, more or less wedge-shaped inflorescence with few, short bracts superficially points to *C. vulpina* – but this is not always the case so that sole dependence on these characters is not

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reliable. Foley & Porter (1999), after a field study of several British populations of *C. vulpina* together with an examination of a large amount of herbarium material, concluded that the most reliable diagnostic character for distinguishing *C. vulpina* from *C. otrubae* was that originally observed by Samuelsson (1922). This is the presence of more or less papillose, isodiametrically shaped cells on the surface of the adaxial (and often abaxial) side of the usually somewhat smaller, differently shaped, less ridged utricles, as opposed to the non-papillose, elongated-rectangular cells of the larger, distinctly ridged utricles of *C. otrubae*. This cell character is clearly illustrated in Hess *et al.* (1967). In addition, *C. vulpina* differs in having shorter, often almost inconspicuous bracts, an excess of scarious, papery tissue around the ligule and the leaf sheaths (the sheaths themselves often whiter, thinner and more readily split), a shorter, more truncate ligule, and a much earlier time of flowering and fruiting.

Of these characters, the nature and shape of the cells on the surface of the utricles of *Carex vulpina* is considered to be diagnostic (best seen at $\times 100+$ magnification) but in the field, in the absence of any ability to determine this, other characters may be collectively taken into account in order to help in identification. However, in preserved material it is often difficult or even impossible to confirm ligule size and shape whilst, by its very friable nature, any excess scarious tissue around the ligule and leaf sheath may be lost. Additionally, the time of flowering and fruit maturity is often unrecorded. In such cases, identifications relying on utricule size and general plant appearance may lead to errors.

Recently, other criteria for separating the two species, including the comparison of isozymes, the shape of leaf stomata, and the surface characters of the nutlets, have been reported by Smith and Ashton (2006).

LINNAEUS' SPECIMEN IN HERB. LINN

As stated above, the specimen (LINN 1100.22), selected by Nelves (1939) as lectotype, comprises just a single stem and inflorescence and is of an immature plant. The inflorescence is very dense consisting mainly of an agglomerated mass of developing glumes and exserted, but undehiscent anthers, with no evidence of maturing fruits (utricles). Due to the lack of the latter and also of other subsidiary characters such as ligules, leaf

sheaths, etc., it is not possible to unequivocally identify the specimen as falling within current usage of *Carex vulpina* and it could, even possibly, be another taxon. In his selection of this specimen as the lectotype, Nelves (1939) implied doubts as to its suitability stating: "The [diagnostic] phrase 'inferne laxiore' does not fit the specimen in the Linnaean herbarium....", thereby recognising conflict with the protologue. In addition, the inflorescence is not many times divided ("*spica supradecomposita*") and, due to its immaturity, it is also not possible to confirm Linnaeus's statement: 'spikelets androgynous, ovate, sessile, collected closely in a head with male above'.

The shortcomings of this specimen in fixing the correct application of the name *Carex vulpina* and also in its exhibiting some conflict with the protologue, has led to an examination of the additional elements cited by Linnaeus in order to ascertain whether any of these assist in clarifying the situation. They are discussed below.

CITED ELEMENTS

The full protologue of *Carex vulpina* L. reads as follows:

CAREX *spica supradecomposita inferne laxiore: spiculis androgynis ovatis sessilibus glomeratis: superne masculis. Hort. cliff. 438. Fl. suec. 750. Dalib. [Dalibard] paris. 286. Roy. [van Royen] lugdb. 74. Gmel. [Gmelin] sib. 1. p.146. t. 32.*

Carex palustris major, radice fibrosa, caule exquisite triangulari, spica brevi habitiore compacta. Mich. [Micheli] gen. 69. t. 33. f. 13. 14.

Gramen Cyperoides palustre majus, spica compacta. Bauh. [Bauhin] pin. 6. Moris. [Morison] hist. 3. p. 244 s. 8. t. 12. f. 14.

In *Hortus Cliffortianus*, Linnaeus (1738) based his description of "*Carex spica supradecomposita, spiculis androgynis...*" on a specimen now in BM (herb. Clifford, no. 438) but this is *Carex arenaria* L. (cf. Nelves 1939).

The description in *Flora Suecica* (Linnaeus 1745) is presumably based on Swedish material. However, the specimen in the Stockholm herbarium (S LINN) numbered "7" (the *Species plantarum* number) was collected by Loefling in Spain (i.e. post-1745), Linnaeus noting on the reverse of the sheet:

“Hispania 662.6. Loeﬂ.”. An image of this specimen has been examined but appears to be of an immature plant (confirmed as such by the curator of S) and in consequence lacks the developed utricles necessary for certain identification.

The specimens upon which Dalibard (1749) in *Florae Parisiensis* based his description would not have been seen by Linnaeus and are therefore irrelevant for this purpose. Also, it has also not been possible to trace appropriate material in L relating to *Florae Leydensis prodromus* (van Royen 1740).

Gmelin’s plate (Gmelin 1747–1749, t. 32) could have iconotypic potential but is of an immature plant very similar to LINN 1100.22. It could even be from the same collection since Gmelin was known to be in correspondence with Linnaeus and to send him material. Even if the specimen on which it is based is still available, because of its immaturity it is unlikely to confirm the illustration as being of *Carex vulpina* and, in any case, for similar reasons as the LINN specimen, is in some conflict with the protologue and current usage.

Examination of the two illustrations cited in *Nova plantarum genera* (Micheli 1729, t. 33, f. 13 & f. 14) shows f. 14 to be the closer in general facies to Linnaeus’ protologue and to the plant currently accepted as *Carex vulpina*, with the other illustration (f. 13) most definitely less so. In referring to the former (f. 14), the author (Micheli 1729) stated that he received relevant material from William Sherard: “Londino a D. Sherardo missa....”. In the Florence herbarium (FI) [where Micheli’s material is held] there are no specimens referred to *C. vulpina* which have a documented link to Sherard but there is one which bears a Petiver label. These two men exchanged specimens and were close associates, Petiver describing Sherard as “my worthy Friend and Kinsman”. However, examination of the utricles of one of these (specimen 17276 in Herb. Micheli at FI) showed it to be referable to *C. otrubae* but, in any case, it is not necessarily the plant illustrated.

The 17th century herbarium of Joachim Burser is now at Uppsala, Sweden (UPS); here the specimens were arranged and named by Burser in accordance with Bauhin’s *Pinax* (Bauhin 1623) and are known to have been consulted by Linnaeus. Bauhin’s name “*Gramen Cyperoides palustre majus spica compacta*”, cited in Linnaeus’ protologue, is repeated on a sheet (herb. Burser 1: 78 (UPS);

microfiche IDC 1064-1, 78!) containing a specimen with an elongate, lax inflorescence. It is very doubtful, however, that this is *C. vulpina* as currently understood.

Finally, there is the plate in *Plantarum historiae universalis* (Morison 1699, s. 8, t. 12, f. 24 [not “f. 14” as cited by Linnaeus]). In this illustration the long bracts depicted at the base of the spikelets are inconsistent with *C. vulpina* and it almost certainly represents *C. otrubae*.

CONCLUSION

The currently designated lectotype (LINN 1100.22) of *Carex vulpina* (Nelmes 1939) has been found to be in some conflict with the protologue, but not seriously so. An examination of Linnaeus’ cited elements has also shown evidence of some conflict and, in addition, a failure to comply closely with current usage. Despite this, under rules of the *International Code of Botanical Nomenclature* (Greuter *et al.* 2000), it is not possible for the lectotype to be superseded, since in order to be so, it has to be “in serious conflict with the protologue” (Article 9.17(b)). However, the lectotype is a very immature specimen in which important taxonomic characters are undeveloped and is misleading in respect to the correct application of the name. Therefore, in order to fix this application effectively, an interpretative epitype, which conforms closely to current usage, is here designated:

***Carex vulpina* L. Epitypus (hic designatus):** [England] E. Gloucs., v.c. 33, near Haw Bridge, 15 June 2004, M. J. Y. Foley 2020 (BM; duplicates: E, FI, G, LANC).

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REFERENCES

- BAUHIN, C. (1623). [Pinax] *theatri botanici*. Basileae.
- CHATER, A. O. (1980). *Carex* L. in: TUTIN, T. G., HEYWOOD, V. H., BURGESS, N. A., MOORE, D. M., VALENTINE, D. H., WALTERS, S. M. & WEBB, D. A. (eds.) *Flora Europaea* 5: 290–293. Cambridge.
- DALIBARD, T. F. D. (1749). *Florae Parisiensis prodromus*. Paris.
- EGOROVA, T. V. (1999). *The Sedges (Carex L.) of Russia and adjacent states*. St. Petersburg.
- FOLEY, M. J. Y. & PORTER, M. S. (1999). *Carex vulpina* – morphological differentiation from *Carex otrubae*. *B.S.B.I. News* 81: 74.
- GMELIN, J. G. (1747–1749). *Flora Sibirica*. Petropoli.
- GREUTER, W., MCNEILL, J., BARRIE, F. R., BURDET, H.-M., DEMOULIN, V., FILGUERIAS, T. S., NICOLSON, D. H., SILVA, P. C., SKOG, J. E., TREHANE, P., TURLAND, N. J. & HAWKSWORTH, D. L. (eds.). (2000). *International Code of Botanical Nomenclature (St Louis Code)*. Koeltz Scientific Books. Königstein.
- HAUSSKNECHT, C. (1877). Bemerkungen zu *Carex nemorosa* Rebentisch. *Oesterr. Bot. Zeitschr.* 27: 153–156.
- HENDRICH, M., MICHALSKI, S., BEGEROW, D., OBERWINKLER, F. & HELLWIG, F. H. (2004). Phylogenetic relationships in *Carex*, subgenus *Vignea* (Cyperaceae), based on ITS sequences. *Plant Systematics and Evolution* 246: 109–125.
- HESS, E., LANDOLT, E. & HIRZEL, R. (1967). *Flora der Schweiz und angrenzender Gebiete* 1. Basel & Stuttgart.
- LINNAEUS, C. (1738). *Hortus Cliffortianus*. Amstelredami.
- LINNAEUS, C. (1745). *Flora Suecica*. Stockholmiae.
- LINNAEUS, C. (1753). *Species plantarum*. Holmiae.
- MICHELL, P. A. (1729). *Nova plantarum genera*. Florentiae.
- MORISON, R. (1699). *Plantarum historiae universalis* 3. Oxonii.
- NELMES, E. (1939). Notes on British Carices, IV. *Carex vulpina* L. *Journal of Botany* 77: 259–266.
- PODP. RA, J. (1922). Plantae Morivicae novae vel minus cognitae. *Spisy P. řídovedeckou Fakulty Masarykovy University*, 12: 1–35.
- REBENTISCH, J. F. (1804). *Prodromus florae neomarchicae*. Berolini.
- ROYEN, A. VAN (1740). *Florae Leydensis prodromus*. Lugduni Batavorum.
- SAMUELSSON, G. (1922). Floristiska Fragment IV: 2. *Carex nemorosa* Reben. och *C. vulpina* L. *Svensk Botanisk Tidskrift* 16: 207–220.
- SCHRANK, F. VON P. (1789). *Baiersche Flora* 1. München.
- SCHULTZE-MOTEL, W. (1968). Cyperaceae in: Hegi, G. (ed.) *Illustrierte Flora von Mitteleuropa* II(1): 2–274. Hamburg.
- SMITH, C. & ASHTON, P. A. (2006). Distinction between the sedges *Carex vulpina* L. and *C. otrubae* Podp. and the potential for identification of hybrids. *Watsonia* 26: 15–25.
- STACE, C. A. (1991). *New Flora of the British Isles*. Cambridge.

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A reassessment of the distribution of *Carex recta* Boott (Cyperaceae) in the British Isles

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ABSTRACT

Carex recta Boott (Cyperaceae), Estuarine Sedge, is a rare sedge in the British Isles and is currently known from only three sites in Scotland. At another Scottish locality a presumed hybrid *C. acuta* × *recta* has been identified. The morphological distinction between *C. recta* and *C. acuta* was investigated using qualitative and quantitative characters. Using the characters that discriminate between these two species, the presumed hybrid has been reassessed and is identified as *C. recta*.

KEYWORDS: Estuarine Sedge, hybridisation, morphology, multivariate analysis.

INTRODUCTION

Carex recta Boott (Estuarine Sedge) is one of the seven species in *Carex*, subgenus *Carex*, section *Phacocystis* found in the British Isles. It is a Red Data Book species currently recognised from only three 10 km squares, all located in north-eastern Scotland (Wigginton 1999; Preston *et al.* 2002). *C. recta* grows in brackish marshes and on the tidal flats of rivers and estuaries, towards the upper parts of the tidal influence. It is found where there is a supply of fresh water draining into the area. Although a rare sedge in the British Isles, it has an amphiatlantic distribution and is not uncommon in parts of its North American range where it extends from the shores of Hudson Bay and along the coast and river estuaries on the eastern coast from Labrador in the north to Maine in the south (Cayouette & Catling 1992).

The earliest records of *C. recta* in the British Isles are from specimens collected as *C. kattergatensis* Fr. and *C. salina* var. *kattergatensis* Alm. from the River Wick in 1885 by J. Grant and H. N. Ridley (Marren 1999). It was subsequently found and collected from the River Beaulieu in 1888 by G. C. Druce, and in 1967 Faulkner discovered the third site on both banks of the Kyle of Sutherland at Invershin.

Downriver from the location at Invershin, close to Bonar Bridge, are several stands of sedges with the characteristics of species in section *Phacocystis*. The local Flora records carices at Bonar Bridge as representing another member of the section, *C. acuta* L. (Slender Tufted Sedge) “det. Chater with signs of introgression with *C. recta*” (Duncan 1980).

Specimens in this section presenting the typical morphological form can be separated using any of the sedge keys to British species, for example (Jermy *et al.* 1982; Rose 1989; Sell & Murrell 1996; Stace 1997). However, due to intraspecific morphological variation, hybridisation and introgression, this section has been considered difficult, and uncertainty over the correct identification of some specimens is recognised across Europe (Sylvén 1963; Hylander 1966; Jermy *et al.* 1982). In the field the Bonar Bridge populations present many similarities to *C. recta*. Although all the specimens examined had long female glumes at the base of the female spikes, not all of them had awned glumes in this position, the feature often considered characteristic of *C. recta*.

As there are so few sites for this species it is important to establish its current distribution. This paper aims to reassess the identification of the Bonar Bridge populations, currently reported as *C. acuta* × *recta*, using morphological and stomatal density measurements. Multiple characters have been analysed in recent studies to determine relationships between closely related *Carex* taxa (Blackstock & Ashton 2001; epka 2003). Similar techniques may also reveal novel character combinations that are useful in distinguishing between these taxa.

METHODS

Live material of *C. recta*, *C. acuta* and the Bonar Bridge carices was examined for this study (Table 1). Herbarium material (OXF) was used to supplement measurements made in

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TABLE 1. ORIGINS OF *CAREX* SECTION *PHACOCYSTIS* SPECIMENS USED IN THE STUDY

Taxon	Location	Grid Ref.	v.c.	No. of specimens used	
				Morphological study	Stomatal density
<i>C. recta</i>	Wick, north bank River Wick, Caithness	ND354514	109	22	10
	Invershin (south bank), E. Ross	NH578953	106	21	10
	River Beauly, Beauly, Easternness	NH539465	96	19	10
<i>C. acuta</i>	Formby, Merseyside	SD278071	59	10	1
	Lazonby, Cumbria	NY552403	70	5	1
	Edenhall, Cumbria	NY571327	70	3	1
	River Severn, Shropshire	SJ538085	40	1	1
	Three Cornered Meadow, Denbighshire	SJ406582	50	1	6
Bonar Bridge taxon	Bonar Bridge West of road bridge, E. Ross	NH607917	106	19	5
	Bonar Bridge East of road bridge, E. Ross	NH608913	106	20	5

the field. Stomatal density data were obtained from plants in cultivation.

The total of 62 characters that were used in this study were separated into quantitative and qualitative characters, and specimens were measured and assessed in the field in June and July 2001 and July 2002. Characters examined for this study were selected from the characters used for section *Phacocystis* by Standley (1987) with additional characters considered relevant to *C. recta* and *C. acuta*. Morphometric measurements were made in the field from randomly selected culms and vegetative shoots from specimens at least 2 m apart. Wherever possible, culms and vegetative shoots were taken from the same genet, although in some cases the closely packed nature of the stands of sedges means it was not possible for this to be determined. Measurements of the youngest mature leaf (i.e. the one most central to the vegetative shoot or flowering shoot) were recorded separately for vegetative leaves, defined as the leaves forming a sterile shoot, and for culm leaves, defined as the leaves surrounding the basal part of the culm and forming a fertile shoot. In a few specimens the culm leaf was sheathing the culm for just over half its length, so in these specimens culm leaf width was measured from 1 cm above the top of the sheath instead of at the midpoint.

Due to lack of fertility and mechanical damage, there were incomplete data for some specimens. To maintain consistency of characters employed in the analysis with minimum

loss of data, these characters were excluded. This meant that the qualitative characters often used to distinguish between species such as female glume and utricle characteristics were not available for use (Jermy *et al.* 1982). The 17 qualitative and 14 quantitative characters used in further analysis are shown in Table 2. Quantitative analyses of genus *Carex* have used similar numbers of characters: eleven characters (Blackstock & Ashton 2001), 15 characters (Waterway 1994), 17 characters (McClintock & Waterway 1994) and 27 characters (epka 2003).

Qualitative characters were checked for consistency within a taxon and compared for differentiation between taxa. MINITAB™ version 13 software (Minitab Inc. 2001) was used to calculate analysis of variance (ANOVA), principal components analysis (PCA) and discriminant analysis (DA). Prior to running ANOVA, quantitative data were checked for normality and outliers using Anderson-Darling test and boxplots respectively. Variances were checked manually as automatic testing of variance can be too sensitive (Quinn & Keough 2002). Log₁₀ and square root transformations were used to reduce deviations from normality, and where this did not remove outliers, ANOVA was run both with and without outliers. Following ANOVA testing, characters for which there was a significant difference at the 5% level were further analysed by Tukey's HSD test. Standardised scores with a mean of zero and standard deviation of one were used for PCA,

TABLE 2. MORPHOLOGICAL CHARACTERS ANALYSED

Quantitative characters	Qualitative characters
1 Proximal bract length	1 Auricles at bract base - absent/present
2 Proximal bract width at midpoint *	2 Culm angle shape - obtuse/acute
3 Culm leaf length*	3 Culm angle texture - smooth/rough
4 Culm leaf width at midpoint*	4 Culm leaf margin teeth - absent/present
5 Culm length*	5 Leaf (vegetative) margin teeth - absent/present
6 Inflorescence length	6 Leaf (vegetative) section type - v-shape/keeled/plicate
7 Leaf (vegetative) length	7 Leaf (vegetative) tip shape - trigonous/not trigonous
8 Leaf (vegetative) width at midpoint	8 Leaf sheath mouth shape - concave/straight/convex/diagonal
9 Ligule length	9 Leaf sheath on decaying - persists entire/becomes fibrillose
10 Female spike length (distal female spike)*	10 Ligule (vegetative leaf) apex shape - acute/obtuse/rounded
11 Peduncle length (distal female spike)*	11 Ligule length (relative to leaf width) - >leaf width/≤ leaf width
12 Female spike length (proximal female spike)	12 Female glume colour
13 Peduncle length (proximal female spike)*	13 Female spike (distal) orientation - erect/pendent
14 Male spike length (terminal spike)*	14 Female spike (distal) male at apex - absent/present
	15 Female spike (proximal) orientation - erect/pendent
	16 Utricle beak - indistinct/distinct short-beak
	17 Utricle nerves - absent/present

* indicates 8 characters used in second DA

which was run using a correlation matrix. DA processed two *a priori* groups of *C. recta* and *C. acuta* using linear discriminant analysis. The sample of the taxon from Bonar Bridge was then added to the DA to predict group membership. The two original groups are not of equal size (62 and 20) and the larger group can have undue influence (Hair *et al.* 1998). A second DA was run with a randomly selected subset of the *C. recta* sample containing 20 specimens so that both groups were the same size. It is recognised that this is a small total sample size for DA, and it necessitated reducing the number of variables from 14 to eight to maintain the 5:1 ratio of specimens to variables recommended (Hair *et al.* 1998). Variables retained were those for which ANOVA had calculated the greatest significant differences in means between the *C. recta* and *C. acuta* samples.

Specimens for the stomatal density study were selected from those in cultivation at Edge Hill, with one mature leaf per specimen used (Table 1). Epidermal replicas of both leaf surfaces were obtained from the middle 5 cm of mature vegetative leaves and applied to microscope slides, adapting a method used for

the leaves of grasses (Poaceae) (Rice *et al.* 1979). Stomata were counted from near the central vascular bundle of the leaf in a quadrat formed by a square graticule using 400× magnification. Five replicates per surface were counted per specimen, and counts were converted to density/mm².

It is intended that voucher specimens will be deposited at Liverpool Museum (LIV) at the end of the associated work.

RESULTS

MORPHOLOGY

Eleven of the 17 qualitative traits considered are shared by *C. recta* and *C. acuta*, four do not present consistent traits and only two can be used to differentiate between the two species (Table 3). This lack of variation precluded any meaningful form of multivariate analysis of the qualitative data. The two are angle texture at the top of the culm (smooth in *C. recta* and rough in *C. acuta*), and absence/presence of nerves on the utricles (absent in *C. recta* and present in *C. acuta*). Comparing the traits presented by the Bonar Bridge sample for these

TABLE 3. *CAREX RECTA*, *CAREX ACUTA* AND BONAR BRIDGE TAXON QUALITATIVE CHARACTER TRAITS

No.	Character	<i>C. recta</i> trait	%	<i>C. acuta</i> trait	%	<i>C. recta</i> & <i>C. acuta</i> shared trait	Bonar Bridge taxon trait	%	alignment
1	auricles	present	94	present	100	yes	present	100	both
2	culm angle shape	acute	100	acute	100	yes	acute	100	both
3	culm angle texture	smooth	90	rough	100	no	smooth	69	69% <i>C. recta</i>, 31% <i>C. acuta</i>
4	culm leaf margin teeth	absent	74	absent	95	yes	absent	82	both
5	veg leaf margin teeth	absent	53	present	100	partial	absent	82	not as <i>C. acuta</i>
6	veg leaf section type	weakly plicate	66	weakly plicate	80	yes	weakly plicate	62	both
7	veg leaf tip shape	not trigonous	95	not trigonous	100	yes	not trigonous	100	both
8	leaf shth. mouth shape	concave	92	concave	65	yes	concave	100	both
9	leaf shth. on decaying	not fibrillose	100	not fibrillose	100	yes	not fibrillose	100	both
10	ligule apex shape	acute	97	acute	50	partial	acute	100	<i>C. recta</i>
11	ligule relative length	> leaf width	61	< or = leaf width	70	partial	> leaf width	72	<i>C. recta</i>
12	f glume colour	dark / black	100	dark / black	100	yes	dark / black	100	both
13	f sp. dist orientation	erect	97	erect	100	yes	erect	100	both
14	f sp. dist male apex	absent	53	present	85	inconclusive	absent	51	n/a
15	f sp. prox orientation	erect	87	erect	100	yes	erect	95	both
16	utricle beak	short-beaked	100	short-beaked	100	yes	short-beaked	100	both
17	utricle nerves	absent	94	present	100	no	absent	100	<i>C. recta</i>

The two characters that distinguish between the species are shown in bold
 Characters and character traits are as shown in Table 2

TABLE 4. QUANTITATIVE CHARACTER MEANS (OUTLIERS INCLUDED) FOR *CAREX RECTA*, *CAREX ACUTA* AND BONAR BRIDGE TAXON

Character	<i>C. recta</i>	<i>C. acuta</i>	Bonar Bridge	<i>P</i>
Proximal bract length/mm	254 a	216 b	211 b	***
Proximal bract width at midpoint/mm	6 2 a	4 1 b	5 2 c	***
Culm leaf length/mm	538 a	738 b	507 a	***
Culm leaf width at midpoint/mm	6 7 a	5 3 b	5 5 b	***
Culm length/mm	728 a	1075 b	640 c	***
Inflorescence length/mm	181 ab	191 b	167 a	*
Leaf (vegetative) length/mm	1047 a	1243 b	1001 a	***
Leaf (vegetative) width at midpoint/mm	5 9 a	6 6 b	5 4 a	***
Ligule length/mm	6 5	5 7	6 5	ns
Female spike length/mm (distal female spike)	32 2 a	48 2 b	31 2 a	***
Peduncle length/mm (distal female spike)	4 5 a	0 4 b	5 3 a	***
Female spike length/mm (proximal female spike)	60	58	55	ns
Peduncle length/mm (proximal female spike)	14 2 a	3 6 b	20 0 c	***
Male spike length/mm (terminal spike)	30 0 a	45 5 b	26 5 c	***

P = level of significant difference: * < 0.05; ** < 0.01; *** < 0.001. ns = no significant difference

Means followed by the same letter are not significantly different at *P* = 0.05

Means of characters transformed before ANOVA are shown as reverse of the transformation

two characters, utricles lack nerves, but culm angle texture was variable. The traits presented for three other characters, the absence of teeth on the vegetative leaf margin, acute ligule apex shape and ligule longer than leaf width, place the sample closer to *C. recta*.

ANOVA between the *C. recta* and *C. acuta* samples detected significant differences in means for eleven of the 14 characters. Removal of outliers from the data had no effect on the analysis as it did not change the level of significance of differences in means for any character. However, although the means may be significantly different, there is overlap in range between the samples in all 14 characters (data not presented). When the Bonar Bridge sample was included and the analysis included all three taxa, ANOVA detected significant differences in means between at least two taxa in twelve of the 14 characters (Table 4). In four of the twelve characters all three taxa were significantly different from each other. The Bonar Bridge sample has the lowest means for nine characters, the highest means for both peduncle lengths, and the same mean as *C. recta* for ligule length. *C. acuta* has the lowest means for both culm leaf width and bract width, the two characters for which the Bonar Bridge sample is intermediate (Table 4). Overall *C. acuta* is the tallest of the three and has the longest terminal male spikes and distal female spikes, *C. recta* is intermediate and

Bonar Bridge the smallest. The range of measurements obtained from the Bonar Bridge sample also overlaps with the other two taxa for all characters. Removing outliers and rerunning ANOVA again had minimal effect on results.

The PCA of the three taxa involved, *C. recta*, *C. acuta* and Bonar Bridge, has not separated the taxa along any of the first three components, which contribute 30.6%, 20.6% and 11.9% of the variation respectively (Table 5). Characters contributing most to PC1 are culm leaf length, culm length and terminal male spike length, and to PC2 proximal bract width, culm leaf width and proximal female spike length. Graphically Figure 1 shows the extent of the overlap between these taxa on both PC1 and PC2. *C. acuta* does have the highest 13 scores along PC1, but does not separate along this axis because the remaining seven are within the range shown by the other two taxa. Bonar Bridge presents a similar range of scores to *C. recta* along both PC1 and PC2. All three taxa overlap along PC2 and PC3 (not shown), although the *C. acuta* scores cluster towards the higher end.

DA of the two *a priori* groups of the original *C. recta* and *C. acuta* samples correctly classified each specimen. The sample from Bonar Bridge was then added to the analysis for prediction of group membership and this assigned all 39 specimens to the *C. recta* group.

TABLE 5. LOADINGS FOR THE FIRST THREE PRINCIPAL COMPONENTS FROM PCA OF *CAREX RECTA*, *CAREX ACUTA* AND BONAR BRIDGE

Eigenvalue	4.2789	2.8826	1.6594
Proportion	0.306	0.206	0.119
Cumulative	0.306	0.512	0.630
Variable	PC1	PC2	PC3
proximal bract length	0.162	-0.297	-0.533
proximal bract width	-0.084	-0.496	-0.149
culm leaf length	0.425	0.068	-0.053
culm leaf width	0.030	-0.472	-0.127
culm length	0.424	0.057	0.147
inflorescence length	0.260	-0.292	-0.233
vegetative leaf length	0.324	0.142	-0.097
vegetative leaf width	0.262	-0.081	-0.037
ligule length	0.046	-0.013	-0.074
distal female spike length	0.274	-0.122	0.524
distal female spike peduncle length	-0.213	-0.288	0.325
proximal female spike length	0.128	-0.384	0.310
proximal female spike peduncle length	-0.253	-0.269	0.237
terminal male spike length	0.401	-0.067	0.223

The three highest loadings for each component are shown in bold

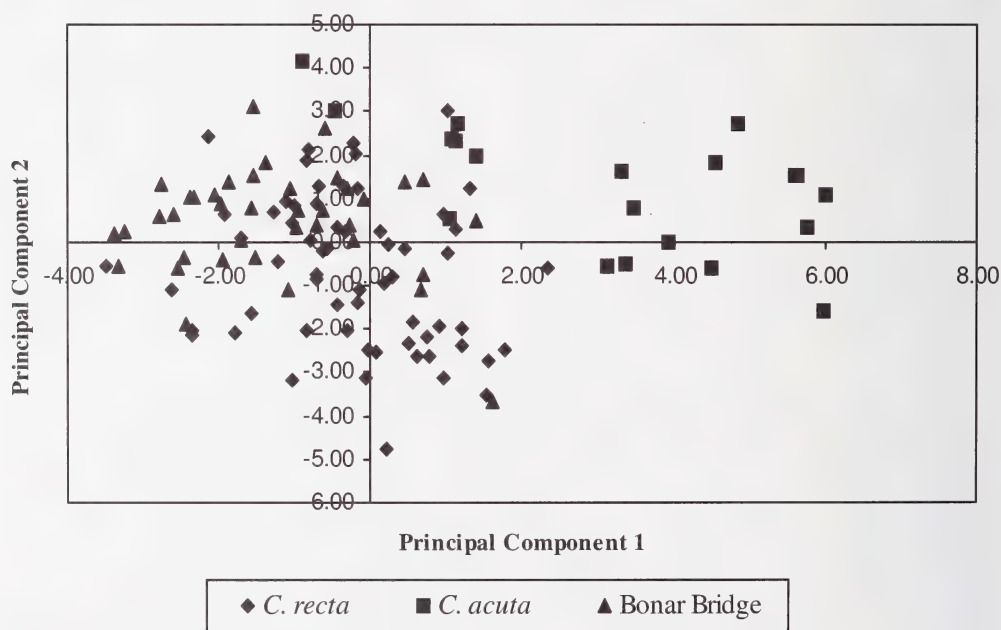
FIGURE 1. PCA Scatter Plot of PC1 v PC2 for *Carex recta*, *Carex acuta* and Bonar Bridge taxon.

TABLE 6. STOMATAL DENSITIES/MM²

Species/site	Adaxial surface			Abaxial surface		
	min	median	max	min	median	max
<i>C. acuta</i>	0	0	20	435	711	1225
<i>C. recta</i> Wick	0	20	138	178	365	573
<i>C. recta</i> Beaully	119	217	415	119	237	454
<i>C. recta</i> Invershin	138	375	474	79	237	415
Bonar Bridge taxon	79	277	494	59	217	454

For 35 specimens the probability that *C. recta* was the correct group was 100%, for the remaining four it was >90%. The second DA of the two even sized groups of 20 specimens and using eight characters also correctly classified each specimen as *C. recta* or *C. acuta*. The predicted classification for the Bonar Bridge specimens in the second DA was 38 *C. recta* and one *C. acuta*. 34 of the 38 are classified with 100% probability, and the remaining four with probability >95%. The one specimen classified as *C. acuta* was one classified as *C. recta* with <100% probability in the original analysis.

STOMATAL DISTRIBUTION AND DENSITY

There are differences in stomatal distribution between the *C. recta* samples. The Wick sample has no or few stomata on its adaxial surface whereas the other two samples are amphistomatous (Table 6). *C. acuta* has abaxial stomata and the abaxial stomatal density is much higher in this taxon than the other two taxa. The Bonar Bridge sample is amphistomatous and presents minimum, median and maximum densities that are similar to those of the *C. recta* samples from Beaully and Invershin.

DISCUSSION

Before the taxonomic position of the Bonar Bridge taxon can be addressed, the morphological characters that differentiate between *C. recta* and *C. acuta* need to be confirmed. Qualitative data showed that only two of the characters studied, smooth or rough culm angle texture at top of culm, and nerveless or nerved utricles, separated *C. recta* and *C. acuta* respectively (Table 3). To use just these two characters is insufficient, and is not completely reliable as some *C. recta* specimens had rough culm angles, so quantitative

characters also need to be included. However, most of these show considerable overlap, even if the means are significantly different (Table 4). This emphasises the difficulties in working with morphologically variable taxa. It may not be possible to identify an individual specimen with certainty if it is not of typical form. Therefore it is beneficial to measure characters from sufficient specimens selected randomly from recognised populations to produce a table of character means, against which new specimens can be assessed. Considering the characters that may be useful in separating the two species, in general *C. recta* has shorter culms and culm leaves, shorter distal female spike and terminal male spike, and longer peduncles. In contrast, *C. acuta* is a larger sedge, with longer terminal male spike and distal female spike, but short peduncles, the distal female spike usually sessile. In addition, with sufficient specimens multivariate analyses can be used, and both the DA with the full *C. recta* sample and the DA with the equal sized *C. recta* and *C. acuta* samples classified all *C. recta* and *C. acuta* specimens correctly. This confirms that the set of characters used can differentiate between *C. recta* and *C. acuta*.

A hybrid taxon may be expected to be morphologically intermediate between the parental species in most characters (Flatberg 1972; Waterway 1994). However, an intermediate morphology is not found in the Bonar Bridge samples. Comparison with the differentiating criteria for qualitative characters, the Bonar Bridge sample usually has smooth culm angles and nerveless utricles, indicating an affinity with *C. recta* (Table 3). Analysis of quantitative characters (Table 4) indicates the Bonar Bridge samples generally have lower means than the other two taxa. Except for peduncle lengths, the Bonar Bridge sample is consistent with a smaller form of the *C. recta* found elsewhere in the British Isles. The

sample means for several of the length characters, culm leaf, culm, inflorescence, vegetative leaf, distal female spike and terminal male spike, are significantly lower than the *C. acuta* sample, so the Bonar Bridge sample is much smaller than *C. acuta*. Overall, of the three taxa, the Bonar Bridge sedges are the smallest. Stomatal density and distribution also align the Bonar Bridge samples with *C. recta* (Table 6).

PCA did not separate the three taxa, but the complete overlap of the Bonar Bridge and *C. recta* samples along the first two axes implies a very close similarity between the two (Fig. 1). DA also identified a close proximity between *C. recta* and the Bonar Bridge taxon, classifying all 39 specimens as *C. recta* in the first run, and all but one in the second run with reduced volume of data.

There is also strong circumstantial evidence against the presence of a *C. acuta* × *recta* hybrid at Bonar Bridge. Although pre-1970 records indicate that *C. acuta* was found at Strathpeffer in the same vice county as the presumed hybrid (Duncan 1980), the current distribution of *C. acuta* in the UK extends no further north in Scotland than the Clyde-Forth line, so the recognised distributions of *C. acuta* and *C. recta* do not overlap (Preston *et al.* 2002). In addition studies including experimental hybridisation between *C. recta* and *C. acuta* produced a low mean seed set, although this was based on a small sample (Faulkner 1973). Combining these two observations it seems unlikely that this inter-specific cross would have occurred naturally.

The evidence presented from morphology, stomatal distribution and geographical location support the reassessment of the Bonar Bridge taxon as *C. recta*. This population and other small ones down river are new records for *C. recta* in East Ross-shire (v.c. 106). This increases the distribution of the plant in the UK from three to five 10-km squares. The *C. recta* population at Invershin, approximately 5 km upriver, is proposed as the progenitor of this population. Clumps detached from the main sedge stand at Invershin have been observed at the edge of the river, and could float downriver and be left stranded on the shoreline or on the edges of the creeks. It is proposed that such events led to the founding of the Bonar Bridge populations and the other small populations found along the estuary. The Bonar Bridge site to the east of the road bridge is very exposed, resulting in a smaller stature, and this may be a product of phenotypic plasticity.

CURRENT DISTRIBUTION

EASTERNESS V.C. 96

On the north bank of the River Beauly approximately 1 km east of the town of Beauly at NH539465. There is a large stand on the flat area beside the river and below the river defence bank. There are scattered sedges in the lagoon area just north of this at NH539466, but these become hidden by the tall, dense vegetation of *Phragmites australis* during the summer.

EAST ROSS-SHIRE V.C. 106

There are three locations on the south-western bank of the Kyle of Sutherland. Furthest upriver near Kilmachalmack from NH503990 to NH508989 although this stand is not continuous.

The second location is below Carbisdale Castle, where there are stands in marshy areas beside the river at NH573958, and there is a large stand of *C. recta* on the riverbank just upriver from the railway bridge at NH578953.

The third location starts at Bonar Bridge at NH6091. There are small stands to the west of the road bridge and one large population to the east of the road bridge. There are several small populations along the river's edge downriver as far as Kincardine including stands at the following grid references: NH604910, NH607894, NH607896 and the furthest downriver at NH605898.

EAST SUTHERLAND V.C. 107

There are locations on the north-eastern bank of the Kyle of Sutherland opposite those on the south-western bank in v.c. 106. Furthest upriver near Altass there is a stand on the riverbank at NH504992 and two stands in a marsh at NH503992 and NH505992.

At the second location near Invershin the population extends along the riverbank from NH575960 to NH578956. Some specimens show signs of hybridisation, probably with *C. nigra* (L.) Reichard. Small, scattered stands of *C. recta* are found upriver at the heads of small bays, for example at NH571967, NH570967 and NH570968. Only one small stand has been found at the third location, Bonar Bridge, at NH610914.

CAITHNESS V.C. 109

On both banks of the River Wick, but mainly on the north bank, just upriver from the town of Wick. On the north bank there is a large stand at ND354514. There are stands extending from ND354514 to ND350516, but amongst these

there are stands with specimens that are introgressed or have hybridised with *C. aquatilis* Wahlenb. On the south bank the stands of *C. recta* show morphological characters of introgression to *C. aquatilis*. There is a stand at ND353513, and there are other small stands close by.

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REFERENCES

- BLACKSTOCK, N. & ASHTON, P. A. (2001). A re-assessment of the putative *Carex flava* agg. (Cyperaceae) hybrids at Malham Tarn (v.c. 64): A morphometric analysis. *Watsonia* **23**: 505–516.
- CAYOUE, J. & CATLING, P. M. (1992). Hybridization in the Genus *Carex* with special reference to North America. *The Botanical Review* **58**: 351–440.
- DUNCAN, U. K. (1980). *Flora of East Ross-shire*. Botanical Society of Edinburgh, Edinburgh.
- FAULKNER, J. S. (1973). Experimental hybridization of north-west European species in *Carex* section *Acutae* (Cyperaceae). *Botanical Journal of the Linnean Society* **67**: 233–253.
- FLATBERG, K. I. (1972). *Carex* × *lidii* Flatb. = *C. canescens* L. × *chordorrhiza* Ehrh., a new hybrid. *Norwegian Journal of Botany* **19**: 91–106.
- HAIR, J. F., ANDERSON, R. E., TATHAM, R. L. & BLACK, W. C. (1998). *Multivariate Data Analysis*. Prentice-Hall International (UK) Ltd, London.
- HYLANDER, N. (1966). *Nordisk Kärnväxtflora*. Almqvist & Wiksell, Stockholm.
- JERMY, A. C., CHATER, A. O. & DAVID, R. W. (1982). *Sedges of the British Isles*, 2nd ed. Botanical Society of the British Isles, London.
- MARREN, P. (1999). *Britain's Rare Flowers*. T. & A. D. Poyser Ltd, London.
- MCLINTOCK, K. A. & WATERWAY, M. J. (1994). Genetic differentiation between *Carex lasiocarpa* and *C. pellita* (Cyperaceae) in North America. *American Journal of Botany* **81**: 224–231.
- MINITAB INC. (2001). *MINITAB User's Guide*. USA.
- PRESTON, C. D., PEARMAN, D. A. & DINES, T. D. (2002). *New Atlas of the British and Irish Flora*. Oxford University Press, Oxford.
- QUINN, G. P. & KEOUGH, M. J. (2002). *Experimental Design and Data Analysis for Biologists*. Cambridge University Press, Cambridge.
- EPKA, R. (2003). The *Carex muricata* aggregate in the Czech Republic: multivariate analysis of quantitative morphological characters. *Preslia* **75**: 233–248.
- RICE, J. S., GLENN, E. M. & QUISENBERRY, V. L. (1979). A rapid method for obtaining leaf impressions in grasses. *Agronomy Journal* **71**: 894–896.
- ROSE, F. (1989). *Grasses, Sedges, Rushes and Ferns of the British Isles and north-western Europe*. Penguin Group, London.
- SELL, P. & MURRELL, G. (1996). *Flora of Great Britain. Butomaceae-Orchidaceae*. Cambridge University Press, Cambridge.
- STACE, C. A. (1997). *New flora of the British Isles*, 2nd ed. Cambridge University Press, Cambridge.
- STANDLEY, L. A. (1987). Taxonomy of the *Carex lenticularis* complex in eastern North America. *Canadian Journal of Botany* **65**: 673–686.
- SYLVÉN, N. (1963). Det Skandinaviska flora-området Carices distigmaticae. *Opera Botanica A Societate Botanica Lundensi, Botaniskea Notiser* **8**: 1–161.
- WATERWAY, M. J. (1994). Evidence for the hybrid origin of *Carex knieskernii* with comments on hybridization in the genus *Carex* (Cyperaceae). *Canadian Journal of Botany* **72**: 860–871.
- WIGGINTON, M. J. (1999). *British Red Data Books: 1 Vascular Plants*, 3rd ed. Joint Nature Conservation Committee, Peterborough.

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Changes in the floristic composition of sand-dune slacks over a twenty-year period

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ABSTRACT

The aim of this study was to compare vascular plant species-richness and composition in 26 dune-slacks in Birkdale Sandhills, Merseyside during 2003 with the results of a similar survey conducted in 1983. A total of 213 taxa was recorded, as opposed to 150 in 1983, a 42% increase. There is a significant positive correlation between the number of taxa per slack in the two surveys and a significant relationship between species-richness and slack area in both years.

Thirty-six notable taxa were recorded in 2003, an 80% increase on the 20 found in 1983. Fifteen taxa have undergone major increases in frequency, while seven, particularly maritime species, show major declines.

The reasons for these changes are discussed and recommendations made for the conservation of the slack flora.

KEYWORDS: compositional change, conservation, dune-slacks, notable taxa, species richness.

INTRODUCTION

In 1983, Sefton Metropolitan Borough Council commissioned a report from the Lancashire Trust for Nature Conservation (now the Lancashire Wildlife Trust) on the ecology of the Birkdale frontal dunes, a narrow strip of sand-dunes 4.23 km long and 120 to 215 m wide, west of the coastal road between Ainsdale and Birkdale (SD322164–SD300122). This dune area was subsequently added to the Birkdale Sandhills Local Nature Reserve.

The report (Smith 1983) drew particular attention to the slacks within the study area. These were considered to have special conservation interest, being rich in vascular plants, including many uncommon or rare species. In addition, several of the slacks were used for breeding by the endangered Natterjack Toad (*Bufo calamita*).

Having mapped the study area using aerial photographs, the 26 slacks present were searched for vascular plants in June and July

1983, the richest supporting 78 taxa. Fifteen slacks were considered to have an “incipient” character; i.e. recently created by wind-erosion and therefore in an early stage of vegetation development. Indeed, reference to a time sequence of aerial photographs showed that many of the slacks had formed during the exceptionally dry period of the mid-1970s. Twenty years on from the original study, it was decided to resurvey the slacks, using similar methodology, to determine how species richness and composition had changed and to make recommendations for management.

In addition to its Local Nature Reserve status, the study area lies within the Sefton Coast SSSI, a candidate Special Area of Conservation and a Ramsar site.

METHODS

Each of the 26 mapped slacks (Fig. 1) was revisited at least twice in both June and July 2003. Search time was roughly in proportion to the size of the slack but averaged about 30 minutes per slack per visit. The presence of all vascular taxa (species, sub-species and hybrids) was recorded. Care was taken to include only plants associated with the slack floor and not the surrounding areas relatively unaffected by the water-table. An assessment of slack type was made using the water-table criteria of Ranwell (1972), and the need for management was determined. Slack areas were measured using the Sefton Coast Geographic Information System (GIS).

RESULTS

SLACK HABITAT

There was no evidence for changes in slack areas, such as infill by blown sand, between the two study periods. The 26 slacks have a total area of 3.31 ha, a size range of 93 to 9856 m²,

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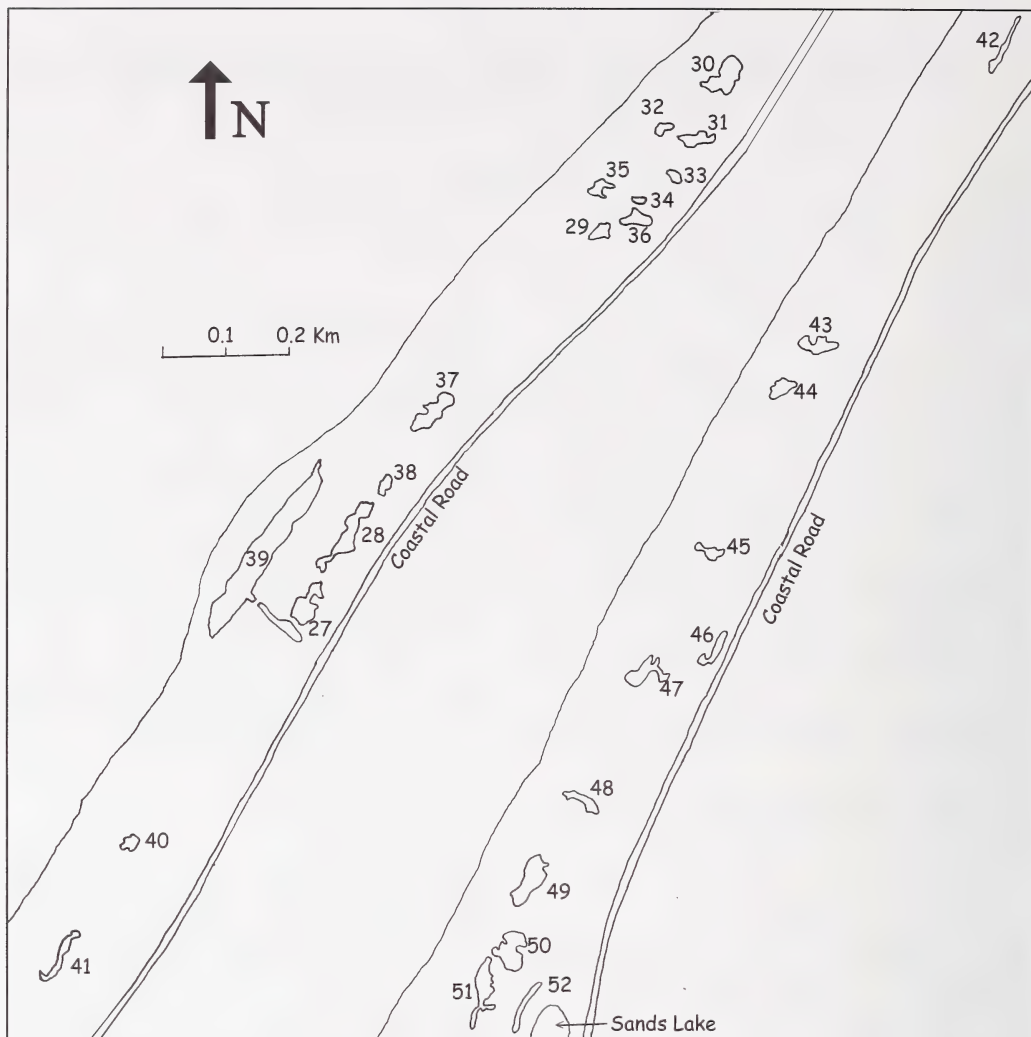


FIGURE 1. Map of Birkdale frontal dune slacks.

and a mean area of 1274 m². Only one slack (no. 44; 875 m²) was considered to be incipient, having a relatively young open vegetation type, compared with 15 slacks in 1983. Using Ranwell's (1972) water-table criteria, 16 slacks were classed as wet-slacks, six as dry-slacks and four as semi-aquatic (Table 1). Twenty-five slacks have a "mature" vegetation type characterised by a near complete plant cover and a high frequency of shrubs, especially *Salix repens*. In addition, eight of the wet-slacks have a semi-aquatic component due either to scrapes having been dug for Natterjack Toad breeding pools since the first study or to the presence of an open drain outfall (slack no. 27).

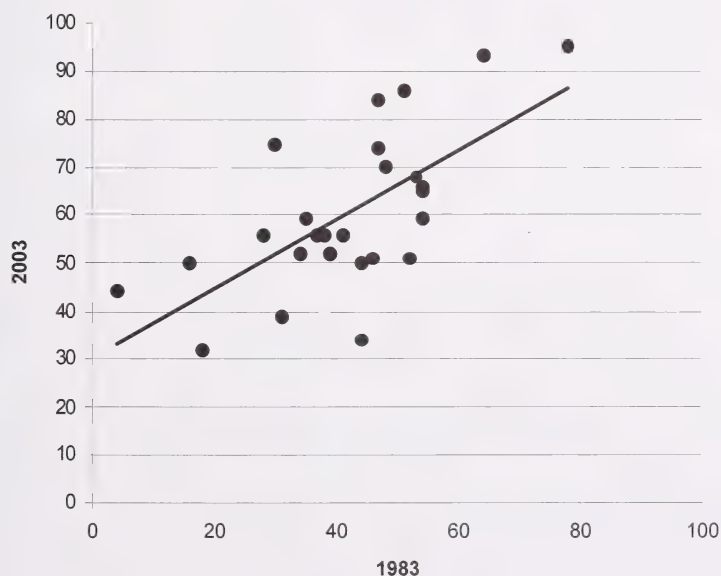
SPECIES-RICHNESS

A total of 213 vascular taxa was recorded in the 26 slacks, compared with 150 in 1983, a 42% increase in 20 years. Only 22 taxa seen in 1983 were not refound in 2003, representing 15% of the 1983 flora. The range of taxa per slack was 32 to 95 in 2003, as opposed to 4 to 78 in 1983 (Table 1). Mean numbers per slack were 60.3 in 2003 and 41.8 in 1983. This difference is statistically highly significant ($t = 6.07$; $p = 0.0001$). On average, species-richness has increased by 18.7 taxa per slack.

There is a statistically significantly positive relationship between taxon-number per slack in 1983 and 2003 ($r = 0.595$; $p = 0.001$) (Fig. 2);

TABLE 1. SLACK AREAS, HABITAT AND SPECIES-RICHNESS

Slack no. (N. to S.)	Area (m ²)	Slack habitat 1983	No. of taxa	Slack habitat 2003	No. of taxa
30	1924	Dry	44	Dry	50
31	694	Wet	52	Mature wet	51
32	393	Wet incipient	18	Dry	32
33	354	Wet incipient	37	Dry	56
34	124	Wet	31	Mature wet	39
35	660	Wet incipient	34	Dry	52
36	105	Dry	41	Dry	56
29	93	Wet	44	Mature wet	34
37	1649	Dry	53	Mature wet	68
38	325	Wet incipient	16	Semi-aquatic	50
28	2001	Wet	51	Mature wet/Semi-aquatic	86
27	2063	Wet	78	Mature wet/Semi-aquatic	95
39	9856	Semi-aquatic incipient	64	Semi-aquatic	93
40	462	Wet	28	Mature wet	56
41	718	Wet	35	Semi-aquatic	59
42	662	Dry	39	Dry	52
43	1021	Wet incipient	30	Mature wet/Semi-aquatic	75
44	875	Wet incipient	4	Wet incipient	44
45	372	Wet incipient	47	Mature wet	84
46	702	Semi-aquatic incipient	46	Semi-aquatic	51
47	1327	Wet incipient	47	Mature wet/Semi-aquatic	74
48	636	Wet incipient	54	Mature wet	59
49	1988	Wet incipient	54	Mature wet	65
50	2523	Wet incipient	54	Mature wet/Semi-aquatic	66
51	1240	Wet incipient	38	Mature wet	56
52	365	Wet incipient	48	Mature wet	70

FIGURE 2. Number of taxa per slack, 1983 vs. 2003 ($r = 0.595$; $p = 0.027$).

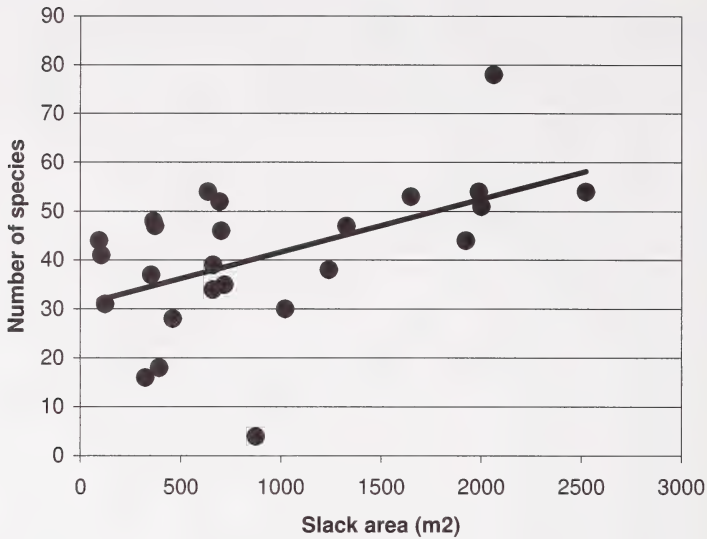


FIGURE 3. The relationship between number of taxa and slack area in 1983 (slack no. 39 excluded) ($r = 0.416$; $p = 0.020$).

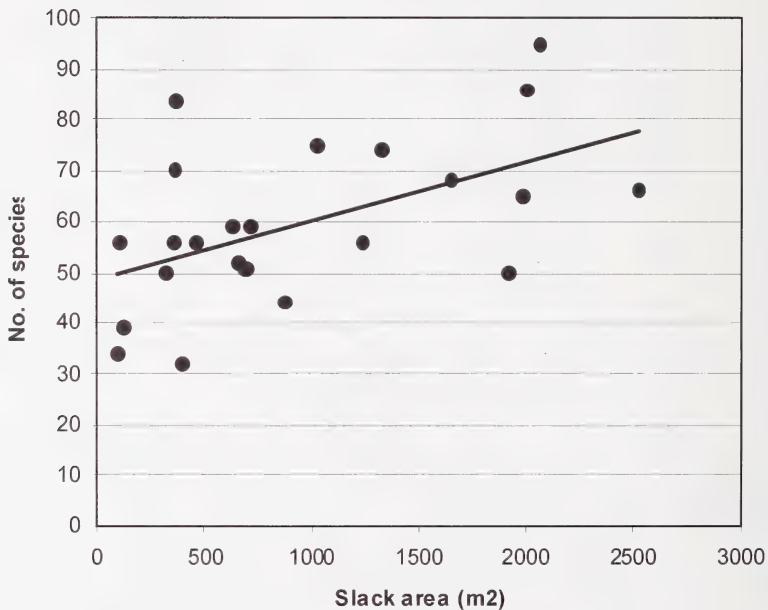


FIGURE 4. The relationship between number of taxa and slack area in 2003 (slack no. 39 excluded) ($r = 0.399$; $p = 0.027$).

in other words, the most species-rich slacks in 1983 tended also to be the richest in 2003. Thus, the slack with the highest number of taxa is no. 27 with 78 plants in 1983 and 95 in 2003. Similarly, the incipient slack no. 44 with only four taxa in 1983, had 44 by 2003, one of the lowest counts in the second survey (Table 1). However, this relationship may be affected by

other factors, such as slack area. It could reasonably be expected that larger slacks would support more taxa. Regression analysis shows that the relationship between species-richness and slack area is positive and significant in both years (1983: $r = 0.416$; $p = 0.020$; 2003: $r = 0.399$; $p = 0.027$). Clearly though, this relationship is weak (Fig. 3, Fig. 4). The r^2

TABLE 2. NOTABLE VASCULAR TAXA IN THE BIRKDALE SLACKS

Taxon	Occurrences per slack		Status		
	1983	2003	Nationally Rare	Nationally Scarce	Species of Conservation Importance
<i>Anacamptis pyramidalis</i>		3			+
<i>Anagallis tenella</i>		2			+
<i>Apium inundatum</i>		2			+
<i>Baldellia ranunculoides</i>		2			+
<i>Blasmus compressus</i>	2	10			+
<i>Carex disticha</i>	1	2			+
<i>Carex pseudocyperus</i>		1			+
<i>Carex viridula</i> subsp. <i>viridula</i>	11	6			+
<i>Catabrosa aquatica</i>		1			+
<i>Centaurium littorale</i>	10	13		+	+
<i>Centaurium pulchellum</i>	3	4			+
<i>Dactylorhiza incarnata</i> subsp. <i>coccinea</i>	19	23		+	+
<i>Dactylorhiza purpurella</i>	1	3			+
<i>Epipactis dunensis</i>	1	6	+		+
<i>Epipactis palustris</i>	14	22			+
<i>Epipactis phyllanthes</i>		1		+	+
<i>Equisetum variegatum</i>	9	3		+	+
<i>Hippuris vulgaris</i>		1			+
<i>Juncus ambiguus</i>		1			+
<i>Juncus balticus</i>	6	3		+	+
<i>Juncus maritimus</i>	3	3			+
<i>Myosotis ramosissima</i>		4			+
<i>Oenanthe fistulosa</i>		1			+
<i>Oenanthe lachenalii</i>		1			+
<i>Parnassia palustris</i>	4	9		+	+
<i>Potamogeton gramineus</i>		2			+
<i>Potamogeton pusillus</i>		1			+
<i>Pyrola rotundifolia</i> subsp. <i>maritima</i>	4	8		+	+
<i>Salix xangusensis</i>		7	+		
<i>Salix xfriesiana</i>	11	9	+		
<i>Samolus valerandi</i>	2	9			+
<i>Schoenoplectus pungens</i>		2	+		+
<i>Schoenoplectus tabernaemontani</i>	3	9			+
<i>Trifolium fragiferum</i>	10	7			+
<i>Triglochin palustris</i>	5	6			+
<i>Vulpia fasciculata</i>	1	1		+	+

values reveal that only 17.3% (1983) and 15.9% (2003) of the variability is accounted for by this relationship and that the correlation is even weaker in 2003 than in 1983.

Interestingly, in 2003, only 17 dune-slack taxa (8%) were considered to be non-native, in contrast to about 36% in the Sefton Coast sand-dune system as a whole (Smith 2005a).

NOTABLE TAXA

Using nationally accepted criteria and those of the Regional Biodiversity Steering Group for North West England (1999), a total of 20

notable taxa was recorded in 1983, compared with 36 in 2003, an 80% increase over the 20 years (Table 2). These include 34 Species of Conservation Importance in North West England, eight Nationally Scarce and four Nationally Rare taxa. The latter comprise *Schoenoplectus pungens*, for which Birkdale is now the only known British locality (Smith 2005b), *Epipactis dunensis* and the two willow hybrids *Salix xangusensis* and *S. xfriesiana*. These hybrids are extremely rare in Britain, the former being endemic (Meikle & Robinson 2000; Stace 1997). The Nationally Scarce

TABLE 3. A COMPARISON OF UBIQUITOUS TAXA IN 1983 AND 2003

Taxon	Frequency 1983	Frequency 2003
<i>Agrostis stolonifera</i>	25	25
<i>Carex flacca</i>	15	23
<i>Carex arenaria</i>	22	23
<i>Cirsium arvense</i>	18	25
<i>Dactylorhiza incarnata</i>	19	23
<i>Festuca rubra</i>	23	26
<i>Hippophae rhamnoides</i>	21	24
<i>Holcus lanatus</i>	22	24
<i>Juncus articulatus</i>	25	17
<i>Juncus bufonius/J. ambiguus</i>	22	5
<i>Leontodon saxatilis</i>	22	23
<i>Mentha aquatica</i>	14	22
<i>Oenothera fallax</i>	9	23
<i>Ononis repens</i>	17	24
<i>Ranunculus repens</i>	7	22
<i>Rubus caesius</i>	7	25
<i>Salix repens</i>	22	26
<i>Salix cinerea</i>	17	24
<i>Senecio jacobaea</i>	22	25
<i>Trifolium repens</i>	18	24

group includes *Juncus balticus*, a northern species whose only sites in England are at Birkdale Sandhills (Smith in press), *Centaureum littorale*, *Dactylorhiza incarnata* subsp. *coccinea*, *Epipactis phyllanthos*, *Equisetum variegatum*, *Parnassia palustris*, *Pyrola rotundifolia* subsp. *maritima* and *Vulpia fasciculata*.

Another taxon worth mentioning here, although not nationally or regionally notable, is *Carex paniculata*. This species seems not to have been reported on the Sefton Coast since before 1963 (Smith 2005a) but a single large plant was found in slack no. 45.

CHANGES IN SPECIES FREQUENCY

Smith (1983) remarked that 12 vascular taxa were identified in more than 20 of the 26 slacks and may be said to characterise the slack vegetation in the study area. This pattern was essentially similar in 2003, except that the qualifying level for a "ubiquitous" taxon was set at presence in 22 out of the 26 slacks (Table 3). In 2003, a total of 18 taxa was considered ubiquitous, five species (*Carex flacca*, *Mentha aquatica*, *Oenothera fallax*, *Ranunculus repens* and *Rubus caesius*) showing substantial increases in frequency over the twenty-year period (Table 3). Only two plants that were ubiquitous in 1983 have declined markedly,

namely *Juncus articulatus* and *J. bufonius/J. ambiguus* (the latter two taxa were not separated in 1983). These species are particularly associated with the damp, bare sand of incipient slack floors.

Table 4 shows that 15 vascular plants have undergone major increases (a factor of $\times 3$ or more) since 1983. These include three notable taxa – *Blismus compressus*, *Epipactis dunensis* and *Samolus valerandi*. Although *B. compressus* has severely declined nationally (Preston *et al.* 2002), its occurrence at Birkdale has increased from two to ten slacks. Colonisation by *E. dunensis* probably reflects maturation of the communities, while *S. valerandi* is often associated with the scrapes. Also interesting is the increase from one to fifteen slack occurrences of *Dactylorhiza praetermissa*, a plant which tends to appear locally when suitable slack habitat reaches an age of around 20 years (personal observations). Increased frequency of *Cirsium vulgare*, *Galium aparine* and *Sonchus arvensis* may reflect substrate disturbance and high soil nitrogen associated with recent removal of *Hippophae rhamnoides* scrub (Rodwell 2000). These three species have a mean Ellenberg value for nitrogen of 6.7 (richly fertile places) (For an explanation of Ellenberg indicator values see Hill *et al.* 2004.).

TABLE 4. TAXA SHOWING MAJOR INCREASES IN FREQUENCY (AT LEAST $\times 3$) SINCE 1983

Taxon	Frequency 1983	Frequency 2003
<i>Blysmus compressus</i>	2	10
<i>Cirsium vulgare</i>	3	15
<i>Dactylorhiza praetermissa</i>	1	12
<i>Epipactis dunensis</i>	1	6
<i>Filipendula ulmaria</i>	1	5
<i>Galium aparine</i>	1	11
<i>Galium palustre</i>	1	15
<i>Oenanthe crocata</i>	2	11
<i>Pastinaca sativa</i>	1	12
<i>Polygala vulgaris</i>	1	8
<i>Ranunculus acris</i>	1	7
<i>Rubus caesius</i>	7	25
<i>Samolus valerandi</i>	2	9
<i>Schoenoplectus tabernaemontani</i>	3	9
<i>Sonchus arvensis</i>	4	16

TABLE 5. TAXA SHOWING MAJOR DECLINES IN FREQUENCY (BY AT LEAST A THIRD) SINCE 1983

Taxon	Frequency 1983	Frequency 2003
<i>Elytrigia repens</i>	5	1
<i>Equisetum variegatum</i>	9	3
<i>Juncus bufonius/J. ambiguus</i>	22	5
<i>Leontodon autumnalis</i>	4	1
<i>Poa annua</i>	14	2
<i>Ranunculus sceleratus</i>	6	2
<i>Salix viminalis</i>	4	1

TABLE 6. CHANGES IN TAXA CONSIDERED TO BE MARITIME

Taxon	Frequency 1983	Frequency 2003
<i>Aster tripolium</i>	1	0
<i>Bolboschoenus maritimus</i>	8	12
<i>Glaux maritima</i>	6	4
<i>Juncus gerardii</i>	8	4
<i>Plantago maritima</i>	2	0
<i>Puccinellia maritima</i>	1	0
<i>Spartina anglica</i>	1	0
<i>Triglochin maritimum</i>	11	4

Seven species show major declines in occurrence (Table 5). Of these, the most notable is *Equisetum variegatum*, which, in 2003, was found in only three slacks compared with nine in 1983. This species seems less common now than formerly throughout the dune system (personal observations) and, having a boreo-arctic montane European distribution (Hill *et al.* 2004), might be being adversely affected by

climatic change. The largest rates of decline are shown by *Juncus bufonius/J. ambiguus* and *Poa annua*, both associated with open communities. Slacks occupied by *Juncus balticus* fell from six to three (Table 2) but the total area of patches actually increased (Smith in press).

Smith (1983) identified eight maritime or sub-maritime species, more usually associated with salt-marshes, reflecting the proximity of

the slacks to the foreshore (Table 6). They have a mean Ellenberg value for salt tolerance of 4.4 (consistent but low salinity) (Hill *et al.* 2004). Interestingly, four of these species had disappeared from the slacks by 2003, three have declined in frequency and only one (*Bolboschoenus maritimus*) has increased.

CONSERVATION

Smith (1983) made a number of suggestions for the effective conservation of the Birkdale frontal dune-slacks. For example, attention was directed to the problem of unauthorised motor-cycling which was churning some slacks into mud. Fortunately this was subsequently well controlled by the introduction of full-time rangers by the Sefton Coast & Countryside Service, and the affected slack floors have recovered well. Human trampling was also mentioned as a factor, though this was seen as being generally beneficial in helping to maintain open vegetation types which favour several of the rarer plants. This is still the case with many of the slacks having moderately well-used informal footpaths.

The earlier study also noted that, although the invasive introduced shrub *Hippophae rhamnoides* was well-established, there were relatively few large clumps and the many young bushes, seedlings and suckers could easily be removed. However, it was the mid-1990s before the site managers could secure funds to tackle this problem and by then, *H. rhamnoides* had spread considerably and was threatening the biodiversity of many slacks. In consequence, this is almost certainly the reason why *Juncus balticus* was lost from four northern slacks (Smith *in press*). Since about 1996, *H. rhamnoides* has been systematically removed by cutting and follow-up spraying of regrowth using an approved herbicide, several slacks being cleared annually. The southern slacks, which were treated first, have recovered satisfactorily but the two cleared in the winter of 2002/03 (slack nos. 31 and 33) retained only small areas of slack vegetation, being characterised by expanses of bare ground and ruderal, nitrophilous plants, such as *Cirsium*, *Epilobium* and *Sonchus* spp. and also *Urtica dioica*. It will be interesting to follow their recovery.

In addition to *H. rhamnoides*, some slacks have been partly colonised by *Betula pubescens* and *Salix cinerea* subsp. *oleifolia*. Because of the presence of rare *Salix* hybrids, willow control needs to be approached with care but can probably still be justified. Thus, Smith

(2005b) noted that *S. cinerea* bushes were restricting the growth of *Schoenoplectus pungens* in two slacks. Although rabbit-grazing is prevalent, especially in the northern slacks, scrub control will need to be ongoing, although not with the same intensity as in the recent past.

Since about 1996, two slacks (nos. 48 and 49) have been mowed almost annually. While this does not seem to have added significantly to their species-richness (Table 1), it has certainly prevented scrub invasion.

The first study recommended the excavation of two scrapes for Natterjack Toads in slack nos. 38 and 40. In the event, 12 scrapes were dug in eight slacks since 1983 and these have contributed considerably to the number of vascular plants in the affected slacks. At least six notable taxa (*Anagallis tenella*, *Apium inundatum*, *Baldellia ranunculoides*, *Carex pseudocyperus*, *Oenanthe fistulosa* and *Schoenoplectus pungens* are uniquely associated with the scrapes in the study area, the latter having been translocated here during a conservation exercise (Smith 2005b).

DISCUSSION

Smith (1983) considered that the Birkdale frontal dunes had a higher botanical interest than had been previously thought, this being partly due to the rich dune-slack plant communities. The current study shows that this interest has continued to grow during the past 20 years with a 42% gain in species-richness, an average of 18.7 more taxa per slack being recorded. Also encouraging is the 80% increase in nationally and regionally notable plants since the first survey.

A number of factors seems to be responsible for these changes. First, most of the slacks have undergone succession from an incipient to a mature phase, involving colonisation by additional vascular taxa. Relatively few species have declined during this process, those that have being typical either of an early successional stage or of maritime conditions. Their loss has, incidentally, been offset by the development of the adjacent Birkdale Green Beach, a 44 ha strip of salt-marsh, embryo dunes and dune slacks which has formed on the foreshore since 1986 and supported 217 vascular taxa in 2003 (Smith 2003). These include many maritime species and also *Juncus balticus*, 12 small patches of which were recorded in 2004 (Smith *in press*).

Secondly, the habitat in eight slacks has been diversified by the excavation of scrapes,

initially as breeding sites for Natterjack Toads, but providing ideal conditions for a wide variety of semi-aquatic and aquatic plants. The drain outfall from slack no. 27, though present in 1983, has been colonised by several more aquatic taxa, including the pondweeds *Potamogeton crispus*, *P. natans* and *P. pusillus* which are not represented elsewhere in the slack sequence.

Finally, control of *H. rhamnoides*, initiated in the mid-1990s, has reversed the trend towards the domination of slacks by scrub and has encouraged a greater diversity of low-growing, less competitive plants, including many dune-slack specialists.

The overall effect of vegetation changes, resulting in part from conservation measures,

has been to produce a series of slacks which, despite their relatively small size, are as species-rich as any in the internationally important Sefton Coast sand-dune system, itself particularly well-endowed with humid dune-slacks (Smith 1999), a priority Annex 1 habitat type in the EU Habitats Directive.

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REFERENCES

- HILL, M. O., PRESTON, C. D. & ROY, D. B. (2004). *PLANTATT. Attributes of British and Irish Plants: Status, Size, Life History, Geography and Habitats*. NERC Centre for Ecology and Hydrology. Abbots Ripton.
- MEIKLE, R. D. & ROBINSON, N. A. (2000). A new record for *Salix xangusensis* (Salicaceae) Rech. f. from Ainsdale Sand Dunes National Nature Reserve, S. Lancs. v.c. 59. *Watsonia* **23** (2): 327–330.
- PRESTON, C. D., PEARMAN, D. A. & DINES, T. D. (2002). *New Atlas of the British & Irish Flora*. Oxford University Press. Oxford.
- RANWELL, D. S. (1972). *Ecology of Salt Marshes and Sand Dunes*. Chapman & Hall. London.
- REGIONAL BIODIVERSITY STEERING GROUP FOR NORTH WEST ENGLAND (1999). *A Biodiversity Audit of North West England*. 2 vols. Environmental Advisory Service. Maghull, Merseyside.
- RODWELL, J. S. (2000). *British Plant Communities Vol. 5. Maritime communities and vegetation of open habitats*. Cambridge University Press. Cambridge.
- SMITH, P. H. (1983). *Ecology and Management of Birkdale Frontal Dunes, Merseyside*. Unpublished. report to Sefton Metropolitan Borough Council. Bootle.
- SMITH, P. H. (1999). *The Sands of Time. An introduction to the sand-dunes of the Sefton Coast*. National Museums & Galleries on Merseyside. Liverpool.
- SMITH, P. H. (2003). *Further studies on the vascular plants of the Birkdale Green Beach*. Unpublished. report to the Sefton Coast Partnership. Bootle.
- SMITH, P. H. (2005a). *Inventory of Vascular Plants for the Sefton Coast, Merseyside*. Unpublished. report to the Sefton Coast Partnership. Bootle.
- SMITH, P. H. (2005b). *Schoenoplectus pungens* on the Sefton Coast. *BSBI News* **98**: 30–33.
- SMITH, P. H. (in press). Revisiting *Juncus balticus* Willd. in England. *Watsonia*.
- STACE, C. A. (1997). *New Flora of the British Isles*. (2nd ed.) Cambridge University Press. Cambridge.

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***Calamagrostis scotica* (Druce) Druce (Poaceae), a Red Data Book Plant: its history, taxonomy, ecology and genetics**

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ABSTRACT

The history, taxonomy, ecology and genetics of the British endemic *Calamagrostis scotica* (Druce) Druce, known with certainty from only one extant locality in Scotland, are reviewed and discussed. In the field, *C. scotica* is only reliably distinguished from its close relative *C. stricta* (Timm) Koeler by its glume characters with the result that its allocation to specific rank (and its classification as an endemic) has been questioned. Preliminary genetic work suggests that *C. scotica* lies within the genetic variation of *C. stricta* and that, in addition, it is not of hybrid origin via the parentage: *C. epigejos* × *C. stricta*. Evidence also suggests that the population at Loch of Durran is not clonal.

KEYWORDS: Scottish small-reed *Calamagrostis epigejos*, *C. stricta*, hybrids, DNA, Robert Dick.

INTRODUCTION

Calamagrostis scotica (Druce) Druce (Scottish small-reed) is considered to be a British endemic taxon occurring at only one site in Caithness. In morphology, it closely resembles the rather more widespread *Calamagrostis stricta* (Timm) Koeler itself of *British Red Data Book* status, so that the acceptance of *C. scotica* as a distinct species has often been questioned. This has implications when considering the steps to be taken in respect to its conservation. In the following paper, the history, taxonomy and ecology of *C. scotica* are discussed, and the results of a preliminary genetic evaluation of the taxon in relation to its closest ally, *C. stricta* are summarised.

HISTORY

Calamagrostis scotica appears to have been first discovered in 1863 by Robert Dick (Bennett 1892) at what is thought to be its only extant site at Loch of Durran, Caithness, v.c. 109 (Smiles 1878). Dick (1811–1866), a Thurso baker, was a self-taught botanist and geologist who also found another rare grass, *Hierochloa odorata*, on the banks of the Thurso River. He recognised his Loch of Durran plant as being something different, Smiles (1878) stating “Dick went to Loch Duran (sic).....to see the Bullrush, rather a rare plant in the far north; and besides the Lake Bullrush, he found a much rarer plant, the Lapland Reed. He could find the plant nowhere else”. Subsequently, there was a great deal of confusion as to its identity, partly due to the fact that what is now known as *Calamagrostis stricta*, a taxonomically close ally, occurred at several other localities in Caithness and possibly also at Loch of Durran. Both *C. scotica* and *C. stricta* have rough lemmas with the spikelet-axis produced as a small hairy bristle beyond the palea. In this way they both differ from the other British species of *Calamagrostis* and have sometimes been placed in the separate genus *Deyeuxia* Clar. In the case of the Loch of Durran plant this distinction was accepted by Bennett (1892), although he had referred to it as *Deyeuxia strigosa* Kunth.

Dick drew his find of the plant at Loch of Durran to the attention of Professor Balfour of the Royal Botanic Garden, Edinburgh who considered it to be the Scandinavian *C. strigosa* (Wahlenb.) Hartm., now known to be the

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hybrid *C. epigejos* × *C. stricta*. However, Dick did not agree (Bennett 1892). It was also identified as this by N. E. Brown according to G. C. Druce (in sched.) and it would seem that both men were confusing it with the locally more widespread *C. stricta* (then known as *Deyeuxia neglecta*). In 1885, J. Grant re-collected *C. scotica* at the Loch of Durran site (apparently by then drained) and it was also searched for near there ("about half a mile away") by Druce and H. J. Riddelsdell in August, 1902. On that occasion, they found a grass which reminded Druce of one that he had found near Loch Tay in 1888 and which he described as *Deyeuxia neglecta* Kunth var. *borealis*. Unfortunately, this had become extinct by 1895; however, it would seem from notes on a related herbarium sheet that this was *C. stricta* rather than *C. scotica*.

In July 1907, Druce visited another Caithness loch (Loch Watten) where he claimed to have found Dick's plant, calling it *Deyeuxia neglecta* Kunth var. *scotica* and stating "it is sufficiently distinct from normal *neglecta* [= *Calamagrostis stricta*] to warrant a varietal name, var. *scotica*, characterised as 'Panicles larger and more diffuse than type, glumes longer, and more longly acuminate'" (Druce in sched.). Subsequently (Druce 1928), he raised it to specific status to what is now the current and accepted name, *Calamagrostis scotica* (Druce) Druce. However, it is uncertain whether *C. scotica* has ever been recorded at Loch Watten and it does not appear to be present there now. In addition, there are other unconfirmed records of *C. scotica* from Caithness such as at St. John's Loch, but these need further evaluation.

Much further south, at Ale Moor Loch, Selkirkshire (v.c. 79) some plants found in 1965 by R. W. M. Corner were identified as *C. scotica* by A. Melderis (Corner 1967) but this was later refuted by C. E. Hubbard. The latter initially thought it to be the hybrid *C. epigejos* × *C. stricta* but later, after discussions with P. J. O. Trist, considered it to be *C. canescens* × *C. stricta*. However, following intervention by a third party, this became a contentious issue and their conclusions were never published. Plants in this Ale Moor population (hereafter referred to as the "Borders hybrid") in close proximity to others of *C. stricta* have recently been examined in the field. They were found to exhibit some morphological similarities to those at Loch of Durran but at present the latter is the only extant, confirmed site for *C. scotica*.

TAXONOMY

In July 2002, the type locality for *Calamagrostis scotica* at Loch of Durran was visited by the authors. When plants were examined it was noted that the inflorescence was usually strict (although occasionally slightly patent), brownish in colour, with the flowering culms to 1 metre in length. The ligules were c. 3 mm long, +/- acute, scarious, friable, and the glumes at least 5 mm long (and often to 6.5 mm), usually acuminate but not always so (and occasionally varying in this respect within the same plant). The pedicels and peduncles had forward-pointing serrations. It is conjectured that introgression from *C. stricta* might be present in some plants within this population since some occasionally appear to approach the latter. However, most were examples of "good" *C. scotica* possessing the long c. 6 mm glumes, a high proportion of which were distinctly acuminate.

Calamagrostis stricta and *C. scotica* differ from all other British species of *Calamagrostis* in that their callous hairs are distinctly shorter than the lemmas; in all other British species the callous hairs exceed the lemmas. Additionally, they differ from the other species in their lemmas being minutely rough and with the spikelet-axis produced as a small hairy bristle beyond the palea. In other morphological characters the two taxa closely resemble each other. Both have culms with 2–3 nodes reaching one metre in height, green leaves to 60 cm long and 5 mm wide, blunt, membranous ligules to 3 mm long and erect panicles to 20 cm long and 3 cm wide. The panicles of *C. scotica* are sometimes described as being slightly shorter, darker and less strict than those of *C. stricta* but such differences are difficult to determine in the field and cannot be relied upon to separate the two taxa.

To distinguish between the two it is necessary to examine the spikelets, especially the upper glumes. In *C. scotica* these are generally between 4.5 and 6.0 mm long with many, although not all, having distinctly acuminate tips. In contrast the upper glumes of *C. stricta* are usually shorter, to 4 mm long, with pointed tips which are only rarely acuminate. The length of the lemmas can also have some diagnostic value, generally being slightly less than 4 mm in *C. scotica* but rarely exceeding 3.0 mm in *C. stricta*. In both taxa the callous hairs are approximately (1.5–) 2(–2.5) mm in length and distinctly shorter than the

lemmae. Consequently, in *C. stricta*, the ratio between the mean length of the callous hairs in respect to that of the lemma is greater (0.65–0.90) than is the case in *C. scotica* (c. 0.50–0.55). Also, in *C. scotica*, the awn may be set slightly lower on the back of the lemma than is the case with *C. stricta* but this is a rarely a useful character for determination in the field.

However, *Calamagrostis scotica* can only be reliably separated from *C. stricta* by comparing the length and shape of the upper glumes.

ECOLOGY

The site at Loch of Durran is a wet mire pasture, now grazed by cattle and, as mentioned above, occupies the bed of the former loch, drained towards the end of the nineteenth century. Water levels are normally high during the winter and the habitat is wet throughout the year. The community in which *C. scotica* grows has been classified as the *Juncus effusus* sub-community of the *Juncus effusus*-*J. acutiflorus*-*Galium palustre* rush-pasture (National Vegetation Classification M23b) (Rodwell 1991–2000). Associated species include the dominants *Deschampsia cespitosa*, *Filipendula ulmaria* and *Juncus effusus* along with such associates as the sedges *Carex nigra*, *C. ovalis* and *C. rostrata*, as well as *Caltha palustris*, *Cardamine pratensis*, *Equisetum palustre*, *Galium palustre*, *Juncus acutiflorus*, *Lychnis flos-cuculi*, *Persicaria bistorta* and *Rhinanthus minor* (Lusby & MacDonald 1995).

When visited in 2002 (MJYF & MSP) the plant was found to be local but scattered over a fairly wide area at an approximate altitude of 20 metres, and was especially frequent near to, and along the banks of, the most westerly of the prominent drains which run south to north across the lowest part of the site, especially centred on Grid References ND20665.64880 to ND20672.64896. Opinions differ as to whether *Calamagrostis stricta* is present in the area where *C. scotica* occurs.

It is thought that any large change in the level of the water table, with or without a reduction in grazing, will adversely affect the plant, so these factors need to be monitored. Other associates observed during the visit included *Carex echinata*, *C. vesicaria*, *Phalaris arundinacea*, *Potentilla palustris* and *Menyanthes trifoliata*. (It should also be noted that *Agrostis canina*, also present in the same

area, has apparently caused confusion to some observers in the past).

CULTIVATION OF PLANTS FOR GENETIC ANALYSIS

At the time of the visit, seed had not matured and so arrangements were made for this to be collected under permit in the autumn. In mid-September 2002, J. K. Butler collected a single inflorescence with abundant mature spikelets from each of six well-separated plants which were sent for cultivation at the University of Lancaster. A condition was imposed by the site's farmers that all live offspring must be retained at Lancaster and not used for subsequent relocation elsewhere.

On receipt, each inflorescence was examined in order to confirm compliance with the current concept of *C. scotica* morphology (cf. Table 1) then seed was sown in John Innes No 2 compost and placed in a cool greenhouse. Seed and subsequent offspring were identified as "Scot1" to "Scot6" relating to the six original parent plants. For some parental plants, seed germination took place within two weeks but in other cases this was much slower. Seed from the parent source reference Scot5 failed to germinate but in all other cases offspring were produced. These developed slowly throughout the winter and by late Spring 2003 many had developed into robust plants each with several leaves to 15 cm long. None of the plants flowered that year. It was found that offspring from two of the *C. scotica* sources (Scot3 & Scot6) were much more robust than those from Scot1, Scot2 and Scot4 and also exhibited a higher rate of germination.

In mid-July, 2003, leaf tissue from these plants was sampled (in powdered silica gel) for DNA evaluation to the Royal Botanic Gardens, Edinburgh. The samples comprised material from the following offspring: Scot1 (5 plants), Scot2 (6 plants), Scot3 (6 plants), Scot4 (6 plants) and Scot6 (6 plants).

For comparison purposes and as potential controls, seed of *Calamagrostis stricta* from Back Loch (Selkirks, v.c. 79) and Malham Tarn (Mid-West Yorkshire, v.c. 64) was collected under permit and sown at the same time as that of the *C. scotica*. The former germinated very poorly and the latter not at all; in consequence they were abandoned as controls. For the genetic analysis it was therefore necessary that new controls be found and these were obtained by H. McHaffie & C Gantz (RBGE) from the

TABLE 1. MEAN GLUME CHARACTERS OF THE SAMPLED POPULATIONS

Locality	Length (mm)	Shape of apex	Callous hairs/lemma
Ashkirk Loch (<i>C. stricta</i>)	3.1	acute	2.0/2.8 = 0.71
Shaws Upper Loch (<i>C. stricta</i>)	3.7	acute	2.0/2.5 = 0.80
Lynemore (<i>C. stricta</i>)	4.0	acute/subacuminate	2.5/2.8 = 0.90
Loch of Mey (<i>C. stricta</i>)	4.2	acute	2.5/3.8 = 0.66
Loch of Durran (<i>C. scotica</i>)	5.0	acuminate	0.50–0.55

live populations indicated in the table. These were checked by the authors and found to conform with our current understanding of their morphology, although plants from Loch of Mey exhibited some similarity with *C. scotica* and those from Lynemore were not fully typical of *C. stricta* (Table 1).

GENETICS: DNA ANALYSIS

To assess whether *Calamagrostis scotica* is taxonomically distinct, a preliminary genetic investigation was undertaken (for details see Gantz 2003). For this work 107 individuals were sampled from seven populations. These comprised non-flowering plants of *C. scotica* grown from seed at the University of Lancaster collected from the five parents (see above) at the type locality, Loch of Durran. Also investigated were plants from four populations of *C. stricta* (Ashkirk Loch, Roxburghshire, v.c. 80, Shaws Upper Loch, Selkirkshire, v.c. 79, Lynemore, Perthshire, v.c. 88 and Loch of Mey, Caithness, v.c. 109). Since *C. epigejos* had been considered a possible parent in any hybrid origin of *C. scotica*, a population of the former from Tentsmuir, Fife, v.c. 85, together with a single plant cultivated at Logan Botanic Garden, were also sampled.

All were examined for genetic variation using five Random Amplified Polymorphic DNA (RAPD) primers. These gave a total of 53 polymorphic bands. Using a range of methods of analysis (including principal coordinates analysis and analysis of molecular variance (Gantz 2003)) the following preliminary findings were obtained.

1. The plants of *C. epigejos* are genetically quite distinct from all other samples. (This is perhaps not surprising since the species are also very distinct in their morphology).
2. Individuals of *C. scotica* and *C. stricta* are not separable as distinct genetic groups.
3. The four populations of *C. stricta* show a high level of genetic differentiation (with Lynemore the most extreme) and with the plants of *C. scotica* 'nested' within this range.

In addition, Principal Coordinates Ordination of the offspring of *C. scotica* with respect to their separate families (see Gantz 2003) indicated that in most cases there was clear familial separation.

These results are only preliminary and it is difficult to draw from them any firm conclusions regarding the taxonomic status of *C. scotica*. However, what can be said, is that in this work no clear evidence has been obtained indicating that *C. scotica* is highly divergent from *C. stricta*. Additionally, there is no evidence that *C. scotica* is of hybrid origin between *C. stricta* and *C. epigejos*. Further research, including broader sampling of *C. stricta*, and experiments with *C. scotica*, *C. stricta*, *C. canescens* and the 'Borders hybrids' may be informative. The possible hybrid origin of *C. scotica* via *C. canescens* × *C. stricta* as suggested by Trist (see above) should be checked.

CONCLUSIONS

When cultivated from seed, the speed and success of germination of the offspring of the six parents of *C. scotica* showed considerable inter-parental variation but varied little between the respective offspring. A variation in robustness was also apparent between offspring of one parent as opposed to another. In addition, the genetic analysis of the offspring of *C. scotica* with respect to their separate families (Gantz 2003) indicates that, in most cases, there is clear familial separation. All this suggests that the population of *C. scotica* at the only confirmed site, Loch of Durran, is comprised of separate individuals rather than being clonal, which has sometimes been suggested.

In physical morphology, *C. scotica* is separated from the closely similar *C. stricta* by glume characters and, to a lesser extent, by the callous hair/lemma ratio. However, when examined genetically, all the plants of *C. scotica* were found to lie within the range of variation of the four control populations of *C. stricta*. Further genetic work to include other relevant populations of *Calamagrostis* species (e.g. *C. stricta* at Lough Neagh in Ireland) is proposed and should further elucidate the situation.

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REFERENCES

- BENNETT, A. (1892). Contribution towards a Flora of Caithness. No. 11. *Annals of Scottish Natural History*, 252.
- CORNER, R. W. M. (1967). *Calamagrostis scotica* in southern Scotland (v.c. 80). *Transactions of the Botanical Society of Edinburgh*, 40(3): 336–337.
- DRUCE, G. C. (1928). *British Plant List*, 2nd Edition, p. 127. Arbroath.
- GANTZ, C. (2003). *Taxonomic complexity in the British Flora: Calamagrostis scotica* (Druce) Druce. M.Sc. Thesis, Royal Botanic Garden Edinburgh, University of Edinburgh; Edinburgh.
- LUSBY, P. & MACDONALD, I. (1995). *Calamagrostis scotica, species dossier*. Edinburgh Scottish Natural Heritage.
- RODWELL, J. S. ed. (1991–2000). *British Plant Communities*, Vols. 1–5. Cambridge.
- SMILES, S. (1878). *Robert Dick, baker, of Thurso, geologist and botanist*. London.

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Revisiting *Juncus balticus* Willd. in England

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ABSTRACT

In England, the Baltic Rush is confined to a small area of the Birkdale Sandhills on the Sefton Coast, Merseyside. Since 1982, several sites in the north of its range here have been lost but the plant has spread southwards and now occupies a 34% larger area than previously. Likely reasons for these changes are examined. Associated vascular taxa and phytosociological affinities are described. Updated information is given on the two *Juncus balticus* hybrids that occur in Merseyside and Lancashire, while the conservation of these plants is discussed.

KEYWORDS: Baltic Rush, hybrids, monitoring, conservation, England.

INTRODUCTION

Baltic Rush *Juncus balticus* Willd. is a nationally scarce plant of sand-dune slacks and other damp areas in maritime sand, mud or peat. In Britain, it is largely confined to the north and north-eastern coasts of Scotland and the Hebrides. Preston *et al.* (2002) record its post-1986 presence as a native plant in 53 hectads, though they remark that it is probably still present in many of the Scottish sites which have no post-1986 records.

In England, the plant is confined to a small area of the Birkdale Sandhills on the Sefton Coast, Merseyside, in v.c. 59 (South Lancashire), where it was discovered in 1913. Its history, distribution and ecology here were studied by Smith (1984). In 1981/82 he recorded *J. balticus* at 10 sites in the dunes, counting 71 patches of the rush with a total area of 137.7 m². Most of the sites were wet-slacks, lying east and west of the coastal road at the northern end of Birkdale Sandhills Local Nature Reserve (Fig. 1). Three of the slacks were considered to have originated before World War II but the others were of more recent origin, five having been formed by wind erosion during the 1970s, and therefore only

recently colonised by the rush. The availability of this new habitat seemed to account for the improvement in fortunes of the Sefton Coast population as, in 1969/70, Stace (1972) had found only three extant colonies. He predicted the plant's extinction here "in the fairly near future" (Stace 1970).

Two Baltic Rush hybrids, *Juncus balticus* × *J. inflexus* and *J. balticus* × *J. effusus* (= *J. xobotritorum*) also occur in the sand-dunes of Merseyside and Lancashire, the former being endemic to the region (Stace 1972). Both hybrids have been found three times in a wild state as infertile clones but, by 1982, only the three *inflexus* hybrid clones were still extant, the *effusus* hybrid having become extinct in the wild. However, several of the clones were in cultivation at botanical gardens and had been translocated to various slacks in the Sefton Coast sand-dunes, where most had survived (Smith 1984).

Over 20 years on, therefore, it was felt appropriate to revisit the sites for Baltic Rush and its hybrids in England, with the aim of monitoring any changes in their distribution and status. It was hoped that such a study would also have relevance to the North Merseyside Biodiversity Action Plan (Merseyside Biodiversity Group 2001), which includes both *J. balticus* and the hybrids.

METHODS

During the summer of 2003, the whole of the known and potential range of *J. balticus* on the Sefton Coast was the subject of a detailed search. This field work was conducted as part of a separate study to record the vascular plants of the Birkdale frontal slacks and the adjacent Green Beach, the latter comprising about 44 ha of sand-dune, dune-slack and salt-marsh habitat which has formed by accretion on the foreshore since 1986. As a result, several new sites for the rush were found.

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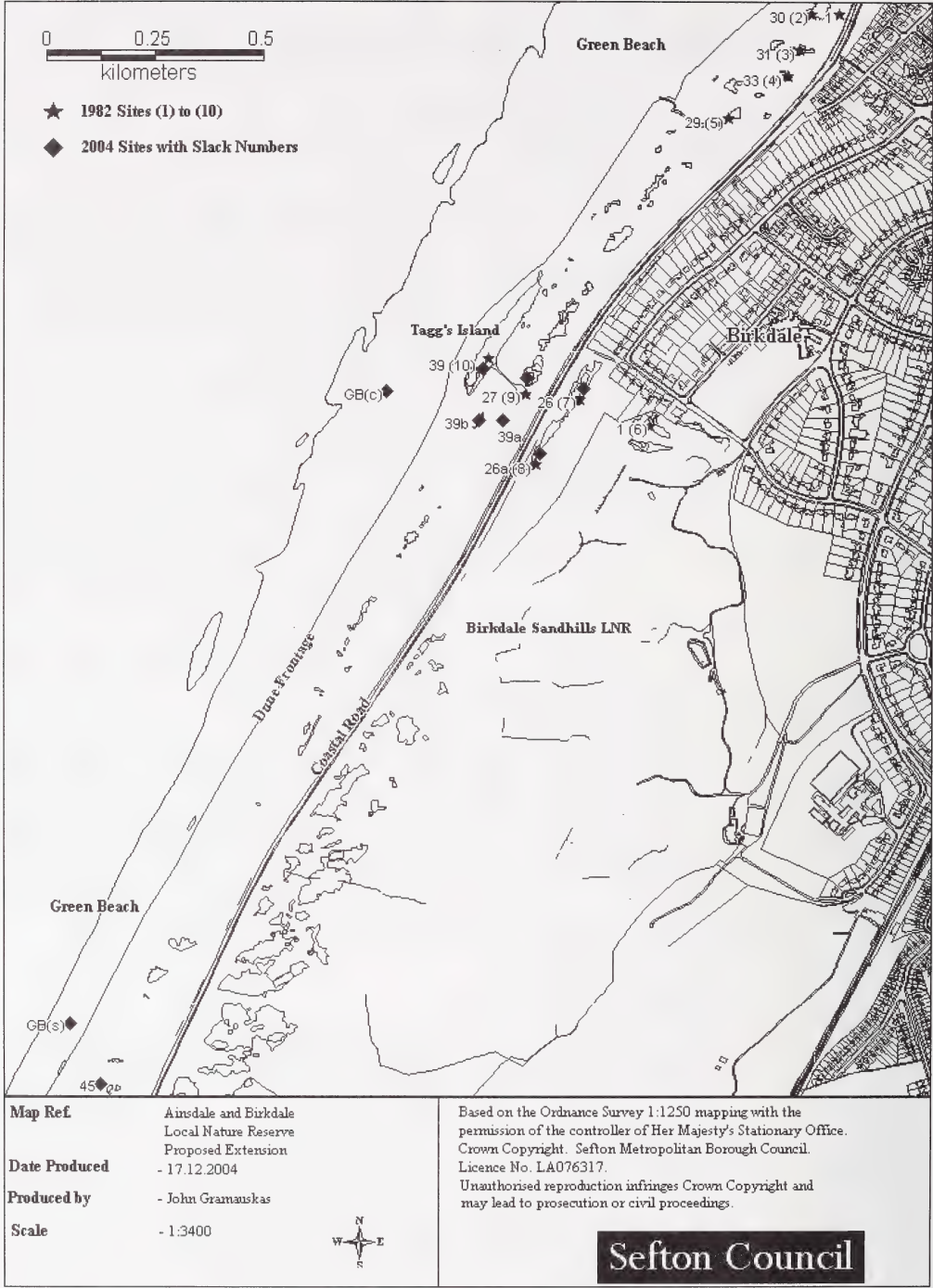


FIGURE 1. Map of Ainsdale and Birkdale Local Nature Reserve. Sites of *Juncus balticus* 1982(★), 2004 (◆).

Also, in that summer, all known wild clones and transplant sites for the hybrids on the Sefton Coast were examined. The locations of patches were determined using a GPS and areas of patches and average heights of shoots were measured. Using, the criteria of Ranwell (1972), the sites were classed as semi-aquatic, wet or dry-slacks. Notes were taken on habitat condition and the need, if any, for conservation management. Information on the Lytham-St Annes (v.c. 60, West Lancashire) clone of the *inflexus* hybrid was obtained from the former LNR warden, Maurice Jones (*in litt.*).

The following summer, 2004, all the Baltic Rush sites found the previous year, together with those east of the coastal road, were visited. The number and areas of patches were recorded using the same methods as Smith (1984). Patch locations were determined using a GPS. In addition, twenty-five 2 × 2 m quadrats were recorded, using N.V.C. methodology (Rodwell 1992), for all large patches at every site. These data were analysed using a TABLEFIT programme and compared with ten samples taken in 1981/82. A list of vascular plant associates with *J. balticus* was drawn up and notes were made in the field on habitat condition and conservation status.

RESULTS

BALTIC RUSH

Eighty-six patches of *J. balticus* were located in ten sites with a total area of 185.0 m², an increase of 34% since 1982 (Table 1). By far the most important site for the rush is now slack 27 (site 9 in Smith 1984), where the number of patches has increased from one to 44 and the area covered from 0.7 to 134.6 m². Also significant is Tagg's Island marsh (site 10) with an increase from one (0.3 m²) to 13 patches (20.6 m²).

However, the distribution of *J. balticus* at Birkdale has changed markedly. It has disappeared from six northern slacks, including the Royal Birkdale Golf Course, but has consolidated and extended its southern range, colonising three new slacks and also the recently formed Green Beach where 12 small patches were found, the first being located in 2000. The southernmost locality (slack 45) is now about 2 km south of that in 1982 (Fig. 1).

There has been a major decline in the old slacks (nos. 26 and 26a) east of the coastal road, where the area occupied by the rush has fallen from 61.5 to 3.5 m².

TABLE 1. *JUNCUS BALTICUS*
DISTRIBUTION AT BIRKDALE
IN 1981/2 AND 2004

Site	Slack no.	1981/82		2004	
		No. patches	Area (m ²)	No. patches	Area (m ²)
1	-	1	0.8	-	-
2	30	1	4.0	-	-
3	31	17	59.7	-	-
4	33	32	4.9	-	-
5	29	1	0.3	-	-
6	RBGC	2	5.5	-	-
7	26	13	60.7	7	3.5
8	26a	2	0.8	2	0.0
9	27	1	0.7	44	134.6
10	Tagg's Is.	1	0.3	13	20.6
-	39a	-	-	3	5.0
-	39b	-	-	4	15.1
-	GB (C)	-	-	10	3.2
-	GB (S)	-	-	2	1.1
-	45	-	-	1	1.9
	Totals	71	137.7	86	185.0

RBGC = Royal Birkdale Golf Course.

GB (C) = Green Beach (central); GB (S) = Green Beach (south).

Associates of *J. balticus* totalled 80 vascular taxa in 2004, compared with 60 in 1981/2. They are all typical wet-slack plants of the Sefton Coast dune system and only two, *Aster novi-belgii* and *Hippophae rhamnoides*, are non-native to the region (Table 2).

The most frequent associates are *Agrostis stolonifera* (23 out of 25 samples), *Holcus lanatus* (19), *Festuca rubra* (17), *Salix repens* (16), *Carex arenaria* (14), *Mentha aquatica* (13) and *Hydrocotyle vulgaris* (11). Of these, *Agrostis stolonifera*, *Festuca rubra* and *Salix repens* were among the commonest associates in 1982, but others included *Carex flacca*, *Dactylorhiza incarnata*, *Eleocharis quinqueflora*, *Equisetum palustre*, *Juncus articulatus*, *Lotus corniculatus*, *Trifolium fragiferum* and *T. pratense* (Smith 1984). The latter species were also listed in 2004 (Table 2).

Phytosociological affinities of *J. balticus* at Birkdale are summarised in Table 3. Unfortunately, of 25 samples taken, 16 were poor or very poor fits to known N.V.C. dune-slack, swamp, salt-marsh or grassland communities. The best results were obtained in the old slack 26, east of the coastal road. Here, good and very good agreements were found

TABLE 2. VASCULAR ASSOCIATES OF *JUNCUS BALTICUS* IN 2004 AND 1982

Taxon	2004	1982	Taxon	2004	1982
<i>Agrostis stolonifera</i>	+	+	<i>Lathyrus pratensis</i>	+	+
<i>Alnus glutinosa</i>	+		<i>Leontodon autumnalis</i>	+	+
<i>Angelica sylvestris</i>	+		<i>Leontodon saxatile</i>	+	+
<i>Apium nodiflorum</i>		+	<i>Linum catharticum</i>	+	
<i>Arrhenatherum elatius</i>	+		<i>Lolium perenne</i>	+	+
<i>Aster novi-belgii</i> *	+		<i>Lotus corniculatus</i>	+	+
<i>Aster tripolium</i>	+	+	<i>Lycopus europaeus</i>	+	
<i>Bellis perennis</i>		+	<i>Mentha aquatica</i>	+	+
<i>Blackstonia perfoliata</i>	+		<i>Myosotis laxa</i>	+	+
<i>Blysmus compressus</i>	+	+	<i>Odontites vernus</i>	+	
<i>Bolboschoenus maritimus</i>	+	+	<i>Oenanthe crocata</i>	+	
<i>Calystegia sepium</i>	+		<i>Ononis repens</i>	+	
<i>Cardamine pratensis</i>	+		<i>Ophrys apifera</i>	+	
<i>Carex arenaria</i>	+	+	<i>Parapholis strigosa</i>	+	
<i>Carex extensa</i>	+		<i>Parnassia palustris</i>		+
<i>Carex flacca</i>	+	+	<i>Pastinaca sativa</i>		+
<i>Carex nigra</i>	+		<i>Persicaria amphibia</i>		+
<i>Carex otrubae</i>	+		<i>Phragmites australis</i>	+	
<i>Carex viridula viridula</i>	+	+	<i>Plantago coronopus</i>	+	
<i>Carlina vulgaris</i>		+	<i>Plantago lanceolata</i>	+	+
<i>Centaureum erythraea</i>	+		<i>Plantago major</i>	+	+
<i>Centaureum pulchellum</i>	+		<i>Plantago maritima</i>	+	
<i>Cerastium fontanum</i>		+	<i>Poa pratensis</i>		+
<i>Cirsium arvense</i>	+	+	<i>Potentilla anserina</i>		+
<i>Crepis capillaris</i>	+		<i>Prunella vulgaris</i>		+
<i>Dactylis glomerata</i>	+		<i>Pulicaria dysenterica</i>	+	+
<i>Dactylorhiza incarnata</i>	+	+	<i>Pyrola rotundifolia</i>		+
<i>Eleocharis palustris</i>	+		<i>Ranunculus acris</i>		+
<i>Eleocharis quinqueflora</i>		+	<i>Ranunculus flammula</i>	+	
<i>Elytrigia juncea</i>	+		<i>Ranunculus repens</i>	+	
<i>Elytrigia repens</i>	+		<i>Rhinanthus minor</i>	+	+
<i>Epilobium palustre</i>	+		<i>Rosa</i> sp.	+	
<i>Epilobium parviflorum</i>	+		<i>Rubus caesius</i>	+	+
<i>Epipactis palustris</i>	+	+	<i>Rumex crispus</i>	+	+
<i>Equisetum arvense</i>	+	+	<i>Sagina apetala</i>	+	
<i>Equisetum palustre</i>	+	+	<i>Sagina nodosa</i>	+	+
<i>Equisetum variegatum</i>		+	<i>Salix cinerea oleifolia</i>	+	+
<i>Equisetum x-litorale</i>	+		<i>Salix repens</i>	+	+
<i>Euphrasia nemorosa</i>	+	+	<i>Salix x-friesiana</i>		+
<i>Festuca rubra</i>	+	+	<i>Samolus valerandi</i>	+	
<i>Filipendula ulmaria</i>	+		<i>Senecio jacobaea</i>	+	+
<i>Galium palustre</i>	+	+	<i>Sonchus arvensis</i>	+	
<i>Glaux maritima</i>	+	+	<i>Taraxacum officinale</i> agg.		+
<i>Hieracium umbellatum</i>	+		<i>Trifolium fragiferum</i>	+	+
<i>Hippophae rhamnoides</i> *	+		<i>Trifolium pratense</i>	+	+
<i>Holcus lanatus</i>	+	+	<i>Trifolium repens</i>	+	+
<i>Hydrocotyle vulgaris</i>	+	+	<i>Triglochin maritimum</i>		+
<i>Hypochaeris radicata</i>		+	<i>Triglochin palustris</i>		+
<i>Iris pseudacorus</i>	+		<i>Tripleurospermum maritimum</i>	+	+
<i>Juncus articulatus</i>	+	+	<i>Tussilago farfara</i>	+	
<i>Juncus bufonius</i>		+	* = non-native taxon		

TABLE 3. N.V.C. ANALYSIS OF
JUNCUS BALTICUS 2004 SAMPLES

Site	Sample No.	N.V.C. Community/ sub-community	% fit	Assessment of fit
Slack 26	1	SD15	78	Good
	2	SD15	81	Very good
	3	SD16b	45	Very poor
Slack 27	1	MG11	49	Very poor
	2	S19c	44	Very poor
	3	SD15	57	Poor
	4	SD15	60	Fair
	5	SD14a	64	Fair
	6	SD14a	64	Fair
	7	SD15	52	Poor
Tagg's Is.	8	SD15	69	Fair
	1	SD15	34	Very poor
	2	MG11	55	Poor
	3	SD15	65	Fair
	4	SD15	75	Good
	5	SD15	60	Fair
Slack 39a	6	SD15d	44	Very poor
Slack 39b		MG11	55	Poor
Green Beach (central)		MG11	54	Poor
	1	MG12	51	Poor
	2	SM16e	38	Very poor
	3	MG11	41	Very poor
	4	SM16d	48	Very poor
Green Beach (south)		SM13b	13	Very poor
Slack 45		SD16b	46	Very poor

TABLE 4. N.V.C. ANALYSIS OF 1981/82
JUNCUS BALTICUS SAMPLES

Sample (Slack)	N.V.C. Community/ sub-community	% fit	Assessment of fit
1	SD8a	46	Very poor
2 (Slack 30)	SM16d	58	Poor
3 (Slack 31)	SD16d	61	Fair
4 (Slack 33)	SD16d	41	Very poor
5 (Slack 29)	SD16d	35	Very poor
6 (Golf Course)	SD17	58	Poor
7 (Slack 26)	MC9	59	Poor
	or SD16d	58	Poor
8 (Slack 26a)	SD14d	41	Very poor
	or SD16d	40	Very poor
	or SD14c	40	Very poor
9 (Slack 27)	SD16d	28	Very poor
10 (Tagg's Is.)	OV19d	43	Very poor

with the SD15 *Salix repens* – *Calliergon cuspidatum* dune-slack, a community that is characteristic of old slacks kept wet by prolonged flooding with circumneutral ground waters (Rodwell 2000).

Four of the eight samples taken in slack 27 were fair fits to SD14a or SD15 dune-slack communities. According to Rodwell (2000), SD14 (*Salix repens* – *Campylyum stellatum* dune-slack) is a scarce vegetation type found in slacks of young to moderate age where the ground water is quite base-rich." Four samples in drier sites came closest to the MG11 *Festuca rubra* – *Agrostis stolonifera* – *Potentilla anserina* grassland, though, again, fits were poor to very poor. This community is characteristic of a wide variety of moist but free-draining circumneutral soils which are, in many cases, frequently inundated with fresh or brackish surface water (Rodwell 1992)." The youngest habitats colonised by *J. balticus* are Tagg's Island marsh and the Green Beach. Table 3 shows that poor or very poor fits to N.V.C. communities were generally obtained, the exception being three samples at Tagg's Island where fair to good agreement with SD15 was achieved. Of the five Green Beach samples, three were attributed to salt-marsh communities.

Analysis of ten samples taken in 1981/92 (Table 4) also shows, in most cases, poor or very poor accordance with N.V.C. communities. A majority of samples is closest to the SD16d, *Salix repens* – *Holcus lanatus* dune-slack, *Agrostis stolonifera* sub-community. Rodwell (2000) indicates that this is a widespread and common slack vegetation, characteristic of older and drier slacks that are rarely flooded to any great extent, though the *A. stolonifera* sub-community represents the wetter end of the spectrum."

BALTIC RUSH HYBRIDS

Smith (1984) summarised information on the naturally occurring hybrids of *J. balticus* in England up to 1982. Since then, one clone of the *inflexus* hybrid, that at Ainsdale Sand Dunes NNR, has been lost to sand-blow in the late 1980s. Fortunately, it had been taken into cultivation. The two other clones still exist; the one at Birkdale Sandhills (slack 18) has prospered, having increased in area by 450%, from about 450 to 2475 m² (Table 5). This clone is particularly vigorous, and has spread up the sides of the slack onto adjacent fixed dunes. The Lytham-St Annes clone is also

TABLE 5. SUMMARY OF INFORMATION ON *JUNCUS BALTICUS* HYBRIDS*JUNCUS BALTICUS* × *J. INFLEXUS*

Site & Grid Ref. (SD)	Habitat	Origin of material	Date of transplant	Patch area 1982	Patch area 2003	Av. Ht of stems	Fate in 2003
Ainsdale NNR Large Pond 303112	Semi-aquatic	Birkdale	1976	2	13	-	Extant
Ainsdale NNR Slack 15 286105	Wet-slack	Birkdale	1968	14	14	90	Extant
Ainsdale NNR Slack 13a 286102	Semi-aquatic	Ainsdale	1992	-	7.5	120	Extant
Ainsdale NNR Slack 13c	Semi-aquatic	Ainsdale	1992	-	11.6	140	Extant
Ainsdale LNR Slack 166 294120	Semi-aquatic	Unknown	1992	-	31.5	100	Extant
Birkdale LNR Slack 19 305139	Semi-aquatic	Birkdale	1992	-	-	-	Not found
Birkdale LNR Slack 18 305139	Wet-slack	natural	Pre-1951	450	2475	170	Extant
St Annes LNR 312303	Wet-slack	natural	1966	138	221	115	Extant

JUNCUS BALTICUS × *J. EFFUSUS*

Site & Grid Ref. (SD)	Habitat	Origin of material	Date of transplant	Patch area 1982	Patch area 2003	Av. Ht of stems	Fate in 2003
Ainsdale NNR Slack 15 278106	Wet-slack	Ainsdale	1968	37	60	80	Extant
Ainsdale NNR Slack 13a 286102	Semi-aquatic	Ainsdale	1992	-	-	-	Not found
Ainsdale NNR Slack 56 291113	Semi-aquatic	Ainsdale	1978	0.1	99	80	Extant
Ainsdale NNR Slack 118 286107	Dry-slack	Ainsdale	1968	21	-	-	Not found
Altcar Rifle"Range Slack 8 286050	Wet-slack	Hightown	1977	3	5	75	Extant
Hightown dunes Scrape 1 296022	Semi-aquatic	Hightown	1992	-	9	55	Extant

doing well; its area has gone up from 138 to 221 m², representing a 60% increase since 1982 (M. Jones *in litt.*).

By 1982, the Birkdale clone of the *inflexus* hybrid had been transplanted to four sites in the Ainsdale NNR and was still extant at two of these (the Large Pond and slack 15) (Smith 1984). However, in 1992, translocations from both Sefton Coast clones were made to Ainsdale NNR (two sites) and to Birkdale Sandhills LNR (one site), using material grown by Prof. C. A. Stace (Simpson 1992). The Birkdale transplant could not be found in 2003 but the other five are still present (Table 5), representing both the Ainsdale and Birkdale clones. In addition, a transplanted patch of undoubted *J. balticus* × *J. inflexus* was found in Ainsdale Sandhills LNR (slack 166). This had been incorrectly recorded as the *effusus* hybrid by Simpson (1992). Unfortunately, the origin of this material cannot now be established with certainty but it is likely to be from the Ainsdale clone, as Simpson did not relocate Birkdale material to Ainsdale NNR.

Table 5 shows that all but one of the transplanted *inflexus* hybrids have grown considerably. The exception is that in Ainsdale NNR slack 15, which occupies the same area as it did in 1982. Five sites were categorised as semi-aquatic and three as wet-slacks; the single lost clone (at Birkdale) was in semi-aquatic habitat.

Since the earlier study, despite extensive searches, no new clones of the *effusus* hybrid, *Juncus xobotritorum* have been found on the Sefton Coast. Smith (1984) reported that, up to 1978, six attempts had been made to translocate this hybrid and four were still extant in 1982. Using material from Prof. Stace, Simpson (1992) organised two further transplants to Hightown and to Ainsdale (slack 13a). The latter seems to have failed, as there was no sign of it in 2003. However, all the others have done well, especially the 1978 transplant to Ainsdale NNR (slack 56) which has increased from 0.1 to 99 m² in 21 years (Table 5). Both the 1933 Ainsdale clone and the 1973 Hightown clone are represented in these translocations, the only one entirely lost being the 1966 clone found in a Hightown dune-slack by V. Gordon (Smith 1984).

Table 5 shows that three samples of *J. xobotritorum* have been transplanted to semi-aquatic habitat, two to wet-slack and one to dry-slack. Losses have occurred from semi-aquatic (one) and dry-slack (one).

The mean height of stems of the *inflexus* hybrid was 122.5 cm, that of the less robust *effusus* hybrid being only 72.5 cm (Table 5). The data collected were insufficient to distinguish between the stem heights of the different clones.

DISCUSSION

This study has shown that *Juncus balticus* is still well established at Birkdale in its only English locality and occupies an encouragingly larger area than it did in 1982. However, it has seriously declined in the northern and eastern part of its range here. The reasons for this are not hard to find. First, Smith (1984) concluded that the plant is a good coloniser of young, sparsely vegetated wet-slacks and may then persist for many years, before declining as the habitat becomes drier and more heavily vegetated. Slacks 26 and 26a, east of the coastal road, originated about 1884 (Smith 1984) so it is not surprising that the Baltic Rush is now much reduced in quantity here. Similarly, the golf-course site now supports a dense sward of waist-high *Bolboschoenus maritimus* and *Carex acutiformis*, which is clearly unsuitable for *J. balticus* (personal observations).

The northern slacks, which are of more recent origin, have suffered badly from scrub invasion over the last 20 years. Observations in the early/mid-1980s showed that, although there were few large clumps, *Hippophae rhamnoides* was well-established and spreading. It soon dominated these slacks. Unfortunately, it was not until the mid-1990s that the site managers were able to secure funding to control the plant. The northernmost slacks in the Birkdale frontal dunes were not cleared until 2002/03, by which time only small areas of slack vegetation survived. Also, it was noted in the mid-1990s that the remaining patches of *J. balticus* in these slacks were being heavily grazed by Rabbits (personal observations).

D. E. Allen (*in litt.*) knew of another population in the 1950s. It was "In a remote slack roughly midway between Ainsdale Beach and Hillside Station". The exact locality cannot be traced but the general area has been searched many times without success. The plant seems unlikely to have survived, because the slacks here are now very mature and much colonised by scrub.

Fortunately, suitable young slack habitat in the south of its range has allowed the Baltic

Rush to spread to new sites. Currently, the largest area of the rush is in slack 27. Photographs taken in 1984 show that the floor of this slack was almost completely churned up by illegal motorcycle scrambling (personal observations). Smith (1984) commented on the apparent resistance of the rush to mechanical damage and the fact that it had spread, under similar circumstances, in site 4 (slack 33). This seems to be a satisfactory explanation for the plant's present abundance in slack 27.

Tagg's Island marsh began to form in 1978, while the Green Beach dates back only to 1986, so these two areas provide the immature, open vegetation that the Baltic Rush seems to prefer. The first patch of *J. balticus* on the Green Beach was found in 2000, due west of the colonies in slacks 39a and 39b. Similarly, another nine small patches on the central Green Beach appeared in 2003/04 just to the west of the first one (Fig. 1), suggesting that they may have arisen from propagules carried by pedestrians from the older dune sites (Smith 1984). Smith (1984) found that many patches of Baltic Rush were associated with informal footpaths, implying that propagules (especially seeds) could be transported by pedestrians. This association is still apparent, especially in slack 27, where many of the rush patches lie on the routes of lightly-used paths and some are suppressed by localised heavier trampling. Similarly, the cluster of small patches which appeared in 2003/04 on the central Green Beach are on or close to an old 4-wheel-drive track which is often used by walkers." The Green Beach is extensive and is still developing westwards (personal observations), so this should ensure suitable habitat for *J. balticus* is present at Birkdale for at least several decades.

From the N.V.C. data, it is difficult to determine the preferred vegetation type for *J. balticus* at Birkdale. What can be deduced is that the plant is capable of growing in a wide variety of dune-slack, salt-marsh, damp mesotrophic grassland, maritime grassland, ephemeral and swamp communities under varying water-table and base status conditions.

CONSERVATION OF *J. BALTICUS* AND ITS HYBRIDS

All the sites for Baltic Rush and its hybrids on the Sefton Coast are statutorily protected by Site of Special Scientific Interest and candidate Special Area of Conservation designations.

Many of the hybrid transplant locations also lie within the Ainsdale Sand Dunes National Nature Reserve, while most of the *J. balticus* populations are in the Birkdale Sandhills Local Nature Reserve. The Birkdale Green Beach, which is likely to become increasingly important for the rush, is a proposed extension to the LNR.

Past losses of parts of the Baltic Rush population and some of the hybrid clones has been attributed to building development, coastal erosion, sand-blow and competition from maturing vegetation (Smith 1984). The future of these plants should be assured by protection of their habitats and, more importantly, by sympathetic management regimes within the reserve structures of the coast. For example, a major programme of scrub control by all land-managers since the early 1990s is crucial to the maintenance of open plant communities. Similarly, extensive winter-grazing by sheep on the Ainsdale NNR and parts of the Ainsdale Sandhills LNR, introduced from 1990 onwards, is also making a significant contribution to holding back succession. It is hoped that grazing will soon be extended to the Birkdale Sandhills. Sefton Council's proactive policy towards dune accretion along the foreshores is playing an important role in reversing the trend towards a stable and over-mature dune system (Smith 1999), and can only be beneficial to Baltic Rush and its hybrids.

This study has shown that conservation by translocation has worked well for the hybrid clones, particularly when they are planted in semi-aquatic or wet-slack habitats with sparse vegetation. Both their origins and their subsequent fate have generally been well monitored. There are no imminent plans for further transplantation, though this could be justified for the Hightown *J. balticus* × *J. effusus* clone which is confined to two small patches.

Smith (1984) concluded by stating: "*Juncus balticus* is still restricted to a small part of an otherwise large dune system. However, its recent increase, ability to colonise and persist in a wide variety of slack types and its apparent resilience to public pressure indicate that it should survive as an interesting and important component of the Merseyside sand-dune flora in the foreseeable future." These sentiments seem as valid today as they did twenty years ago.

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kindly allowed me to use a TABLEFIT programme to determine N.V.C. communities. Maurice Jones and Frank Walsh measured the patch of *Juncus balticus* $\times$ *J. inflexus* at Lytham-St. Annes Local Nature Reserve. Thanks are also due to Royal Birkdale Golf Club for access to the course and to Mike Wilcox who made helpful and detailed comments on a draft of the manuscript.

REFERENCES

- MERSEYSIDE BIODIVERSITY GROUP (2001). *North Merseyside Biodiversity Action Plan 2001*. Unpub. report.
- PRESTON, C. D., PEARMAN, D. A. & DINES, T. D. (2002). *New Atlas of the British & Irish Flora*. Oxford University Press, Oxford.
- RANWELL, D. S. (1972). *Ecology of Salt Marshes and Sand Dunes*. Chapman & Hall, London.
- RODWELL, J. S. ed. (1992). *British Plant Communities*, vol. 3. *Grassland and montane communities*. Cambridge University Press, Cambridge.
- RODWELL, J. S. ed. (2000). *British Plant Communities*, vol. 5. *Maritime communities and vegetation of open habitats*. Cambridge University Press, Cambridge.
- SIMPSON, D. E. (1992). Rare species : *Juncus balticus* hybrids and *Schoenoplectus pungens*. Reintroduction of *Juncus balticus* hybrids to the Sefton Coast. Unpub. report, Ainsdale Sand Dunes NNR.
- SMITH, P. H. (1984). The distribution, status and conservation of *Juncus balticus* Willd. in England. *Watsonia*, **15**: 15–26.
- SMITH, P. H. (1999). *The Sands of Time. An introduction to the Sand Dunes of the Sefton Coast*. National Museums & Galleries on Merseyside, Liverpool.
- STACE, C. A. (1970). Unique *Juncus* hybrids in Lancashire. *Nature, Lond.*, **226**: 180.
- STACE, C. A. (1972). The history and occurrence in Britain of hybrids in *Juncus* subgenus *Genuini*. *Watsonia*, **9**: 1–11.

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Notes

AN HYSTRICEAN BRAMBLE (*RUBUS* SP.) FROM INLAND KINCARDINESHIRE: LISTING BY BABINGTON, ROGERS, TRAIL AND WATSON REPUDIATED

In 1876 John Sim, a farmer and keen naturalist living in Strachan, Kincardineshire, sent a bramble to C. C. Babington for determination. Babington was then Professor of Botany in Cambridge and had become the leading bramble authority. Two sheets in **CGE** are extant from Sim's collection, both bearing the names *R. Koehleri* – *infestus*. *R. Reuteri* in Babington's handwriting.

The first published record of this determination seems to have been in Watson's *Topographical Botany* (1883): the list of vice counties for *Rubus glandulosus* Bellardi var. *reuteri* Mercier includes South Aberdeenshire. Assignment to the wrong vice-county perhaps resulted from the locality being given on the herbarium sheets as Strachan near Banchory, N. B. (i.e. North Britain). Babington himself was responsible for the next citation of the record (1886): under *Rubus reuteri* Mercier he reported that specimens from Sellack and Penyard Wood (both Herefordshire), Kirkby (Lancashire), Banchory (N. B.) and Thirsk (Yorkshire) "all agree fairly well with the authentic specimens of *R. reuteri*", these having been collected near Geneva, where Mercier first described the species (Babington 1873).

The third publication of Babington's determination of Sim's bramble was by Rogers (1893). The name had again changed, to *Rubus obscurus* Kaltenb., but the localities given in 1886 are all retained (Hereford, Lancashire, Banchory N. B. and Yorkshire) and Monmouthshire is added. Rogers provided a reasonably full description of *R. obscurus*, placing it next to *R. koehleri* Weihe & Nees within his Group 7 *Koehleriani* (= *Hystrices*). Rogers' *Key to British Rubi* (1893) and *Handbook of British Rubi* (1900) gave a much improved understanding of British brambles, and led Trail to attempt a vice-county listing for Scotland (1902/03). Following a further name change (Rogers 1895), Sim's bramble was listed by Trail as *Rubus rosaceus* Weihe & Nees ssp. *purchasianus* Rogers, its only Scottish records being for v.cc. 91 and 92. It seems that Trail uncritically accepted the South Aberdeenshire citation given by Watson

(1883), but knowing that Banchory was in Kincardineshire responded to the locality list of Babington (1886) by adding v.c. 91.

Both records were classed by Trail (1902/03) as "in much need of confirmation"; he had probably noted that Rogers (1897) included *Rubus rosaceus* var. *purchasianus* in a list of brambles that he (Rogers) had not seen either fresh or dried from Scotland. By this time Trail had a sound knowledge of the bramble species of north-east Scotland, as shown by his *Flora of Buchan* (1902), and he may well have suspected that the species was either rare or incorrectly determined. Since 1903 there have been no more mentions of Sim's record in the literature, and the distribution given in Edees & Newton (1988) for *Rubus purchasianus* Rogers, the present name of the bramble, centres on Herefordshire and Monmouthshire.

I therefore sought to refind Sim's bramble in the Strachan-Banchory area. My search produced in summer 2002 a puzzling bramble allied to the *Hystrices* on a laneside at NO684934 midway between Strachan and Banchory; both David Allen and Alan Newton considered it an unnamed form. In summer 2003 I found further bushes of the same bramble in an ungrazed strip along a stream fenced off from fields to either side (NO681933). The 1881 Census showed John Sim occupied Gateside Farm which was stated to be 140 acres (57 ha) in extent, and from the 1866 6" O.S. maps it seemed likely that the fenced-off stream was its east boundary. The present farmer to its east has confirmed to me that the stream has indeed long been the boundary of Gateside Farm. However, the *Hystricean* bramble growing there is considerably different to *Rubus purchasianus*, having almost round leaves, pinkish to pink petals and hairy anthers (cf. rhomboid or obovate leaves, bright pink petals and glabrous anthers).

I then examined the two sheets in **CGE** to try to establish what species Sim had collected. Unfortunately, the material is inadequate lacking proper stem pieces, and at least one of the four pieces present belongs to a different species. On the sheet I designate A, there are

two similar shoot tops 27 and 22 cm long ending in young inflorescences. On sheet B, there is a 29 cm long shoot top with inflorescence undeveloped and a 15 cm shoot top from a different species that bears several flowers; this latter shoot has no stalked glands whereas the three other stems have abundant stalked glands. I consider the 15 cm shoot to be *Rubus scissus* W. C. R. Watson, and the other three pieces to be *Rubus echinatoides* (Rogers) Dallman, those on sheet A certainly so. This sheet is annotated in pencil "probably *echinatoides*" by an unknown hand.

In Strachan parish there are now very few bramble species and *Rubus echinatoides* and *Rubus mucronulatus* Boreau are about equally abundant. *Rubus fissus* Lindley, *R. plicatus* Weihe & Nees and *R. scissus* occur sparsely, and there is one large patch of *Rubus pictorum* Eedes. Only one species belonging to the series *Hystrices* occurs in Kincardineshire, this being *Rubus dasyphyllus* Rogers (E. S. Marshall) for which the nearest locality is at Muchalls (NO89), 25 km east of Strachan.

Sim was a competent bryologist (Macvicar 1902) and collected hard-to-spot flowering plants as shown by specimens of *Equisetum variegatum* Schleicher and *Hammarbya paludosa* (L.) Kuntze in ABD, and I suggest he realised that on his boundary streamside he had a different bramble to the distinctive *R. echinatoides* and *R. mucronulatus* that are ubiquitous in west Kincardineshire. In fact the bushes of the unknown *Hystricean* presently grow intermixed with these two species, so

perhaps Sim inadvertently made a mixed gathering including *echinatoides*, and Babington discarded the *Hystricean* shoots. Just possibly a third party was involved, either Trail (who was already collecting *Rubus* specimens in 1876 including some from Banchory in ABD) or George Nicholson, Kew, who gave many bramble specimens collected in northern Scotland to ABD. This person could have suggested to Babington that Sim's plant was *Hystricean* and Babington, having recently established *Rubus reuteri* as a species, chose shoots to mount which superficially resembled it, particularly in the rhomboidal shape of the leaves. This was a key feature of *Rubus reuteri* from the descriptions in Babington (1873, 1874).

A final complication is that Druce collected from Strachan in 1926 a bramble he named *Rubus koehleri* (specimens in BM and OXF). Again the material is inadequate but sufficient to reject that determination (David Allen, pers comm.). Perhaps Druce expected to find this species from the literature. I hope this present paper makes clear that the listings of *Rubus reuteri*, *R. obscurus* and *R. rosaceus* ssp. *purchasianus* for v.cc. 91 and 92 are all wrong.

ACKNOWLEDGMENTS

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REFERENCES

- BABINGTON, C. C. (1873). *Rubus Reuteri* Merc. *Journal of Botany* 11: 140–141.
 BABINGTON, C. C. (1874). *Manual of British Botany*. 7th edition. Van Voorst, London.
 BABINGTON, C. C. (1886). Notes on British Rubi: with special reference to the list in "London Catalogue", Ed. 8. *Journal of Botany* 24: 216–237.
 EDEES, E. S. & NEWTON, A. (1988). *Brambles of the British Isles*. The Ray Society, London.
 MACVICAR, S. M. (1902). The herbarium (Hepaticae) of the late Mr John Sim. *Annals of Scottish Natural History* 1902: 179–182.
 ROGERS, W. M. (1893). *An Essay at a Key to British Rubi*. West, Newman & Co., London.
 ROGERS, W. M. (1895). On the Rubi list in *London Catalogue* 9. *Journal of Botany* 33: 100–106.
 ROGERS, W. M. (1897). On some Scottish Rubi. *Journal of Botany* 35: 42–50.
 ROGERS, W. M. (1900). *Handbook of British Rubi*. Duckworth, London.
 TRAIL, J. W. H. (1902). *Flora of Buchan*. P. Scrogie, Peterhead.
 TRAIL, J. W. H. (1902/03). Scottish Rubi. *Annals of Scottish Natural History* 1902: 59, 170–176, 233–244; 1903: 41–47, 103–107.
 WATSON, H. C. (1883). *Topographical Botany*. Ed. 2. Quaritch, London.

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A SIMPLE GENETIC BASE FOR THE SPREADING AND APPRESSED HAIR TYPES IN *ANTHYLLIS VULNERARIA* L. (FABACEAE)

Rich (2001) reviewed the status of *Anthyllis vulneraria* L. subsp. *corbierei* (Salmon & Travis) Cullen, and concluded that it was probably part of the polymorphic variation in *A. vulneraria* subsp. *vulneraria*. It was noted that genetic experiments were required to establish the basis of inheritance of the key spreading and appressed hair characters on the lower stem and petioles which distinguish the taxa (hairs spreading in subsp. *corbierei* and appressed in subsp. *vulneraria*). The results of such an experiment are reported here.

METHODS

One fruit was collected at random from each of about 50 plants of *Anthyllis vulneraria* at the type locality of subsp. *corbierei* at South Stack, which contains a mixture of plants with appressed and spreading hairs (Rich 2001). Fruits were stripped out of the persistent calyx and the single seed extracted from each pod. Each seed coat was nicked with nail-clippers, and the seeds were sown in standard John Innes No. 1 potting compost and grown in a greenhouse in Cardiff. Due to lack of water during one holiday, only eight plants survived to flowering, six plants with spreading hairs and two with appressed hairs. The plants were kept isolated from insects and allowed to self-pollinate. All seeds from each plant were harvested and sown as above. The number of seeds that germinated from each plant was very variable. Progeny were scored for spreading or appressed hairs on the petioles and surfaces of the first leaves of the seedlings.

RESULTS

The numbers of seedlings of each type from the eight parent plants are shown in Table 1. The two parents with appressed hairs (plants 4 and 7) both produced seedlings only with appressed hairs. Parent plants with spreading hair types either produced seedlings with spreading hairs

TABLE 1. RESULTS OF SEED GERMINATION TRIALS

Plant	Parental hair type	No. seedlings with each hair type		
		Spreading	Appressed	Ratio
4	Appressed	0	12	0:1
7	Appressed	0	12	0:1
2	Spreading	3	0	1:0
6	Spreading	5	0	1:0
8	Spreading	5	0	1:0
1	Spreading	14	5	2.8:1
3	Spreading	26	7	4.7:1
5	Spreading	3	2	1.5:1

only (plants 2, 6 and 8) or a mixture of seedlings with spreading and appressed hairs (plants 1, 3 and 5). In these latter three plants, the proportions of seedlings with spreading or appressed hairs do not depart significantly from what would be expected with a simple 3:1 ratio (Chi-squared test: plant 1, $p = 0.89$; plant 3, $p = 0.62$; plant 5, $p = 0.44$).

DISCUSSION

The results are consistent with a simple Mendelian genetic model of a dominant gene for spreading hairs (S) with a recessive gene for appressed hairs (s), assuming the two parent plants with appressed hairs were homozygous recessives (ss), the three parents producing only seedlings with spreading hairs were homozygous dominants (SS) and the three parents producing mixed seedlings were heterozygotes (Ss). The results indicate that the spreading/appressed hair character states are a simple polymorphism, supporting the argument that the supposed taxon with spreading hairs does not merit recognition at subspecific rank (Rich 2001).

REFERENCE

- RICH, T. C. G. (2001). What is *Anthyllis vulneraria* L. subsp. *corbierei* (Salmon & Travis) Cullen (Fabaceae)? *Watsonia* 23: 469–480.

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Plant Records

Records for publication must be submitted to the appropriate Vice-county Recorder (see *BSBI Year Book 2005*), and not to the Editors. Following publication of the *New Atlas of the British & Irish Flora* and the *Vice-county Census Catalogue*, new criteria have been drawn up for the inclusion of records in *Plant Records*. (See *BSBI News* no. 95, January 2004 pp 10 & 11). These are outlined below:

- First records of **all** taxa (species, subspecies and hybrids) included in the VCCC, designated as native, archaeophyte, neophyte or casual.
- First record since 1970 of the taxa above, except in the case of *Rubus*, *Hieracium* and *Taraxacum*.
- Records demonstrating the rediscovery of all taxa published as extinct in the VCCC or subsequently.
- Newly reported definite extinctions.
- Deletions from the VCCC (e.g. through the discovery of errors, the re-determination of specimens etc.) **NB** – only those errors affecting VCCC entry.
- New 10-km square records for Rare and Scarce plants, defined as those species in the *New Atlas* mapped in the British Isles in 100 10-km squares or fewer. (See *BSBI News* no. 95, January 2004 pp 36–43).
- Records for the subdivisions of vice-counties will not be treated separately; they must therefore be records for the vice-county as a whole. However, records will be accepted for the major islands in v.cc. 102–104, 110 and 113.

In the following list, records are arranged in the order given in the *List of Vascular Plants of the British Isles* and its supplements by D.H. Kent (1992), from which the species' numbers, taxonomy and nomenclature are taken. The Ordnance Survey national grid reference follows the habitat and locality. With the exception of collectors' initials, herbarium abbreviations are those used in *British and Irish Herbaria* by D.H. Kent & D.E. Allen (1984). Records are field records if no other source is stated. For *Rubus* records 'det.' or 'conf.' appear after the herbarium if the determination was based on material already in an institutional herbarium, otherwise before the herbarium.

The following signs are used:

- * before the vice-county number: to indicate a new vice-county record.
- † before the species number: to indicate that the plant is an archaeophyte.
- ‡ before the species number: to indicate that the plant is a neophyte.
- ø before the species number: to indicate that the plant is a casual.

The above 3 signs may also be used before the vice-county number to indicate the status of the plant in that vice-county.

☐ before the vice-county number: to indicate that this is an additional hectad for a Rare or Scarce plant.

Ø at end of entry: apparently established taxon not listed in *Vice-county Census Catalogue*.

[] enclosing a previously published record: to indicate that that record should be deleted or changed.

The following list contains records up to the end of 2004. Records for 2005 will be published in the next two issues of *Watsonia*.

4/1.3. *EQUISETUM VARIEGATUM* **110**, Outer Hebrides: Luskentyre, S Harris, NG073987, C.N. Page, 1972. 1st record since 1970.

4/1.3. *EQUISETUM VARIEGATUM* var. *WILSONI* ***44**, Carms.: Large patches, c. 20 × 5 m in calcareous flushed area on floor of disused Carboniferous Limestone quarry near kilns, Pentregwenlais Quarry, Llandybie, SN608163, I.K. Morgan & R.N. Stringer, 2003, **NMW & herb. C.N.P.**, conf. C.N. Page. 1st record for variety outside Killarney, Ireland (*teste* CNP).

4/1.5×8. *EQUISETUM* × *ROTHMALERI* (*E. ARVENSE* × *E. PALUSTRE*) *44, Carms.: Many plants in calcareous flushed area on floor of disused Carboniferous Limestone quarry, near kilns, Pentregwenlais Quarry, Llandybie, SN608163, BSBI meeting, 2003, NMW & herb. C.N.P., det. S. Thomas, conf. C.N. Page. 1st confirmed record. *45, Pembs.: Growing in the *Angelica sylvestris* sub-community of *Molinia caerulea*-*Potentilla erecta* mire, Llambod, Mathry, SM886326, A. Turner & S. Bosanquet, 2003.

4/1.8pol. *EQUISETUM* *PALUSTRE* var. *POLYSTACHUM* *44, Carms.: Derelict colliery, Emlyn Colliery site, Penygroes, SN579134, I.K. Morgan, 2003, NMW, conf. G. Hutchinson. 1st record of variety.

5/1.2. *OPHIOGLOSSUM* *AZORICUM* 103, Mid Ebudes (Mull): 13 plants in coastal grassland, W. of Beinn Duill, NM334472, L. Farrell, 2004, conf. F.J. Rumsey. 1st record for Mull. 110, Outer Hebrides: Headland near Reineigadal, NB229018 to NB233015, S. Taylor, 2004. Hundreds, maybe thousands, of plants.

15/2.4. *ASPLENIUM* *MARINUM* *61, S.E. Yorks.: On stone wall bordering dock above waterline, Humber dock basin, Hull, TA0928, R. Middleton, 2004.

15/2.6. *ASPLENIUM* *VRIDE* 106, E. Ross: Rock outcrop, Breabag Ridge, NC303189, B.R. & C.B. Ballinger, 2004. 1st record since 1970. Just inside v.c. boundary. 110, Outer Hebrides: Sgurr Scaladale, NB1608, P.A. Smith & G.M. Orledge, 1999. 1st record since 1970. Only known site for v.c. 110, still there!

15/2.8. *ASPLENIUM* *SEPTENTRIONALE* 47, Monts.: Several colonies in view but access difficult on rocks, Glaslyn Mont. Trust Reserve, SN89, M. Lawley, 2004, NMW. 2nd record & 1st since 1970.

‡16/1.1. *MATTEUCCIA* *STRUTHIOPTERIS* *67, S. Northumb.: Established in scrub on south bank of R. Wansbeck, Bothal, NZ240864, Q.J. Groom & M. McKay, 2004.

17/3.1×2. *DRYOPTERIS* × *MANTONIAE* (*D. OREADES* × *D. FILIX-MAS*), *110, Outer Hebrides: Mula Mac Sgiathain, altitude c 170 m, NB023281, BSBI Field Meeting/P.A. Smith, 2001, NMW, det. G. Hutchinson, conf. A.C. Jermy.

17/3.2×3. *DRYOPTERIS* × *COMPLEXA* (*D. FILIX-MAS* × *D. AFFINIS*) *50, Denbs.: Woodland, Trefor, SJ2552, R. Maskew, 2004.

17/3.3b. *DRYOPTERIS* *AFFINIS* subsp. *CAMBRENSIS*, *50, Denbs.: Woodland, Trefor, SJ270420, R. Maskew, 2004.

‡20/1.1. *ABIES* *ALBA* *‡63, S.W. Yorks.: Park Hill, Sheffield, SK3687, Sheffield Wildlife Trust, 1998.

‡20/1.3. *ABIES* *PROCERA* *110, Outer Hebrides: Old garden, Kyles Lodge, NF998878, R.J. Pankhurst, 2002.

‡20/3.1. *TSUGA* *HETEROPHYLLA* *H12, Co. Wexford: Self-sown along forest ride, Ballythomas, T109717, P.R. Green, 2003.

‡20/7.3. *PINUS* *CONTORTA* *H12, Co. Wexford: Self-sown along forest ride, Slievegar, S8348, P.R. Green, 2003.

‡20/7.5. *PINUS* *RADIATA* *34, W. Gloucs.: Two or three large trees in shelterbelt above Horton Court, ST769847, M.A.R. & C. Kitchen, 2004. Planted.

‡20/7.thu. *PINUS* *THUNBERGII* *110, Outer Hebrides: Stornoway Castle grounds, NB4133, W.A.J. Cunningham, 2001, det. M. Gardiner. Ø

‡20A/CRY.jap. *CRYPTOMERIA* *JAPONICA* *c42, Brecks.: Planted trees in forestry plantation, Nant Tresglen, Halfway, SN838332, M. & C. Porter, 2003.

‡20.1/SQD.gig. *SEQUIADENDRON* *GIGANTEUM* *68, N. Northumb.: Gainslaw House, NT949523, M.E. Braithwaite, 2003.

‡21/2.1. *CHAMAECYPARIS* *LAWSONIANA* *68, N. Northumb.: Kidland Forest, NT91A, J. O'Reilly, 2003. Planted.

‡21/3.occ. *THUJA* *OCCIDENTALIS* *29, Cambs.: Self-sown in pavement some distance from hedge of probable parent, Mulberry Lane, Chesterton, Cambridge, TL457602, G.M.S. Easy, 2004, herb. G.M.S. Easy. Ø

21/4.1a. *JUNIPERUS* *COMMUNIS* subsp. *COMMUNIS* *63, S.W. Yorks.: Wharncliffe Wood, SK3194, B. Langridge, 1986.

‡22/1.1. *ARAUCARIA* *ARAUCANA* *c50, Denbs.: 28 trees planted on drive to house, Llangernyw, SH846659, J.A. Green, 2004.

23/1.1. *TAXUS BACCATA* *‡**106**, E. Ross: Bank of R. Peffery, Dingwall, NH560585, B.R. & C.B. Ballinger, 2004. Probably planted.

‡24SAU/HOU.cor. *HOOTTUYNIA CORDATA* ***44**, Carms.: Brought in with rubble to make track on disturbed ground on Waun-y-gwial fach, Four Roads, SN446084, A. Stevens, 2003, det. C.D. Preston from photo. 1st Welsh record. Ø

26/2.1×2. *NUPHAR* × *SPENNERIANA* (*N. LUTEA* × *N. PUMILA*) ■‡**67**, S. Northumb.: Pond, Wallington, NZ0284, M. McKay, 2004. Introduced from Chartners Lough (where it is native) long ago.

‡26/2.3. *NUPHAR ADVENA* ***41**, Glam.: Large clump in shallows of former ornamental pond, Sketty Hall, Swansea, SS623943, A.S. Lewis, 2003.

‡28/5.1. *NIGELLA DAMASCENA* *‡**61**, S.E. Yorks.: On waste, Beverley, TA0232, J.K. Dews, 2003.

‡28/9.2. *ANEMONE APENNINA* ***44**, Carms.: Shrubberies, Llanybyther [sic], Carmarthen, SN4140, G. Thomas, 1928, **LTR**, det. C.A. Stace.

‡28/9.hup×vit. *ANEMONE* × *HYBRIDA* (*A. HUPEHENSIS* × *A. VITIFOLIA*) ***44**, Carms.: One clump on disturbed ground on new embankment, Yspitty, Bynea, SS557984, A. & V. Lewis, 2004.

‡28/12.3. *CLEMATIS TANGUTICA* ***50**, Denbs.: Grassed over coal mine, Chirk, SJ298383, BSBI group, 2004. ***96**, Nairns.: At least 7 plants in dunes above beach, east of caravan park, Nairn, NH896574, E.S. Oxenham, 2001, conf. M. Barron.

28/13.4. *RANUNCULUS SARDOUS* **63**, S.W. Yorks.: Wilthorpe Marsh, SE3408, B. Langridge, 1987. 1st record since 1970.

28/13.7. *RANUNCULUS PARVIFLORUS* **50**, Denbs.: Shallow calcareous soil, Mynydd Mariau, SH888774, W. McCarthy & J.A. Green, 2004. 1st record since 1960.

28/13.17c. *RANUNCULUS FICARIA* subsp. *FICARIIFORMIS* ***40**, Salop: Roadside, Albrighton, SJ813034, H.V. Hughes, 2004, conf. S.J. Whild.

28/13.18. *RANUNCULUS HEDERACEUS* **106**, E. Ross: By stream near shore, Tain, NH859746, B.R. & C.B. Ballinger, 2004. 1st record since 1970.

28/13.21. *RANUNCULUS BAUDOTII* ***63**, S.W. Yorks.: S. Ring Drain, R. Torne, SE6703, P.P. Abbott, 1996.

28/13.23×24. *RANUNCULUS* × *VIRZIONENSIS* (*R. AQUATILIS* × *R. PELTATUS*) ***40**, Salop: Upland stream, Wild Moor, SO425965, S.J. Whild, 2004, **herb. S.J.W.**

28/15.1. *MYOSURUS MINIMUS* *‡**70**, Cumberland: C.20 plants by roadside, Spadeadam MOD, NY618702, M. Gregory & J. Parker, 2004, **LANC**. Plants no longer findable a fortnight after discovery.

28/17.4. *THALICTRUM MINUS* ***61**, S.E. Yorks.: Two colonies growing with other calcicoles on a chalk bank, Newton Dale, Wintringham, SE906722, M. Hammond, 2004. Situated remote from possible introduction. Could be native.

‡29/1.7. *BERBERIS JULIANAE* ***40**, Salop: Newport Canal, SJ7419, R.M. Stokes, 2003, **herb. S.J.W.**, conf. S.J. Whild.

‡29/1.agg×wil. *BERBERIS* cf. *AGGREGATA* × *B. WILSONIAE* ***33**, E. Gloucs.: Single bush on edge of long defunct Jurassic limestone quarry, Cleeve Common, SO993265, R. Homan, 2004, det. E.J. Clement. Ø Apparently 1st record for Britain and Ireland.

‡30/1.2. *PAPAVER ATLANTICUM* ***40**, Salop: Bridgnorth, SO722924, R.M. Stokes, 2004, conf. S.J. Whild.

‡30/1.5b. *PAPAVER DUBIUM* subsp. *LECOQII* **68**, N. Northumb.: Weed in flowerbed, Berwick Cemetery, NT9954, M.E. Braithwaite, 2003. 1st record since 1970. ***52**, Anglesey: Thin soil on limestone in gardens, Tynyngogl, SH509828, I.R. Bonner, 2004.

30/2.1. *MECONOPSIS CAMBRICA* ■‡**81**, Berwicks.: Wooded bank, Ninewells, NT8655, M.E. Braithwaite, 2002.

‡30/6.1. *ESCHSCHOLZIA CALIFORNICA* ‡**38**, Warks.: Soil dumped by hedge, Snitterfield, SP231595, J.W. Partridge, 2004. 1st record since 1954.

‡31/2.1. *CORYDALIS SOLIDA* **34**, W. Gloucs.: Small patch on road verge, Ketford Mill, Dymock, SO729308, M.J. Palfrey, 2004. Confirms 1948 *Glos. Flora* record for Ryton. 1st record since 1970.

31/5.3. *FUMARIA BASTARDII* **50**, Denbs.: Roadside, Dolwen, SH883744, K. Watson, 2004. 1st record since Old Atlas (1962).

- 31/5.6. *FUMARIA PURPUREA* [69, Westmorland: Strawberry field, Heversham, SD494825, D. Hughes, 2004, conf. T.C.G. Rich. [69, Westmorland: Lane to Deer Park, Endmoor, SD533846, D. Hughes, 2004, conf. T.C.G. Rich. [81, Berwicks.: Set-aside, Addinston, NT524533, L.W. Gaskell, 2000, det. M.E. Braithwaite. [81, Berwicks.: Disturbed ground, Lauder Golf Course, NT528465, J. Mercer, 2004, det. M.E. Braithwaite. [81, Berwicks.: 500 plants in oil-seed rape, near Killedraught Bay, NT934644, M.E. Braithwaite, 2000. [96, Easternness: In field which had gone wild, one part being used for construction site huts, below railway crossing, Allanfearn, NH713475, H.S. McHaffie, 2004, conf. T.C.G. Rich. Found during Inverness *Fumaria* workshop.
- †31/5.7b. *FUMARIA OFFICINALIS* subsp. *WIRTGENII* *47, Monts.: Sandy mound in farmyard, N of Cefn Coch, SJ049061, S.P. Chambers, 2004. 1st record for subspecies.
- †31/5.10. *FUMARIA VAILLANTII* *11, S. Hants.: Arable, Buckholt Farm, Broughton, SU280325, R.M. Veall, 2004, **herb. M.R.**
- 33/1.1×3. *ULMUS* × *VEGETA* (*U. GLABRA* × *U. MINOR*) *68, N. Northumb.: Station yard and staithe, Berwick, NT95W, M.E. Braithwaite, 2003.
- 33/1.1×3×4. *ULMUS* × *HOLLANDICA* (*U. GLABRA* × *U. MINOR* × *U. PLOTII*) *68, N. Northumb.: Marshall Meadows Hotel, NT979565, M.E. Braithwaite, 2003.
- 33/1.3a. *ULMUS MINOR* subsp. *MINOR* *63, S.W. Yorks.: Wadworth Carr, SK5896, P.A. Seccombe, 2002.
- ‡36/3.1. *SOLEIROLIA SOLEIROLII* *50, Denbs.: Damp walls, Bodnant Garden, SH797723, W. McCarthy, 2003.
- ‡40/2.3. *ALNUS CORDATA* *44, Carms.: Wind-blown seedling in garden, Coronation Road, Llanelli, SS514999, I.K. Morgan, 1996. *H6, Co. Waterford: Self-sown on wall of Kilmolash Bridge, S130949, A.C. Leslie, 2004.
- ‡40/4.2. *CORYLUS MAXIMA* *‡63, S.W. Yorks.: Woodland edge, Dodworth, SE3205, G.T.D. Wilmore, 2004.
- ‡42/TET.tet. *TETRAGONIA TETRAGONIOIDES* 113 (S), Channel Is. (Sark): On boundary bank of St Peter's near churchyard incinerator, WV465760, R.M. Veall, 2004, **herb. Soci  t   Sercquaise**, det. E.J. Clement. Reported (unidentified) by J. Borck. 1st record for Sark.
- †43/1.8. *CHENOPODIUM POLYSPERMUM* *  110, Outer Hebrides: Barra ferry car park, Eriskay, NF784101, R.J. Pankhurst, 2003, E.
- †43/1.11. *CHENOPODIUM URBICUM* 38, Warks.: Alleyway, Grove Street, Leamington Spa, SP314657, J.W. Partridge, 2004, **WARW**, conf. J.R. Akeroyd. 1st record since 1835.
- ‡43/1.bot. *CHENOPODIUM BOTRYS* *29, Cambs.: Field weed in showground, Impington, TL444630, G.M.S. Easy, 1985, **herb. G.M.S. Easy.   **
- ‡43/1.qui. *CHENOPODIUM QUINOA* *38, Warks.: In field sown with seed for wild birds, Hampton in Arden, SP216806, B. Davies, 2004, **WARW**, det. J.W. Partridge. *68, N. Northumb.: Near High Cocklaw, NT954544, M.E. Braithwaite, 2003. Planted as game crop.   
- 43/3.3. *ATRIplex GLABRIUSCULA* 106, E. Ross: Shingle shore, Kilmuir, NH683509, B.R. & C.B. Ballinger, 2004. 1st record since 1970.
- 43/6.3. *SALICORNIA EUROPAEA* *106, E. Ross: Covering approx. 50 square metres on sea shore in mud/sand, Dalmore, NH663682, B.R. & C.B. Ballinger, 2004, det. I.K. Ferguson.
- 43/8.1a. *SALSOLA KALI* subsp. *KALI* 110, Outer Hebrides: Eoligarry, Barra, NF70, A.O. Chater, 1983. 1st record since 1970.
- ‡44/1.3. *AMARANTHUS CRUENTUS* *  38, Warks.: Nursery garden, Charlecote, Warwick, SP264564, H.A. Roberts, 1993, **WARW**, det. T.B. Ryves as *A. hybridus* subsp. *incurvatus* (= *A. cruentus*).
- 46/1.1. *ARENARIA SERPYLLIFOLIA* 106, E. Ross: In dunes near shore, Nigg, NH802689, B.R. & C.B. Ballinger, 2004. 1st record since 1970.
- 46/4.6. *MINUARTIA SEDOIDES* 106, E. Ross: Summit area, Seana Bhraigh, NH288872, G.Rothero, 1995. 1st record since 1970. Still present in 2004.
- 46/5.3. *STELLARIA PALLIDA* 42, Brecks.: Base of castle walls, Tretower, SO185212, M. & C. Porter, 2004. 2nd record & 1st since 1957.
- 46/5.5. *STELLARIA HOLOSTEA* *‡110, Outer Hebrides: Shady path, Stornoway Castle, NB417341, R.J. Pankhurst, 2003.

- 46/7.2×7. *CERASTIUM* ×*PSEUDOALPINUM* (*C. ARVENSE* × *C. FONTANUM*) *63, S.W. Yorks.: Tickhill Castle, SK5992, P.P. Abbott, 1996.
- 46/7.7b. *CERASTIUM FONTANUM* subsp. *HOLOSTEIOIDES* *63, S.W. Yorks.: Bell's Pond, Thorne Moor, SE7115, P.A. Seccombe, 2003.
- 46/7.12. *CERASTIUM SEMIDECANDRUM* *110, Outer Hebrides: Dunes N of North Boisdale, NF732185, P.A. Smith, G.M. Orledge & J. Twelves, 2003, E, det. P.A. Smith. Previously reported from Benbecula, but the first confirmed record.
- 46/12.1. *CORRIGIOLA LITORALIS* ¶63, S.W. Yorks.: Manvers Colliery tip, SE4501, J. Lunn, 1999. 1st record since 1970.
- 46/14.1. *ILLECEBRUM VERTICILLATUM* □¶11, S. Hants.: Forestry ride in conifer plantation, Avon Common Peat, SZ135988, R.M. Walls, 2004.
- 46/17.2. *SPERGULARIA MEDIA* 106, E. Ross: Muddy saltmarsh, Inver, NH860825, B.R. & C.B. Ballinger, 2004. 1st record since 1970.
- ‡46/18.chal. *LYCHNIS CHALCEDONICA* *29, Cambs.: Waste ground, Gorefield, TF418118, G. M.S. Easy, 2004, **herb. G.M.S. Easy**.
- ‡46/20.1. *SILENE ITALICA* *¶11, S. Hants.: 7 plants on steep bank of narrow channel in NE corner of Haslar Lake, Priddy's Hard, Gosport, SZ619995, J.A. Norton & D.R. Allan, 2004, conf. E.J. Clement.
- ‡46/25.2. *DIANTHUS CARYOPHYLLUS* *‡63, S.W. Yorks.: Tickhill Castle, SK5992, P.P. Abbott, 1999.
- ‡46/GYP.rep. *GYPSOPHILA REPENS* *29, Cambs.: Pavement weed along river, Ely, TL544796, G.M.S. Easy, 2002, **herb. G.M.S. Easy**. Ø
- ‡47/1.cap. *PERSICARIA CAPITATA* *¶61, S.E. Yorks.: Pavement, Drifffield, TA0257, E. Chicken, 2000.
- ‡47/5.1×2. *FALLOPIA* ×*BOHEMICA* (*F. JAPONICA* × *F. SACHALINENSIS*) *96, Easternness: W bank of R. Beaul, among stand of *F. japonica*, by Beaul, NH533465, P.R. & I.P. Green, 2002.
- [‡47/5.2. *FALLOPIA SACHALINENSIS*, *91, Kincardines.: Abandoned quarry, Cobairdy, NJ582431, D. Welch, 2004, **ABD**. Record to be deleted. Incorrect v.c.]
- ‡47/5.2. *FALLOPIA SACHALINENSIS* *93, N. Aberdeen: Abandoned quarry, Cobairdy, NJ582431, D. Welch, 2004, **ABD**.
- ‡47/7rha×pal. *RHEUM* ×*HYBRIDUM* (*R. RHAPONTICUM* × *R. PALMATUM*) 106, E. Ross: 1 large plant on bank of River Conon, Brahan, NH492542, B.R. & C.B. Ballinger, 2004. 1st record since 1970.
- 47/8.1b. *RUMEX ACETOSELLA* subsp. *PYRENAICUS* *48, Merioneth: In quantity on roadside banks at Llanddwywe, SH52, P.M. Benoit, 2003. This is the common subspecies in v.c. 48: subsp. *acetosella* is known only from sandy ground at Morfa Harlech, SH53, Morfa Dyffryn, SH52 and the Dysynni Broadwater, SH50.
- 47/8.13×14. *RUMEX* ×*SCHULZEI* (*R. CRISPUS* × *R. CONGLOMERATUS*) *63, S.W. Yorks.: Thorpe Marsh NR, SE5809, B.A. Tregale, 2002.
- 47/8.14. *RUMEX CONGLOMERATUS* *96, Easternness: One plant only among reeds on W bank of R. Beaul, near Beaul, NH541471, I.P. Green, 2004.
- 47/8.14×15. *RUMEX* ×*RUHMERI* (*R. CONGLOMERATUS* × *R. SANGUINEUS*) *11, S. Hants.: Disturbed ground, Priestlands School, Lymington, SZ315951, M.W. Rowe, 2004, det. J.R. Akeroyd.
- 48/1.7a. *LIMONIUM BINERVOSUM* subsp. *BINERVOSUM* *33, E. Gloucs.: Abundant over 60+ metres of central reservation of A4019, Withy Bridge, Boddington, SO906, J.A. Bailey, 2004, **herb. M.A.R.K.**, det. L.A. Boorman.
- ‡49/1.1. *PAEONIA OFFICINALIS* *50, Denbs.: Slate waste in disused quarry, Llyn Brenig, SH979592, J.A. Green, 2003, det. P. Lee.
- 51/1.9. *HYPERICUM TETRAPTERUM* 106, E. Ross: Lane by sea, Redcastle, NH580 494, B.R. & C.B. Ballinger, 2004, **herb. B. Ballinger**. 1st record since 1970.
- ‡51/1.cor. *HYPERICUM CORIS* *33, E. Gloucs.: Naturalised in Jurassic limestone road cutting, Fosse Way, Broadwell, SP1927, M.A.R. & C. Kitchen, 2004, det. E.J. Clement. Deliberately sown. First recorded by A. Underhill in 1995 and still there 2004. Ø Apparently 1st record for Britain and Ireland.

‡51/1.oly. *HYPERICUM OLYMPICUM* *33, E. Gloucs.: Naturalised in Jurassic limestone road cutting, Fosse Way, Broadwell, SP1927, M.A.R. & C. Kitchen, 2004, det. E.J. Clement. Deliberately sown. First recorded by A. Underhill in 1995 and still there 2004. Ø

52/1.1. *TILIA PLATYPHYLLOS* ¶‡81, Berwicks.: Parkland, Newton Don, NT7137, M.E. Braithwaite & ENHS, 2002. ¶‡81, Berwicks.: Parkland, Milne Graden, NT 8744, J. Muscott, 2000.

‡53/1.6. *MALVA PUSILLA* ¶45, Pembs.: Foot of drainpipe on pavement, New Street, St David's, SM754253, D. Dupree, 2003. 1st record since 1970 but casual only.

‡53/1.7. *MALVA NEGLECTA* ¶42, Brecs.: Rubble, waste ground beside house, Fenni-fach Lane, Brecon, SO034289, C. Dyson, 2003. 1st record for 50 years. ¶106, E. Ross: By shore path, near houses, Hilton, NH870760, B.R. & C.B. Ballinger, 2004. 1st record since 1970.

‡53/2.1. *LAVATERA ARBOREA* *29, Cambs.: Several self-sown plants on road verge, Harvest Way, Cambridge, TL464589, A.C. Leslie, 2004, CGE.

‡53/2.2. *LAVATERA CRETICA* *11, S. Hants.: Verge of path, Cleveland Road / Foster Road cycleway, Gosport, SZ607994, D.R. Allan, J.A. Norton & E.J. Clement, 2004, **herb. M.R.**, det. E.J. Clement.

‡53/6.1. *ABUTILON THEOPHRASTI* *38, Warks.: Dumped soil near footpath, Offchurch, Leamington Spa, SP365656, B. Davies, 2004, **WARW**, conf. E.J. Clement. With other birdseed aliens.

‡53/HIB.syr. *HIBISCUS SYRIACUS* *29, Cambs.: Gutter, Ditton Walk, Cambridge, TL474596, G.M.S. Easy, 1999, **herb. G.M.S. Easy**. Presumed self-sown.

56/1.1. *TUBERARIA GUTTATA* *103, Mid Ebudes (Coll): 32 plants on rocky outcrop near coast, Sorisdale, NM270632, S. Wellock *et al.* 2004, conf. L. Farrell. 1st Scottish record.

57/1.4×7. *VIOLA RIVINIANA* × *V. LACTEA* 41, Glam.: Oxwich Point, SS512849, Q.O.N. Kay, 2003. 1st record since 1970.

‡60/2.1. *ECBALLIUM ELATERIUM* *¶61, S.E. Yorks.: On waste, Beverley, TA0232, J.K. Dews, 2003, det. J.L. Mason.

‡60/CUT.pep. *CUCURBITA PEPO* *61, S.E. Yorks.: On waste, Beverley, TA0238, J.K. Dews, 2003, det. B.S. Wurzell.

‡61/1.3Ita. *POPULUS NIGRA* 'ITALICA' *¶50, Denbs.: Planted near farm, Bangor on Dee, SH393439, J.A. Green, 2003. Ø

†61/2.3. *SALIX ALBA* 106, E. Ross: By River Peffery, Dingwall, NH554590, B.R. & C.B. Ballinger, 2004, **herb. B. Ballinger**. 1st record since 1970. Probably planted.

‡61/2.3×bab. *SALIX* ×*SEMPULCRALIS* (*S. ALBA* × *S. BABYLONICA*) *67, S. Northumb.: In broadleaved woodland on north bank of R. Blyth, downstream from Bedlington Bridge, NZ28Q, J.L. Durkin, 2002.

61/2.9×11. *SALIX* ×*SMITHIANA* (*S. VIMINALIS* × *S. CINEREA*) *91, Kincardines.: Steep grassland near sea, Gourdon, NO821702, D. Welch, 2002, **herb. D. Welch**, conf. R.D. Meikle.

61/2.11a. *SALIX CINEREA* subsp. *CINEREA* *63, S.W. Yorks.: Canklow Wood, SK4290, J. Newbould, 1982. Since seen in numerous other sites in the v.c.

61/2.11×15. *SALIX* ×*LAURINA* (*S. CINEREA* × *S. PHYLICIFOLIA*) *63, S.W. Yorks.: Beighton, SK4483, J.R. Comley, 2002.

61/2.12×16. *SALIX* ×*AMBIGUA* (*S. AURITA* × *S. REPENS*) *93, N. Aberdeen: Flushed mire, White Hill of Bogs, NJ443257, D. Welch, 2002, **herb. D. Welch**, det. R.D. Meikle.

61/2.15. *SALIX PHYLICIFOLIA* *‡63, S.W. Yorks.: Skiers Spring Wood, SK3799, J.R. Comley, 1999.

61/2.16×21. *SALIX* ×*CERNUA* (*S. REPENS* × *S. HERBACEA*) *110, Outer Hebrides: St Kilda, NF09, A.H. Gibson, 1889, **E**, det. E.F. Linton.

‡61/2.ela. *SALIX ELAEAGNOS* *85, Fife: Planted shrubs in ornamental grounds, Leslie House, by R. Leven, Glenrothes, NO260017, G.H. Ballantyne, 2004. One of several localities for this increasingly planted species, looking quite at home.

62/3.1. *ALLIARIA PETIOLATA* *‡110, Outer Hebrides: Shady path, Stornoway Castle, NB417341, R.J. Pankhurst, 2003.

62/4.1. *ARABIDOPSIS THALIANA* 110, Outer Hebrides: Ardrol, Uig, NB03, R.J. Pankhurst, 2001. 1st record since 1970.

†62/7.2. *ERYSIMUM CHEIRI* 106, E. Ross: On cliffs, Rockfield, NH922826, B.R. & C.B. Ballinger, 2004. 1st record since 1970. Probably garden escape.

- ‡62/9.1. *MALCOLMIA MARITIMA* ***61**, S.E. Yorks.: On waste, SE9844, J.K. Dews, 2003.
- ‡62/10.1. *MATTHIOLA INCANA* ***63**, S.W. Yorks.: Parkwood, Sheffield, SK3489, Sorby NH Society, 1986. ***85**, Fife: Grassy bank at top of cliff and on face of cliff to east of Pittenweem, NO554026, R.I. Milne, 1997, **herb. G.H.B.**, conf. G.H. Ballantyne. Many plants long established, previously overlooked in a half-hidden situation with several other garden throw-outs.
- 62/12.5×6. *RORIPPA ×ANCEPS* (*R. SYLVESTRIS* × *R. AMPHIBIA*) *‡**81**, Berwicks.: Riverside, haugh below The Lees, NT854389, M.E. Braithwaite, 2004, **herb. M.E.B.** Confirms R.V. Lansdown's record not localised to v.c.
- 62/14.1. *CARDAMINE BULBIFERA* ***42**, Brecks.: Introduced to shady hedgebank, field side of hedge, 1.5 km N of Cwmdu, SO181252, S. Leitch & S. Juniper, 2003. ***47**, Monts.: Overgrown garden area by Lake Vyrnwy, just S of hotel, SJ021196, J. O'Reilly, 2003. Known to have been present for many years.
- ‡62/14.5. *CARDAMINE PRATENSIS flore pleno* ***48**, Merioneth: Escaped from a garden into adjacent marshy meadow (now in quantity) near Hengwrt, Dolgellau, SH71, P.M. Benoit & J.M. Maynard, 2003. 1st record for variety. See *BSBI News* 91: 28 (2002) & 93: 23 (2003) and *Watsonia* 3: 170-174 (1955).
- ‡62/14.cor. *CARDAMINE CORYMBOSA* ***52**, Anglesey: Garden, Bryn-castell, SH565788, G. Gibson, 2003.
- 62/15.2. *ARABIS GLABRA* **63**, S.W. Yorks.: Chapel Flat Dyke, SK4090, J.R. Comley, 2001. 1st record since 1970.
- ‡62/16.1. *AUBRIETA DELTOIDEA* ***44**, Carms.: Self sown plant in tarmac-surfaced lane off Station Road, Llangennech, SN562015, R.D. Pryce & K.A. Cottingham, 2003.
- ‡62/18.2. *ALYSSUM SAXATILE* ***41**, Glam.: On wall of ruin, Waungron, SN590021, P.V. & A.S. Lewis, 2004.
- 62/21.4. *DRABA MURALIS* ‡**48**, Merioneth: Still flourishing on a wall, at Llandderfel Bridge, SH9836, P.M. Benoit, 2003. Recorded here as a 'casual' in 1939 by J.A. Whellan in the *B.E.C. Report* for 1943-44, p. 703 (1946). Apparently the only surviving colony in v.c. 48. ▣‡**81**, Berwicks.: River bank, Fishwick Mains, NT925494, M.E. Braithwaite & B.L. Seed, 2003.
- 62/23.5. *COCHLEARIA DANICA* **106**, E. Ross: Rocky shore, Nigg, North Sutor, NH806689, B.R. & C.B. Ballinger, 2004, **herb. B. Ballinger**. 1st record since 1970.
- 62/28.3. *THLASPI PERFOLIATUM* **33**, E. Gloucs.: Abundant (700 plants) on vertical face of quarry now restored to agriculture, Chalkhill Farm, Temple Guiting, SP128259, J. Hart, 2004.
- ‡62/28.5. *THLASPI MACROPHYLLUM* ***69**, Westmorland: Several colonies in woodland by Hampsfield, Lindale, SD408804, C.D. Pigott, 2004, **LANC**.
- ‡62/29.umb. *IBERIS UMBELLATA* ***110**, Outer Hebrides: Tarbert, NG154999, E. Pilling, 2004.
- ‡62/30.6. *LEPIDIUM LATIFOLIUM* **50**, Denbs.: Industrial wasteland, Wrexham, SJ381491, W. McCarthy, 2004. 1st record since 1970.
- ‡62/34.2b. *BRASSICA NAPUS* subsp. *RAPIFERA* ***81**, Berwicks.: Sown crop in arable field, near Gledswood East Lodge, NT592353, L.W. Gaskell, 1999. 1st localised record.
- ‡62/34.3a. *BRASSICA RAPA* subsp. *RAPA* ***81**, Berwicks.: Sown crop in arable field, near Greenlaw Dean, NT688469, M.E. Braithwaite, 2004. 1st localised record.
- 62/34.3b. *BRASSICA RAPA* subsp. *CAMPESTRIS* ***110**, Outer Hebrides: Road cutting, Eriskay, NF785122, R. Woodall, 2001. First of four records in 2001.
- ‡62/35.2. *SINAPIS ALBA* **93**, N. Aberdeen: Edge of potato field, Williamston, NJ650318, D. Welch, 2002, **ABD**. 1st record since 1930. Relic of pheasant mix sown in 2001.
- ‡62/40.1. *RAPISTRUM RUGOSUM* **67**, S. Northumb.: Around allotment, Skinnerburn Road, Newcastle, NZ240630, A. & G. Young, 2003. 1st record since 1970.
- ‡62/41.hisp. *CRAMBE HISPANICA* ***81**, Berwicks.: Riverside, Milne Graden, NT878445, M.E. Braithwaite, 2004, E, det. D.R. McKean. Seed dispersed from crop. Ø
- ‡62/CAL.irr. *CALEPINA IRREGULARIS* ***9**, Dorset: Road-side weed, Wadbroke Farm, ST324017, R.E.N. Smith, 2004, **NMW**, det T.C.G. Rich.
- ‡62/ERC.ves. *ERUCA VESICARIA* ***40**, Salop: Riverbank, Monkmoor, SJ5213, R.J. Swindells & S.J. Whild, 2004.
- ‡62/ERC.ves.a. *ERUCA VESICARIA* subsp. *SATIVA* **113(S)**, Channel Is. (Sark): Numerous plants on roadside bank outside garden, Rue du Fort, WV466765, R.M. Veall & R. Waterman, 2004, **herb. Société Serquaise**. 1st record for Sark.

‡63/1.2. RESEDA ALBA ¢63, S.W. Yorks.: Laughton-en-le-Morthen, SK5088, *Rotherham Biol. Rec.* 2002. 1st record since 1970.

64/1.1a. EMPETRUM NIGRUM subsp. NIGRUM *45, Pembs.: 4×2m patch in a remnant area of wet heath in valley bog NE of Dol-aeron, Crymych, SN191325, S. Bosanquet, 2003. The size of the patch & intactness of the vegetation suggest a relict rather than a recent arrival.

‡65/4.2. KALMIA ANGUSTIFOLIA 63, S.W. Yorks.: Thorne Moors, SE7213, G.T.D. Wilmore, 2004. 1st record since 1970.

67/1.1. MONOTROPA HYPOPITYS 63, S.W. Yorks.: S. Washlands, Stanley, SE3521, G.T.D. Wilmore, 2004. 1st record since 1970.

67/1.1b. MONOTROPA HYPOPITYS subsp. HYPOPHEGEA *38, Warks.: Conifer wood, Ufton Field NR, SP382615, E.J. Butler, 1986, **WARW**, det M.J. Short. Omitted from VCCC. 38, Warks.: Locally frequent ruderal in Ladywalk NR, Hams Hall Power Station, Whitacre Heath, SP216922, M.A. Arnold & K.M. Green, 2000, **WARW**, det. M.J. Senior.

‡69/3.1. CYCLAMEN HEDERIFOLIUM *42, Brecks.: Lane bank, 1km SW of Hay-on-Wye, SO222417, M. & C. Porter, 2004. *44, Carms.: Locally abundant with *C. coum*, on steep roadside bank, Llangathen, SN583222, V. & A. Lewis, 2001. *49, Caerns.: Two plants amongst scrub in woods, Great Orme, SH7782, W. McCarthy, 2004.

‡69/3.rep. CYCLAMEN REPANDUM *‡63, S.W. Yorks.: Waste ground, Brodsworth, SE5007, G.T.D. Wilmore, 2001.

‡70/1.2. PITTOSPORUM TENUIFOLIUM *45, Pembs.: Odd seedling self-sown on edge of pavement, Pembroke Dock, SM969036, P. Green, 2004.

‡71/HYD.mac. HYDRANGAEA MACROPHYLLA *41, Glam.: Well established in woodland, near High Pool, Newton, Mumbles, SS601886, A.S. Lewis, 2004. 1st Welsh record. *¢63, S.W. Yorks.: Parkwood, Sheffield, SK3489, Sorby NH Society, 1986.

‡72/2.4. RIBES SANGUINEUM 52, Anglesey: Old spoil heap, Parys Mountain, SH4290, E. Wagstaff, 2004. 1st record as neophyte.

‡73/1.3. CRASSULA HELMSII *48, Merioneth: Ornamental pool at Penmaenpool, SH61, R.H. Gritten and, independently, P.M. Benoit, c.1992. Now eradicated.

‡73/5.4. SEDUM SPECTABILE *42, Brecks.: Naturalised on stream bank near church yard, Llandeilo'r - Fan, SN896346, M. & C. Porter, 1999.

‡73/5.7. SEDUM SPURIUM 100, Clyde Is. (Arran): Lamlash Village (1km sq), NS0231, A.R. Church & A.W. Smith, 1994. 1st record since 1970.

‡73/5.8. SEDUM STOLONIFERUM *11, S. Hants.: Edge of beech woodland on chalk, Beech Clump, Farley Mount, SU412292, M. Rand, 2004, det. E.J. Clement. Well-established patch c. 2.5m long.

‡73/5.13. SEDUM SEXANGULARE *44, Carms.: Abundant by track in former opencast site, Tumble Community Woodlands, SN537126, I.K. Morgan, 1985. Since obliterated by Carms. County Council.

‡73/5.14. SEDUM ALBUM 106, E. Ross: Wall by shore, Inver, NH861825, B.R. & C.B. Ballinger, 2004. 1st record since 1970.

73/5.16. SEDUM ANGLICUM ‡63, S.W. Yorks.: Austerfield Churchyard, SK6694, P.A. Seccombe, 1998. 1st record since 1970.

‡74/3.1. BERGENIA CRASSIFOLIA *41, Glam.: On waste ground above the E bank of River Tawe, Swansea, SS662735, A.S. Lewis, 2004. *67, S. Northumb.: At the side of a path, Tynemouth Priory, NZ3769, A. & G. Young, 2002.

‡74/4.1. DARMERA PELTATA *52, Anglesey: Stream edge, Cadnant Dingle, SH558738, N. Brown, 2004.

‡74/5.8. SAXIFRAGA UMBROSA ¢63, S.W. Yorks.: Great Roe Wood, SK3590, Sheffield Ecol. Unit, 1990. 1st record since 1970.

‡74/5.8×9. SAXIFRAGA ×URBIO (S. UMBROSA × S. SPATHULARIS) *¢100, Clyde Is. (Arran): Main Road/Corriegills Road, Strathwhillan, Brodick, NS0235, A.R. Church & A.W. Smith, 1993.

74/5.12. SAXIFRAGA AIZOIDES 106, E. Ross: Hillside flush at 468 m, Glen Choirainn, NH241491, B.R. & C.B. Ballinger, 2004. 1st record since 1970.

‡74/6.1. HEUCHERA SANGUINEA *47, Monts.: Naturalized on S bank of River Vyrnwy, far from any habitation, Pontrobert, SJ093136, K. Thorne, 2004. 1st Welsh record. Possibly brought down by river.

- ‡74/7.1. *TOLMIEA MENZIESII* *81, Berwicks.: Riverside, Gledswood, NT584341, M.E. Braithwaite, 2004. Naturalised. *100, Clyde Is. (Arran): By burn below Acholter bridge, Margnaheglish, NS033320, A.W. Smith, 1988.
- ‡74/8.1. *TELLIMA GRANDIFLORA* *29, Cambs.: Base of wall, Trinity Lane, Cambridge, TL447586, A.C. Leslie, 2004. *42, Brecks.: Shaded hedgerow, Darren, Llangattock, SO202162, A.S. Lewis, 2004.
- ‡75/3.1. *SPIRAEA SALICIFOLIA* *38, Warks.: Old woodland, Windmill Naps, Earlswood, SP088721, J.W. Partridge, 1992, **WARW**, conf. J.C. Bowra. Pheasant cover.
- ‡75/3.1x3. *SPIRAEA xPSEUDOSALICIFOLIA* (*S. SALICIFOLIA* x *S. DOUGLASII*) *100, Clyde Is. (Bute): Ettrick Bay, NS035664, BSBI Field Meeting, 1998.
- ‡75/3.3. *SPIRAEA DOUGLASII* *100, Clyde Is. (Arran): Gortonallister; roadside 100 m NW of Alt Ardoch, NS030297, A.R. Church & A.W. Smith, 1998.
- ‡75/4.1. *ARUNCUS DIOICUS* *c100, Clyde Is. (Bute): Rothesay Town, NS06, L.S. Garrad, 1997.
- ‡75/6.3. *FILIPENDULA KAMTSCHATICA* *c100, Clyde Is. (Arran): Cladach/Home Farm by Brodick, NS0137, A.R. Church & A.W. Smith, 1998.
- ‡75/8.2. *RUBUS TRICOLOR* *40, Salop: Urban area, Shrewsbury, SJ495122, S.J. Whild, 2004, **herb. S.J.W.**
- ‡75/8.8. *RUBUS PHOENICOLASIUS* *29, Cambs.: Garden weed, Trumpington, TL446552, G.M. S. Easy, 1988, **herb. G.M.S. Easy**.
- 75/8.27. *RUBUS PLICATUS* 63, S.W. Yorks.: Hatfield Moor, SE7006, D.R. Grant, 2000. 1st record since 1970.
- ‡75/8.55. *RUBUS LACINIATUS* ‡63, S.W. Yorks.: Kilnhurst, SK4596, E. Ellis, 2004. 1st record since 1970. *110, Outer Hebrides: Loch Odhairn, Eishken, NB31, A.O. Chater & R.J. Pankhurst, 1980.
- 75/8.62. *RUBUS MACROPHYLLUS* 63, S.W. Yorks.: Tankersley, SK3599, D.R. Grant, 1999. 1st record since 1970.
- 75/8.69. *RUBUS PLATYACANTHUS* 63, S.W. Yorks.: Loxley Valley, SK2689, J.R. Comley, 1993. 1st record since 1970.
- 75/8.90. *RUBUS AMPLIFICATUS* 63, S.W. Yorks.: Loxley Valley, SK3089, J.R. Comley, 2001. 1st record since 1970.
- 75/8.142. *RUBUS ULMIFOLIUS* *110, Outer Hebrides: Walled garden, Borge Lodge, NG035949, R.J. Pankhurst, 1980.
- 75/8.143. *RUBUS WINTERI* 63, S.W. Yorks.: Nor Wood, SK5390, R. Smith, 1981. 1st record since 1970.
- 75/8.161. *RUBUS SURREJANUS* *29, Cambs.: Garden weed on side of drive, 103 Commercial End, Swaffham Bulbeck, TL557624, A.L. Bull, 2004, conf. A. Newton, **herb. A.L. Bull**. Presumably birdsown.
- 75/8.190. *RUBUS LEIGHTONII* *63, S.W. Yorks.: Ickles, SK4191, J.R. Comley, 2002.
- 75/8.232. *RUBUS ECHINATUS* 63, S.W. Yorks.: Arksey Ings, SE6006, D.R. Grant, 1993. 1st record since 1970.
- 75/8.249. *RUBUS RADULA* *63, S.W. Yorks.: Woodsetts, SK5483, D.R. Grant, 2002.
- 75/8.286. *RUBUS SCABRIPES* *29, Cambs.: Beneath planted shrubs in shrubbery, New Square, Cambridge, TL454586, A.C. Leslie, 2004, det. A. Newton, **CGE**.
- 75/8.312. *RUBUS LATIFOLIUS* 110, Outer Hebrides: Garbh Eilean cliffs, Shiant Islands, NG416980, P.A. Smith, 2002, **E**, det. G.H. Ballantyne. 1st record since 1970.
- 75/11.1. *FRAGARIA VESCA* 110, Outer Hebrides: Glen Seilebost, NG0695, R.J. Pankhurst, R.A.H. Smith & E. Pilling, 1997. 1st record since 1970.
- ‡75/11.2. *FRAGARIA MOSCHATA* *44, Carms.: Well naturalised at edge of ravine woodland outside walled garden, Glynhir Mansion, SN640150, A.O. Chater *et al.*, 2004.
- ‡75/12.1. *DUCHESNEA INDICA* *c38, Warks.: Churchyard, Frankton, SP425703, V.S. Roberts, 1998, det. J.R. Roberts. Colour slide seen by J.W. Partridge.
- 75/13.2. *GEUM URBANUM* *‡110, Outer Hebrides: Stornoway Castle, NB43, R.J. Pankhurst, 2003.
- ‡75/17.3b. *SANGUISORBA MINOR* subsp. *MURICATA* *68, N. Northumb.: Bank by Whiteadder Bridge in sown area, NT9552, M.E. Braithwaite, 2003.

[75/18.1. *ACAENA NOVAE-ZELANDIAE* **110**, Outer Hebrides: Delete this record. Re-determined as *A. ovalifolia*]

‡75/18.2×4. *ACAENA ANSERINIFOLIA* × *A. INERMIS* ***38**, Warks.: Large vegetatively spreading patch in abandoned allotment, Leamington Spa, SP332655, J.W. Partridge, 2004, **WARW**, det. P.F. Yeo. 2nd record for British Isles?

‡75/18.3. *ACAENA OVALIFOLIA* ***51**, Flints.: Mixed woodland on limestone, Loggerheads Country Park, SJ199629, J. Phillips, 2003, det. P.F. Yeo. ***91**, Kincardines.: Rideside in forest, Blackhall, NO662956, G.H. Read, 2001, conf. D. Welch. ***110**, Outer Hebrides: Road to Chliostair power station, NB055082, R.J. Pankhurst & P.A. Smith, 1996, det. R.J. Pankhurst.

75/19.10a. *ALCHEMILLA FILICAULIS* subsp. *FILICAULIS* ***100**, Clyde Is. (Arran): Creag an fheidh by Glenloig, NR9434, A.R. Church & A.W. Smith, 1996.

‡75/19.15. *ALCHEMILLA MOLLIS* ***52**, Anglesey: Roadside bank, opposite cottage, Trefdraeth, SH4070, I.R. Bonner, 2004.

75/21.4×12. *ROSA* × *VERTICILLACANTHA* (*R. ARVENSIS* × *R. CANINA*) ‡**68**, N. Northumb.: One sprawling bush with previous year's fruits in wood near New Water Haugh, NT979531, M.E. Braithwaite, 2003. 1st record since 1970. *Rosa arvensis* is a rare introduction.

‡75/21.9. *ROSA VIRGINIANA* **41**, Glam.: In scrub on old landfill site, Clyne Valley, Swansea, SS613921, A.S. Lewis, 2004. 1st record as a neophyte. **46**, Cards.: Naturalised on sandy roadside bank, Ynys-las Dunes NNR, SN609937, A.O. Chater, 2004, **NMW**. 1st record as a neophyte.

75/21.11×12. *ROSA* × *ANDEGAVENTIS* (*R. STYLOSA* × *R. CANINA*) ***45**, Pembs.: A single bush on waste ground, Pembroke Dock, SM970038, P. Green, 2004.

75/21.12. *ROSA CANINA* s.s. **100**, Clyde Is. (Arran): Cock Farm /Ossian's Cave, NR9651, A.R. Church & A.W. Smith, 1994. 1st record since 1970.

75/21.12×13. *ROSA* × *DUMALIS* (*R. CANINA* × *R. CAESIA*) **100**, Clyde Is. (Bute): Barr Point, NS083537, M.E. Braithwaite, 2003. 1st record since 1970. ***110**, Outer Hebrides: Roadside, Geocrab, NG112898, R.J. Pankhurst, 2002, **E**, det. A.L. Primavesi.

75/21.12×17. *ROSA* × *MOLLETORUM* (*R. CANINA* × *R. MOLLIS*) ***35**, Mons.: 1 plant on grassy bank of cycle track, S of Blaenavon, SO263075, T.G. Evans, 2004, det. R. Maskew.

75/21.16×17. *ROSA* × *PERTHENSIS* (*R. SHERARDII* × *R. MOLLIS*) ***47**, Monts.: Trackside hedge, Llanwddyn, SJ025186, K. Thorne & M. Wainwright, 2003, det. A.L. Primavesi.

75/21.17. *ROSA MOLLIS* ***100**, Clyde Is. (Bute): Barr Point, NS082539, M.E. Braithwaite, 2003.

†75/22.5. *PRUNUS DOMESTICA* *‡**100**, Clyde Is. (Bute): By burn below Cranslagloan, NS055665, A.C. Hannah, 2003.

[75/22.6. *PRUNUS AVIUM* ***100**, Clyde Is. (Bute): Gorge on E side of Ettrick Glen, NS038686, A.C. Hannah, 2002. Shown as Neophyte in VCCC but no reason to doubt its Native status here.]

‡75/22.8. *PRUNUS MAHALEB* ***29**, Cambs.: One large multi-stemmed tree beside disused railway line and a smaller plant some distance away, Cambridge, TL460616, A.C. Leslie, 2003, **CGE**.

‡75/25.1. *CHAENOMELES SPECIOSA* *‡**63**, S.W. Yorks.: Ecclesall area, SK3283, W.J. Smyllie, 1996.

†75/26.0. *PYRUS COMMUNIS* agg. *‡**63**, S.W. Yorks.: Swallownest, SK4485, *Rotherham Biol. Rec.*, 2002.

75/27.1. *MALUS SYLVESTRIS* s.l. *‡**110**, Outer Hebrides: Wall by roadside, Ormiclate, NF741319, E. Pilling, 2000, det. R.J. Pankhurst.

‡75/27.2. *MALUS PUMILA* ***100**, Clyde Is. (Great Cumbrae): NS15, D.J. McCosh, 1998.

‡75/27.cor. *MALUS CORONARIA* ***29**, Cambs.: One 15 ft shrub, possibly birdsown, beside disused railway line, Cambridge, TL46506138, A.C. Leslie & P.R. Green, 2004, **CGE**. Ø Apparently 1st record for Britain and Ireland.

‡75/27.hup. *MALUS HUPEHENSIS* ***41**, Glam.: in Clyne Valley, Swansea, SS613920 & SS614920, A.S. Lewis, 2003, det. T. Davies. Bird-sown. Ø

‡75/28.7. *SORBUS INTERMEDIA* *‡**100**, Clyde Is. (Arran): Forest car park, Crochandoon, NR898316, A.W. Smith, 1993.

- ‡75/31.1. *PHOTINIA DAVIDIANA* *81, Berwicks.: Hedge by Coldingham, NT906663, M.E. Braithwaite, 2004. Probably planted. *‡100, Clyde Is. (Arran): Amenity planting at FE car park and picnic area, Cnoc na Dail forestry, NS018324, A.R. Church & A.W. Smith, 1993. 106, E. Ross: Roadside at edge of plantation, Hillockhead, NH742605, B.R. & C.B. Ballinger, 2004, **herb. B. Ballinger**. 1st record since 1970. Probably planted originally but seeding.
- ‡75/32.9×10. *COTONEASTER ×WATERERI* (*C. FRIGIDUS* × *C. SALICIFOLIUS*) *100, Clyde Is. (Arran): Auchareoch forestry, NR982226, A.W. Smith, 1998.
- ‡75/32.11. *COTONEASTER DAMMERI* *68, N. Northumb.: Halidon Hill viewpoint, NT980596, M.E. Braithwaite, 2003. Planted.
- [‡75/32.28. *COTONEASTER LUCIDUS* 69, Westmorland: Delete; the available data indicates confusion with authenticated *C. villosulus*.]
- ‡75/32.40. *COTONEASTER STERNIANUS* *H12, Co.Wexford: Self-sown on churchyard wall, Kilsoran, S107113, P.R. Green, 2003.
- ‡75/32.bois. *COTONEASTER BOISIANUS* *29, Cambs.: Epiphytic. One bird-sown shrub in the crown of a pollard *Salix alba*, Sheep's Green, Cambridge, TL448575, A.C. Leslie, 2003, **CGE**, det. J. Fryer.
- ‡75/32.mai. *COTONEASTER MAIREI* *41, Glam.: Cliff-slope, near High Tor, Pennard, SS555872, A.S. Lewis, 2004.
- [‡75/32.pseu. *COTONEASTER PSEUDOAMBIGUUS* 69, Westmorland: Delete; the available data indicates confusion with authenticated *C. laetevirens*.]
- ‡75/33.1. *PYRACANTHA COCCINEA* 41, Glam.: Bird-sown on dunes and waste ground, Swansea, SS6692, A.S. Lewis, 2004. 1st record since 1970.
- ‡75/35.4. *CRATAEGUS CRUS-GALLI* *‡63, S.W. Yorks.: Park Hill, Sheffield, SK3687, Sheffield Wildlife Trust, 1998.
- ‡75/35.6. *CRATAEGUS SUCCULENTA* *40, Salop: Hedge, Priorslee, SJ722105, R.M. Stokes, 2004, **herb. S.J.W.**, det. S.J. Whild.
- 75/35.7×8. *CRATAEGUS ×MEDIA* (*C. MONOGYNA* × *C. LAEVIGATA*) *‡81, Berwicks.: Hedge, Harcase, NT814490, M.E. Braithwaite, 2004. Probably planted.
- ‡77/3.1 *COLUTEA ARBORESCENS* 41, Glam.: On rough ground, increasing by seed, Loughor, SS571989, A.S. Lewis, 2004. 1st record as a neophyte and 1st record since 1970.
- ‡77/3.1×ori. *COLUTEA ×MEDIA* (*C. ARBORESCENS* × *C. ORIENTALIS*) *‡63, S.W. Yorks.: Near Meadowhall, Sheffield, SK3991, Sorby NH Society, 1993.
- 77/7.1. *ANTHYLLIS VULNERARIA* 106, E. Ross: By shore path, Inver, NH864828, B.R. & C.B. Ballinger, 2004. 1st record since 1970.
- 77/8.1. *LOTUS GLABER* ‡44, Carm's.: On old limestone gravel, Penylan, Llanelli, SS517994, J.N. Davies, 2001, **NMW**, det. G. Hutchinson. 1st record since 1970.
- ‡77/8.2sat. *LOTUS CORNICULATUS* var. *SATIVUS* *44, Carm's.: Secondary neutral grassland on restored opencast, Tumble Community Woodlands, SN547132, R.D. Pryce, 2001. 1st record of variety.
- 77/12.2. *HIPPOCREPIS COMOSA* 38, Warks.: Limestone quarry, Little Compton, SP266287, M. J. Senior, 1994, **WARW**, conf. J.C. Bowra. 1st record since 1960.
- 77/14.6. *VICIA HIRSUTA* *110, Outer Hebrides: Near Factor's House, Hirta, NF09, C.P. Petch, 1931.
- ‡77/14.11c. *VICIA SATIVA* subsp. *SATIVA* 110, Outer Hebrides: Edge of arable field, Grogarry road end, NF759398, E. Pilling, 2000, **E**, det. D.R. McKean. 1st record since 1970.
- 77/14.12. *VICIA LATHYROIDES* 38, Warks.: Sandy grass bank, Piles Coppice, Binley, SP385768, M.J. Senior, 2001, **WARW**, conf. J.W. Partridge. 1st record since 1883.
- 77/14.14. *VICIA BITHYNICA* ‡11, S. Hants.: Frequent and well naturalized over an area 300 × 200 m in grassland and scrub on clay, Peartree Green, Southampton, SU437118, I.L. Ralphs, 2004, **herb. M.R.**, conf. M. Rand. Although *V. bithynica* has possibly been a native in v.c. 11 in the past, this is likely to be a recent arrival as the area is well worked.
- ‡77/15.9. *LATHYRUS LATIFOLIUS* *110, Outer Hebrides: Fixed dunes, N.W. Eriskay, NF785118, E. Pilling, 2000, **E**, det. D.R. McKean.
- ‡77/15.10. *LATHYRUS HETEROPHYLLUS* var. *UNIUGUS* *29, Cambs.: Chalkpit, Cherry Hinton, TL4855, S.M. Walters, 1960, **CGE**, det. P.D. Sell.

77/16.3. *ONONIS SPINOSA* *¢44, Carms.: Subsoil bund, former opencast site, Ffos-las, Trimsaran, SN453062, I.K. Morgan, 1999. *¢52, Anglesey: Road edge, near Dwyran, SH458666, G. & P. Radford, 2003, **herb. I.R.B.**, conf. A.O. Chater. Origin uncertain but still present in 2004. 63, S.W. Yorks.: Thrybergh Park, SK4696, *Rotherham Biol. Rec.* 2002. 1st record since 1970.

‡77/17.3. *MELILOTUS OFFICINALIS* *¢93, N. Aberdeen: Edge of potato field, Williamston, NJ650318, D. Welch, 2002, **ABD**. Relic of pheasant mix sown in 2001.

77/18.1. *MEDICAGO LUPULINA* 106, E. Ross: In gravel by shore, Tain, NH7882, B.R. & C.B. Ballinger, 2004. 1st record since 1970.

77/18.4. *MEDICAGO POLYMORPHA* ■11, S. Hants.: Shingle beach and gravelly embankment, Elmore, Lee on Solent, SZ568995 etc, D.R. Allan, E.J. Clement, P.A. Budd & J.P. Poland, 2004, **herb. E.J.C.** New for SU60 in v.c. 11 (occurs in hectad in v.c. 10).

¢77/18.pra. *MEDICAGO PRAECOX* *‡11, S. Hants.: Shingle beach and gravelly embankment, Elmore, Lee on Solent, SZ568995 etc, J.A. Norton, D.R. Allan & A.M. Cross, 2004, **herb. E.J.C.**, conf. E.J. Clement.

77/19.5. *TRIFOLIUM GLOMERATUM* *29, Cambs.: One plant on a bank within the old Chippenham gravel pits, Kennett, TL684688, R.W. Ellis & C.R. Stevenson, 2004.

77/19.13. *TRIFOLIUM MICRANTHUM* *‡100, Clyde Is. (Arran): Garden path at Whiting Bay, NS046254, A.W. Smith, 2003.

‡77/19.19. *TRIFOLIUM INCARNATUM* *¢44, Carms.: North Dock Spit, Llanelli, SS498993, I.K. Morgan, 2001.

‡77/22.1. *LABURNUM ANAGYROIDES* *44, Carms.: Several self-sown seedlings from nearby parent tree in back lane at base of wall behind Walters Road, Llanelli, SN513000, I.K. Morgan, 2001. 1st record of variety.

‡77/22.1x2. *LABURNUM* x *WATERERI* (*L. ANAGYROIDES* x *L. ALPINUM*) *‡63, S.W. Yorks.: Woodland, Langsett, SE2000, G.T.D. Wilmore, 2004.

‡77/23.3. *CYTISUS STRIATUS* *‡63, S.W. Yorks.: Near Drakehouse, SK4283, K. Balkow, 2003.

77/26.1x2. *ULEX EUROPAEUS* x *U. GALLII* *50, Denbs.: Limestone hill, Llysfaen, SH892772, W. McCarthy, 2004, conf. P.M. Benoit.

77/26.2. *ULEX GALLII* *‡100, Clyde Is. (Bute): Scalpsie Bay, NS057583, BSBI Field Meeting, 1998.

77/26.3. *ULEX MINOR* 63, S.W. Yorks.: Doncaster Racecourse, SK6002, G.T.D. Wilmore, 2003. 1st record since 1970.

78/1.1. *HIPPOPHAE RHAMNOIDES* *‡100, Clyde Is. (Bute): Mountstuart, NS112600, A.C. Hannah, 2003.

‡79/2.2. *MYRIOPHYLLUM AQUATICUM* ‡63, S.W. Yorks.: Pond, near Arksey, SE5707, G.T.D. Wilmore, 2004. 1st record since 1970.

‡80/1.1. *GUNNERA TINCTORIA* *44, Carms.: Quarry pond (silica), Mynydd y Garreg, SN436086, A. & V. Lewis, 2004. *¢100, Clyde Is. (Arran): Dye Mill forestry, NS016298, A.W. Smith, 2000.

‡80/1.man. *GUNNERA MANICATA* *44, Carms.: Garden throw-out, with *Crocsmia paniculata* etc. in riverside woodland, near Clwtaw, SN523229, I.K. Morgan, 2001. *81, Berwicks.: Parkland, Duns Castle, NT778544, M.E. Braithwaite, 2004.

84/1.1x8. *EPILOBIUM* x *NOVAE-CIVITATIS* (*E. HIRSUTUM* x *E. CILIATUM*) *40, Salop: Margins of field of set-aside, Eaton Manor Farm, SO5080, G.D. Kitchener, 2003.

84/1.2x3. *EPILOBIUM* x *LIMOSUM* (*E. PARVIFLORUM* x *E. MONTANUM*) *40, Salop: Blists Hill, SJ694033, G.D. Kitchener, 2003. *63, S.W. Yorks.: Thorpe Marsh, SE5809, M. Wilcox, 2002.

84/1.2x6. *EPILOBIUM* x *DACICUM* (*E. PARVIFLORUM* x *E. OBSCURUM*) *40, Salop: Eaton Manor Farm, SO5080, G.D. Kitchener, 2003. *52, Anglesey: Damp ground, by track, Ty Mawr, Paradwys, SH416708, I.R. Bonner, 2004, **herb. I.R.B.**, conf. A.O. Chater.

84/1.2x8. *EPILOBIUM* x *FLORIDULUM* (*E. PARVIFLORUM* x *E. CILIATUM*) *40, Salop: Crifftin Quarry, SJ551137, S.J. Whild & A.J. Lockton, 2003, **herb. S.J.W.**, det. G.D. Kitchener.

84/1.5. *EPILOBIUM TETRAGONUM* *110, Outer Hebrides: Loch Eport, Sidinish, NF876633, J.W. Clark, 1989, **BM, E.** 1st confirmed record.

- 84/1.5×8. *EPILOBIUM* × *MENTIENS* (E. *TETRAGONUM* × E. *CILIATUM*) *40, Salop: Blists Hill, SJ694033, G.D. Kitchener, 2003.
- 84/1.6×8. *EPILOBIUM* × *VICINUM* (E. *OBSCURUM* × E. *CILIATUM*) *40, Salop: Eaton Manor Farm, SO5080, G.D. Kitchener, 2003. *52, Anglesey: Waste ground, Parys Mountain, SH442899, I.R. Bonner & E. Wagstaff, 2004, **herb. I.R.B.**, conf. A.O. Chater.
- 84/1.7. *EPILOBIUM* *ROSEUM* *100, Clyde Is. (Bute): Craigmores, Rothesay, NS105653, M.E. Braithwaite, 2003.
- 84/1.9×10. *EPILOBIUM* × *DASYCARPUM* (E. *PALUSTRE* × E. *ANAGALLIDIFOLIUM*) *110, Outer Hebrides: Ben Eaval, NF8960, W.A. Shoolbred, 1894, **NMW**.
- ‡84/4.1. *OENOTHERA* *GLAZIOVIANA* *61, S.E. Yorks.: Road verge waste, Patrington, TA334228, P.J. Cook, 2002.
- ø84/CLA.amo. *CLARKIA* *AMOENA* *29, Cambs.: Refuse tip, Waterbeach, TL482685, G.M.S. Easy, 1973, **herb. G.M.S. Easy**.
- ‡85/1.3. *CORNUS* *ALBA* 63, S.W. Yorks.: Park Hill, Sheffield, SK3687, Sheffield Wildlife Trust, 1998. 1st record since 1970.
- ‡85/2.1. *AUCUBA* *JAPONICA* *41, Glam.: Bird-sown seedling in woodland, near High Pool, Newton, Mumbles, SS601886, A.S. Lewis, 2004.
- ‡85/3.1. *GRISELINIA* *LITTORALIS* *c100, Clyde Is. (Arran): Merkland Wood between road/track junction and Merkland burn, NS0238, A.R. Church, 1994.
- †91/1.2. *MERCURIALIS* *ANNUA* *c61, S.E. Yorks.: On waste, Beverley, TA0232, J.K. Dews, 2003, det. J.L. Mason. 1st confirmed record but recorded in same locality by R. Atkinson in 2000.
- ‡91/2.7. *EUPHORBIA* *SERRULATA* *29, Cambs.: Four plants on a wall, beside car park of Ickleton Lion (public house), Ickleton, TL492437, A.C. Leslie, 2004.
- ‡91/2.14×wal. *EUPHORBIA* × *PSEUDOVIRGATA* (E. *ESULA* × E. *WALDSTEINII*) 11, S. Hants.: Grassy verge, Long Road, Soberton, SU627175, J. Rowe, 2004, **herb. M.R.**, conf. M. Rand. First recorded at this site in 1940 but not recorded since 1957.
- ‡91/2.16a. *EUPHORBIA* *AMYGDALOIDES* subsp. *AMYGDALOIDES* *‡63, S.W. Yorks.: Anston Stones Wood, SK5382, *Rotherham Biol. Rec.* 2002.
- ‡91/2.16b. *EUPHORBIA* *AMYGDALOIDES* subsp. *ROBBIAE* *41, Glam.: Sandy waste, Newton Nottage, SS838774, A.S. Lewis, 2003. 1st record for subspecies. *44, Carms.: Along 10 m of hedgebank near Parc Hendre, Capel Hendre, SN600113, I.K. Morgan, 2000.
- ‡91/2.17b. *EUPHORBIA* *CHARACIAS* subsp. *VENETA* *44, Carms.: One plant in rough grassland & several on old walls between Robinson Street & Old Lodge, Llanelli, SS508999, I.K. Morgan, 1997.
- 92/1.1. *RHAMNUS* *CATHARTICA* 49, Caerns.: Wooded hillside, Bryn Maelgwyn, Llandudno, SH7980, W. McCarthy, 2004. 1st record for over 100 years and only known extant site.
- ‡93/1.1. *VITIS* *VINIFERA* 41, Glam.: Among gorse and willow, Kilvey Hill, St Thomas, Swansea, SS668935, A.S. Lewis, 2004. 1st record as a neophyte.
- ‡93/2.1. *PARTHENOCISSUS* *QUINQUEFOLIA* *42, Brecks.: Established for 15 years on stone walls of bridge, Llangynidr, SO152202, M. & C. Porter, 2004.
- 94/1.1. *LINUM* *BIENNE* *c47, Monts.: Garden, a bird seed alien with *Phalaris canariensis* & *Raphanus raphanistrum*, Llanidloes, SN955852, M. Oliver, 2003.
- ‡98/1.ind. *AESCULUS* *INDICA* *69, Westmorland: By roadside wall, 100m S of Kings Meaburn, NY623208, G.A. Lines, 2004, photo in **LANC**.
- ‡99/1.1. *ACER* *PLATANOIDES* *100, Clyde Is. (Arran): Cnoc na Dail Forestry, NS018334, A.R. Church & A.W. Smith, 1993.
- ‡100/1.1. *RHUS* *TYPHINA* 41, Glam.: Garden throw-out, spreading on disturbed sand-dunes, Llangennith Burrows, Broughton, Gower, SS416925, A.S. Lewis, 2004. 1st record as a neophyte. 44, Carms.: Two well established trees on edge of open moorland, Cefn coed uchaf, Carreg Dwfn near Llandyfan, SN652174, A. & V. Lewis, 2004. 1st record away from gardens.
- ‡102/1.3. *OXALIS* *CORNICULATA* *100, Clyde Is. (Arran): Corrie village, NS0243, I.P. Green, 2003.
- ‡102/1.4. *OXALIS* *EXILIS* c44, Carms.: Weed at base of wall, Heol Waun-y-clun, Trimsaran, SN452039, I.K. Morgan, 1998. 1st record since 1970. 45, Pems.: Corner of cemetery steps, Portfield, Haverfordwest, SM946153, E.C. Howells, 1984, **NMW**, det. G. Hutchinson. 1st record as a neophyte. *50, Denbs.: Lawn, Bodnant Garden, SH799724, J.A. Green, 2004, **NMW**. c63, S.W. Yorks.: Bawtry, SK6592, G. Coles, 2004. 1st record since 1970.

‡102/1.8. *OXALIS ARTICULATA* *85, Fife: 2/3 clumps among other throw-outs on grassy cliff-top to east of Pittenweem, NO554026, G.H. Ballantyne, 2004. 1st record to be authenticated.

*100, Clyde Is. (Bute): St Blane's Church, Dunagoil Bay, Stravanan Bay, NS05, BSBI Field Meeting, 1998.

‡102/1.10. *OXALIS DEBILIS* *c63, S.W. Yorks.: Thorne Junction, SK6712, G. Coles & G.T.D. Wilmore, 2004. *100, Clyde Is. (Arran): Within the quarry boundary, Ivy Cottage Sand Quarry, Lower Glen Rosa, NS008371, A.R. Church, 1998.

‡102/1.14. *OXALIS INCARNATA* *68, N. Northumb.: Marshall Meadows Hotel, NT979565, M.E. Braithwaite, 2003.

‡103/1.1. *GERANIUM ENDRESSII* *c100, Clyde Is. (Arran): Roadside ground between Tourist Office and Corriegills Road, Strathwhillan, Brodick, NS0235, A.R. Church & A.W. Smith, 1993.

‡103/1.1x2. *GERANIUM OXONIANUM* (G. *ENDRESSII* × G. *VERSICOLOR*) *100, Clyde Is. (Arran): Roadside ground between Tourist Office and Corriegills Road, Strathwhillan, Brodick, NS0235, A.R. Church & A.W. Smith, 1993. *106, E. Ross: One plant in roadside ditch, Nigg, NH802689, B.R. & C.B. Ballinger, 2004, **herb. B. Ballinger**. Probably garden throwout.

‡103/1.2. *GERANIUM VERSICOLOR* 61, S.E. Yorks.: Track side, Wheldrake, SE671433, A. Horne, 2000, conf. P.J. Cook. 1st record since 1955.

‡103/1.13xpla. *GERANIUM X MAGNIFICUM* (G. *IBERICUM* × G. *PLATYPETALUM*) *34, W. Gloucs.: Hillfort ramparts, Uley Bury, ST79, J.P. Martin, 2004, det. E.J. Clement. *47, Monts.: With *Alchemilla mollis* & *Calystegia pulchra* on rough bank beside minor road, N of Llangurig, SN910802, S.P. Chambers, 2003.

‡103/1.17. *GERANIUM MACRORRHIZUM* *41, Glam.: Large patch in trackside hedge, Horton, Gower, SS472857, A.S. Lewis, 2004. *H6, Co. Waterford: Several clumps on road bank, Ballyknock, S592051, D. McGrath, 2004, det. P.R. Green.

103/1.18. *GERANIUM LUCIDUM* 106, E. Ross: On wet sea cliff, Munlochy Bay, NH685521, M. Dean, B.R. & C.B. Ballinger, 2004. 1st record since 1970.

c103/LIM.dou. *LIMNANTHES DOUGLASII* *85, Fife: In quantity on land-slip on Kinkell Braes, St Andrews, NO525157, R.I. Milne, 2003. 100, Clyde Is. (Bute): Rothesay, Craigmore, NS16, BSBI Field Meeting, 1998. 1st record since 1970.

c104/1.maj. *TROPAEOLUM MAJUS* *42, Brecks.: Waste ground near church, Llanigon, SO213399, M. & C. Porter, 1999. *61, S.E. Yorks.: On waste, Beverley, TA0232, J.K. Dews, 2003. *67, S. Northumb.: Derelict land to the west of Shiremoor, NZ3071, A. & G. Young, 2002. Site has now been built over. *68, N. Northumb.: Pavement, Bridge Street, Berwick, NT998527, M.E. Braithwaite, 2003. *100, Clyde Is. (Arran): Shoreline at Pimmill, NR8744, A.W. Smith, 1999.

‡105/1.2. *IMPATIENS CAPENSIS* ‡63, S.W. Yorks.: Park Head, Sheffield, SK3188, Sheffield Wildlife Trust, 1999. 1st record since 1970.

‡105/1.4. *IMPATIENS GLANDULIFERA* *110, Outer Hebrides: Tarbert, NG155999, E. Pilling, 2004.

c105/I.sul. *IMPATIENS SULTANII* *29, Cambs.: Pavement weed, Cambridge, TL449590, G.M. S. Easy, 2004, **herb. G.M.S. Easy**.

106/1.2b. *HEDERA HELIX* subsp. *HIBERNICA* *100, Clyde Is. (Arran): Kildonan/Dippen/Largybeg shoreline, NS02, BSBI Field Meeting, 1987.

‡106/2.2. *ARALIA ELATA* *29, Cambs.: Scattered on graves in graveyard of chapel, Gorefield, TF418119, G.M.S. Easy, 2004, **herb. G.M.S. Easy**.

‡107/1.ran. *HYDROCOTYLE RANUNCULOIDES* *33, E. Gloucs.: Ornamental park pond naturalising along outfall stream, Sandford Park, SO952221, I.L. Ralphs, 2004. *63, S.W. Yorks.: Barnsley Canal, Wilthorpe, SE3208, J. Lunn, 2000.

‡107/3.1. *ASTRANTIA MAJOR* c63, S.W. Yorks.: Loxley Valley, SK3090, J.R. Comley, 1985. 1st record since 1970.

‡107/7.1. *SCANDIX PECTEN-VENERIS* *c110, Outer Hebrides: On a thatched roof near the shore, Stornoway, NB43, P. Ewing, pre-1910.

‡107/9.1. *CORIANDRUM SATIVUM* *c40, Salop: Farm track, Whiston, SJ791027, D.H. Wrench, 2004, **herb. S.J.W.**, conf. S.J. Whild. *c68, N. Northumb.: Beside a footpath south of Horncliffe, NT928496, Q.J. Groom, 2003. Casual from birdseed found on Local Change Field Meeting.

- ‡107/20.1. AETHUSA CYNAPIUM *100, Clyde Is. (Arran): Kildonan farm, NS037213, A.W. Smith, 1991.
- 107/28.4. APIUM INUNDATUM 91, Kincardines.: Pool in birchwood, Auchattie, Banchory, NO687946, D. Welch, 2002, **ABD**. 1st record since 1930. *100, Clyde Is. (Great Cumbrae): NS15, D.J. McCosh, 1998.
- 107/31.1. CICUTA VIROSA *51, Flints.: Field pond, Penymynydd, SJ306624, P. Day, 2003, Only extant site (first found 1988).
- ‡107/37.2. ANGELICA ARCHANGELICA *c69, Westmorland: By foreshore near car park, Sandscale Haws, Dalton, SD199756, G.A. Lines, 2004.
- †107/39.3. PEUCEDANUM OSTRUTHIUM *100, Clyde Is. (Arran): On verge of track to Drimlabarra near Kildonan, NS030216, A.W. Smith, 2003.
- 107/41.1x2. HERACLEUM SPHONDYLLIUM × H. MANTEGAZZIANUM *68, N. Northumb.: One plant in scrub woodland near New Mills, NT950531, M.E. Braithwaite, 2003.
- ‡107/44.1b. DAUCUS CAROTA subsp. SATIVUS *44, Carms.: Numerous plants on grassy track, Mynydd y Garreg, SN436084, A. & V. Lewis, 2004. 1st Welsh record for this subspecies.
- ‡107/44.1maj. DAUCUS CAROTA subsp. MAJOR *50, Denbs.: By garden bird table, Moelfre, Abergele, SH948732, C. Clarke, 2004, conf. M. Southam. 1st record of subspecies.
- 108/6.2. GENTIANA PNEUMONANTHE *44, Carms.: Near Llanon, Llanelli, SN5408, J. Motley, 1840, Motley's MS Flora, seen by H.C. Watson and included in *Top. Bot. II*: 592. 1st record. Considered an error by R.F. May & R.G. Ellis in *Flowering Plants of Wales* (1983) but both I.K. Morgan & R.D. Pryce consider that Motley would not have misidentified such a species. Suitable habitat would have occurred in the area at the time - and still occurs albeit now rank and overgrown.
- †109/1.1. VINCA MINOR *100, Clyde Is. (Bute): Rothesay, Craigmore, NS16, BSBI Field Meeting, 1998. 106, E. Ross: Patch 5 sq. m. by roadside, Swordale, NH564654, B.R. & C.B. Ballinger, 2004. 1st record since 1970
- ‡109/1.3. VINCA MAJOR *100, Clyde Is. (Bute): Ettrick Bay, NS06, BSBI Field Meeting, 1998. 106, E. Ross: Patch approx. 5m x 1m, by shore, Balintore, NH865757, B.R. & C.B. Ballinger, 2004. 1st record since 1970.
- ‡110/1.1. NICANDRA PHYSALODES c63, S.W. Yorks.: Heeley, Sheffield, SK3484, G.T.D. Wilmore, 2003. 1st record since 1970.
- ‡110/6.per. PHYSALIS PERUVIANA *44, Carms.: Several plants with abundant *Lycopersicon esculentum* in disturbed waste ground, Machynys, Llanelli, SS508982, A. & V. Lewis, 2004.
- 110/8.6. SOLANUM DULCAMARA *110, Outer Hebrides: Borge, Beinn na Moine & Cadha Mhor, NF60, P.A. Smith & G.M. Orledge, 2001.
- ‡110/8.7. SOLANUM TUBEROSUM *100, Clyde Is. (Arran): 6 plants on shingle, Corrie village, NS0243, I.P. Green, 2003. *106, E. Ross: Mixed woodland, Marybank, NH481532, B.R. & C.B. Ballinger, 2004. Much evidence of garden waste dumping.
- ‡110/8.vil.b. SOLANUM VILLOSUM subsp. MINIATUM *29, Cambs.: Grounds of school, Coton, TL4058, S. Wilkins, 2004, det. A.C. Leslie.
- ‡110/9.1. DATURA STRAMONIUM *85, Fife: A single plant in recently disturbed soil, former rubbish coup at Balbarton, near Auchentool, NT237906, G.H. Ballantyne, 2004, **herb. G.H.B.** 1st definite, localised record.
- ‡110/9.fer. DATURA FEROX 11, S. Hants.: Barrier bank of imported earth, Gilkicker recreation area, Gosport, SZ601982, J.A. Norton & D.R. Allan, 2004, det. E.J. Clement. 1st record since 1970.
- ‡110/NIC.alaxfor. NICOTIANA ×SANDERAE (N. ALATA × N. FORGETIANA) *41, Glam.: Several plants on rough ground by playing fields, Sketty, Swansea, SS622915, A.S. Lewis, 2004. *44, Carms.: On pile of dumped soil/rubble, Morfa Bacas, E of Bryn Carnarvon Farm, Bynea, SS549982, V. & A. Lewis, 2004.
- ‡110/PET.axixint. PETUNIA ×HYBRIDA (P. AXILLARIS × P. INTEGRIFOLIA) *c61, S.E. Yorks.: On waste, SE9844, J.K. Dews, 2003. *c63, S.W. Yorks.: Heeley, Sheffield, SK3484, G.T.D. Wilmore, 2003.
- 111/3.2x4. CALYSTEGIA ×LUCANA (C. SEPIUM × C. SILVATICA) *40, Salop: Ludlow Castle, SO508745, G.D. Kitchener, 2004.
- ‡111/3.3. CALYSTEGIA PULCHRA 100, Clyde Is. (Bute): Rothesay, Craigmore, NS16, BSBI Field Meeting, 1998. 1st record since 1970.

- €111/IPO.lac. IPOMOEA LACUNOSA *29, Cambs.: Garden weed, Landbeach Rd, Milton, TL478632, G.M.S. Easy, 1985, **herb. G.M.S. Easy**. Probably of birdseed origin.
 114/1.1. POLEMONIUM CAERULEUM ☐‡81, Berwicks.: Ruderal, Kelmscott, NT634492, L.W. Gaskell & K.A. Velander, 2003.
 ‡114/PHL.pan. PHLOX PANICULATA *29, Cambs.: Refuse tip, Thriplow, TL444447, G.M.S. Easy, 1971, **herb. G.M.S. Easy**.
 ‡115/1.1. PHACELIA TANACETIFOLIA *€93, N. Aberdeen: Edge of potato field, Williamston, NJ649318, G. Johnston, 2002, **ABD**. Relic of pheasant mix sown in 2001.
 ‡115/NEM.men. NEMOPHILA MENZIESII 113(S), Channel Is. (Sark): At least 4 groups of several plants about 10 m apart in field with native plants, Rue Lucas, WV469759, R.M. Veall, 2004, **herb. Société Sercquaise**. 1st record for Sark. Ø
 116/1.2. LITHOSPERMUM OFFICINALE *67, S. Northumb.: A single large plant, Blyth Power Station area, NZ28W, Q.J. Groom & J. O'Reilly, 2003. Planted or perhaps from wildflower seed.
 116/2.1. ECHIUUM VULGARE *100, Clyde Is. (Great Cumbrae): Colony spreading around Cumbrae slip and car park, NS183586, A.C. Hannah & E. Doig, 2002. ‡106, E. Ross: Rough ground by sea, Inver, NH864828, B.R. & C.B. Ballinger, 2004. 1st record since 1970. Introduced with seed mix?
 ‡116/2.2. ECHIUUM PLANTAGINEUM *€61, S.E. Yorks.: Blacktoft, SE82, A. Marshall, 1999, Now common as a result of cultivation as a new crop.
 ‡116/4.1x2x4. SYMPHYTUM 'Hidcote Blue' (S. OFFICINALE × S. ASPERUM × S. GRANDIFLORUM) *69, Westmorland: Abundant in copse, Ninezergh, Levens, SD495845, D. Hughes, 2003.
 116/4.3. SYMPHYTUM TUBEROSUM 106, E. Ross: 10 plants in mixed woodland, Tain, NH786816, B.R. & C.B. Ballinger, 2004. 1st record since 1970.
 ‡116/4.6. SYMPHYTUM ORIENTALE *‡63, S.W. Yorks.: Burghwallis Cemetery, SE5312, P.A. Seccombe, 1998.
 ‡116/8.1. PENTAGLOTTIS SEMPERVIRENS 106, E. Ross: By path, Tarbat House, NH775735, B.R. & C.B. Ballinger, 2004. 1st record since 1970.
 ‡116/10.1. TRACHYSTEMON ORIENTALIS *‡63, S.W. Yorks.: Graves Park, Sheffield, SK3582, L. Storer, 1991.
 ‡116/12.2. AMSINCKIA MICRANTHA *100, Clyde Is. (Bute): Frequent in neglected sandy field, Kingarth, NS094557, A.C. Hannah, 2004.
 116/15.1x4. MYOSOTIS xSUZAE (M. SCORPIOIDES × M. LAXA) *91, Kincardines.: Wet mud in gravel pit, Strachan, NO645958, D. Welch, 2002, **ABD**. *110, Outer Hebrides: Marsh by The Obbe, S. Harris, NG021866, R.J. Pankhurst, 2002, **E**, det. D. Welch.
 €116/CER.maj. CERINTHE MAJOR *61, S.E. Yorks.: Beverley, TA0238, J.K. Dews, 2003, det. J.L. Mason.
 €116/NON.ros. NONEA ROSEA *110, Outer Hebrides: Baleloch, NF77, W.A. Shoolbred, 1898. In Shoolbred, W.A. (1899) *Notes on N Uist plants 1898. J. Bot.* 37 478-481.
 ‡117/1.1. VERBENA OFFICINALIS ‡63, S.W. Yorks.: Waste ground, Sheffield, SK3789, J. Lunn, 1991. 1st record since 1970.
 €117/1.bon. VERBENA BONARIENSIS *41, Glam.: Many seedlings, some flowering, on walls and pavement, Coed Saeson Crescent, Sketty, Swansea, SS627930, A.S. Lewis, 2004. *61, S.E. Yorks.: Wasteland, TA0234, J.K. Dews, 2003, det. B.S. Wurzell.
 ‡118/1.2. STACHYS BYZANTINA €63, S.W. Yorks.: Heeley, Sheffield, SK3484, G.T.D. Wilmore, 2003. 1st record since 1970.
 ‡118/5.1. LAMIUM ALBUM 106, E. Ross: By shore, Newhall Point, NH709670, B.R. & C.B. Ballinger, 2004. 1st record since 1970.
 ‡118/5.2. LAMIUM MACULATUM 81, Berwicks.: Dumped soil, East Morriston, NT609419, M.E. Braithwaite, 2002. 1st record since 1931.
 ‡118/6.3. GALEOPSIS SPECIOSA €38, Warks.: Sown grassland, Maxstoke, SP223886, D. Porter, 2004, conf. J.W. Partridge. 1st record since 1960. *110, Outer Hebrides: Stilligarry House, South Uist, NF770389, N. Aspey, 2003.
 ‡118/7.2. PHLOMIS FRUTICOSA *‡63, S.W. Yorks.: Meadowbank, SK3991, A. Woodcock, 1993.
 118/10.4. SCUTELLARIA MINOR 100, Clyde Is. (Bute): Kilchousland chapel and St Ninian's Point (76), NS0362, A.C. Hannah, 2002. 1st record since 1970.

‡118/10.rub. SCUTELLARIA RUBICUNDA *29, Cambs.: One plant on brick wall, opposite signal box on March to Peterborough line, Whittlesey, TL244971, R.M. Payne, 2003, det. K.A. Beckett. Ø Apparently 1st record for Britain and Ireland.

118/12.2. AJUGA PYRAMIDALIS □108, W. Sutherland: Burned, rocky slope, Invernaveir NNR, NC691611, P.A. & I.M. Evans, 2003. Noted on Site Condition Monitoring Survey.

‡118/13.racxnep. NEPETA ×FAASSENII (N. NEPETELLA × N. RACEMOSA) *40, Salop: Prees Heath, SJ5536, R.J. Swindells & N.J. Law, 2003. *¢41, Glam.: On stone wall, Langland Bay, Mumbles, SS607874, A.S. Lewis, 2004.

118/14.1. GLECHOMA HEDERACEA *‡110, Outer Hebrides: Shady path, Stornoway Castle, NB417341, R.J. Pankhurst, 2003.

‡118/17.1. SATUREJA MONTANA *67, S. Northumb.: Established on brick wall, Buston Terrace, Newcastle, NZ259660, Q.J. Groom, 2003.

118/18.2. CLINOPODIUM ASCENDENS ¢63, S.W. Yorks.: Thrybergh, SK4695, E. Ellis, 2004. 1st record since 1970.

118/20.1. ORIGANUM VULGARE *‡106, E. Ross: Sandy area by sea shore, Balintore, NH865756, B.R. & C.B. Ballinger, 2004. Near houses. ?Garden escape.

‡118/21.1. THYMUS VULGARIS *29, Cambs.: Self-sown gutter weed, Parsonage Lane, Burwell, TL585666, P.R. Green & A.C. Leslie, 2004. *¢63, S.W. Yorks.: Waste ground, Sheffield, SK3586, J. Lunn, 1991.

‡118/23.1×2×3. MENTHA ×SMITHIANA (M. ARVENSIS × M. AQUATICA × M. SPICATA) *110, Outer Hebrides: Ditch outside ruined house, Berneray, NF910802, R.J. Pankhurst, 2003, E, det. R.M. Harley.

‡118/23.3×4. MENTHA ×VILLOSA (M. SPICATA × M. SUAVEOLENS) *100, Clyde Is. (Bute): St Blane's Church, Dunagoil Bay, Stravanan Bay, NS05, BSBI Field Meeting, 1998.

118/23.4. MENTHA SUAVEOLENS *‡110, Outer Hebrides: Callanish visitor centre car park, NB215328, R.J. Pankhurst, 2001, E.

118/23.5. MENTHA PULEGIUM *‡50, Denbs.: Grassed over coal mine, Chirk, SJ298383, BSBI group, 2004. ¢63, S.W. Yorks.: Barrow Colliery site, SE3602, Barnsley Naturalists' Society, 2001. 1st record since 1970.

118/25.3. SALVIA PRATENSIS ¢38, Warks.: Roadside, near gardens, Pillerton Priors, SP289476, B.J. Laney, 2004. 1st record since 1970. Probable garden escape.

118/25.4. SALVIA VERBENACA ¢63, S.W. Yorks.: Thrybergh tip, SK4696, E. Ellis, 2002. 1st record since 1970.

¢118/25.ref. SALVIA REFLEXA 61, S.E. Yorks.: On waste, Beverley, TA0232, J.K. Dews, 2003, det. J.L. Mason. 1st record since 1970.

‡118/LAV.int. LAVANDULA ×INTERMEDIA (L. ANGUSTIFOLIA × L. LATIFOLIA) *42, Brecks.: Pavement, Hay-on-Wye, SO229426, M. & C. Porter, 2004. Ø

119/1.1. HIPPURIS VULGARIS 100, Clyde Is. (Bute): Kirk Dam, NS06, NCC Freshwater Loch Survey, 1996. 1st record since 1970.

120/1.3. CALLITRICHE STAGNALIS *106, E. Ross: Ditch by estuary, Ardgay/Bonar Bridge, NH608912, B.R. & C.B. Ballinger, 2004.

120/1.4. CALLITRICHE PLATYCARPA 50, Denbs.: Riverside, River Dee, Trefor, SJ272418, R. Maskew, 2004. 1st record since Old Atlas (1962).

120/1.7. CALLITRICHE HAMULATA s.l. *100, Clyde Is. (Bute): Loch Quien, NS0659, BSBI Field Meeting, 1998.

121/1.3b. PLANTAGO MAJOR subsp. INTERMEDIA *100, Clyde Is. (Arran): Dye Mill forestry, NS015298, A.W. Smith, 2002.

‡122/1.2. BUDDLEJA DAVIDII *110, Outer Hebrides: Causeway, Northbay, NB714032, R.J. Pankhurst & P.A. Smith, 2003.

‡122/1.3. BUDDLEJA GLOBOSA *‡63, S.W. Yorks.: Scrub, Cudworth, SE3910, I.D. Rotherham, 2003.

‡123/1.sus×vir. FORSYTHIA ×INTERMEDIA (F. SUSPENSIA × F. VIRIDISSIMA) *‡63, S.W. Yorks.: Cusworth Park car park, SE5404, G.T.D. Wilmore, 2004. *68, N. Northumb.: At the border of woodland near Stamford, NU224189, J. O'Reilly, 2003.

‡124/1.1. VERBASCUM BLATTARIA ¢44, Carms.: One plant only (white flowered) in disturbed ground/rubble, WDA Delta Lakes site, Machynys, Llanelli, SS508984, A. & V. Lewis, 2004. 2nd record & 1st since 1970.

124/1.7×9. *VERBASCUM* × *SEMIALBUM* (*V. THAPSUS* × *V. NIGRUM*) *38, Warks.: With both parents on grass banks, Bagington Castle, SP342746, M. Burgoine & R.J. Sells, 1997, **WARW**, conf. P.J. Copson & M.J. Senior.

124/1.9. *VERBASCUM NIGRUM* €100, Clyde Is. (Great Cumbrae): NS15, P. Rhind, 1985. 1st record since 1970.

‡124/4.2×3. *MIMULUS* × *ROBERTSII* (*M. GUTTATUS* × *M. LUTEUS*) *100, Clyde Is. (Bute): Ettrick Bay, NS0366, BSBI Field Meeting, 1998.

124/5.1. *LIMOSELLA AQUATICA* 38, Warks.: Abundant in ditch and on lakeside, Marsh Lane NR, Hampton in Arden, SP216808, B. Davies & J.W. Partridge, 2004, **WARW**. Discovered during Local Change visit. 63, S.W. Yorks.: Ingbirchworth Reservoir, SE2106, P.P. Abbott, 1991. 1st record since 1970.

‡124/6.1. *CALCEOLARIA CHELIDONIOIDES* *29, Cambs.: Garden weed, Histon, TF436633, G.M.S. Easy, 1982, **herb. G.M.S. Easy**. Invasive garden weed.

‡124/7.1. *ANTIRRHINUM MAJUS* €81, Berwicks.: Dumped soil, Bellitaw, NT695424, M.E. Braithwaite & J. Waddell, 2003. 1st record since 1960.

‡124/10.1. *ASARINA PROCUMBENS* *29, Cambs.: Naturalised in several places on SE facing side of a brick wall, Coronation Street, Cambridge, TF455575, A.C. Leslie, 2004.

124/13.1. *LINARIA VULGARIS* 100, Clyde Is. (Bute): Kerrytonlia shore, NS1156, A.C. Hannah, 2002. 1st record since 1970.

‡124/13.3. *LINARIA PURPUREA* *100, Clyde Is. (Great Cumbrae): NS15, D.J. McCosh, 1998. *108, W. Sutherland: With garden waste tipped in a disused quarry, W. of Little Assynt, NC148249, P.A. Evans, 2004.

‡124/13.3×4. *LINARIA* × *DOMINII* (*L. PURPUREA* × *L. REPENS*) *48, Merioneth: Several plants with both parents on platform, Barmouth railway station, SH612158, P.M. Benoit, 2003. *68, N. Northumb.: Edwardian Walls, Berwick, NT994532, M.E. Braithwaite, 2003.

€124/13.mar. *LINARIA MAROCCANA* *45, Pems.: Two plants on roadside 300m from houses between Solva and Whitchurch, SM800249, M. Sutton, 2002. *Eschscholzia californica* nearby.

‡124/14.2. *DIGITALIS LUTEA* *€63, S.W. Yorks.: Thrybergh Tip, SK4696, P. Lukey, 2000.

‡124/16.18. *VERONICA PEREGRINA* *41, Glam.: Weed of flower beds and open ground, Margam Park, SS799862, A.S. Lewis, 2004. *€44, Carms.: Disturbed stony waste, Pont Bacas, Bynea, SS553983, A. & V. Lewis, 2002, **NMW**, det. T. Davies.

‡124/17.1. *HEBE SALICIFOLIA* *42, Brecks.: Waste ground near small park, Cefn Coed, SO036077, M. & C. Porter, 2002. *100, Clyde Is. (Bute): Millbank, Ascog, NS106638, A.C. Hannah, 2003.

‡124/17.1×ell. *HEBE* × *LEWISII* (*H. SALICIFOLIA* × *H. ELLIPTICA*) *41, Glam.: One large bush on waste ground, East Bank Way, St. Thomas, Swansea, SS662933, A.S. Lewis, 2004.

‡124/17.2. *HEBE BRACHYSIPHON* *€63, S.W. Yorks.: Slip road near M1, SK4289, J.R. Comley, 2001.

‡124/17.ell×spec. *HEBE* × *FRANCISCANA* (*H. ELLIPTICA* × *H. SPECIOSA*) *€100, Clyde Is. (Bute): Rothesay Town, NS06, L.S. Garrad, 1997.

124/20.5×7. *EUPHRASIA ARCTICA* × *E. NEMOROSA* 110, Outer Hebrides: Machair by ruins, Pabbay, NL607875, R.J. Pankhurst, 1998, **E**, det. A.J. Silverside. 1st record since 1970.

124/20.5×19. *EUPHRASIA* × *VENUSTA* (*E. ARCTICA* × *E. SCOTTICA*) *110, Outer Hebrides: Fiaray, NF739082, R.J. Pankhurst, 2003, **E**, det. A.J. Silverside.

124/20.6×7. *EUPHRASIA TETRAQUETRA* × *E. NEMOROSA* *81, Berwicks.: Coastal grassland, mouth of Lamb's Burn, NT969589, M.E. & P.F. Braithwaite, 2004, **herb. M.E.B.**, conf. V. Jones.

124/20.9. *EUPHRASIA CONFUSA* *100, Clyde Is. (Arran): Glen Rosa, Creag Rosa, NR9938, A.R. Church, 1998.

124/20.15. *EUPHRASIA MARSHALLII* 110, Outer Hebrides: Ness, NB56, R.J. Pankhurst, 1999. 1st record since 1970.

124/20.19. *EUPHRASIA SCOTTICA* 100, Clyde Is. (Bute): Rothesay, NS06, BSBI Field Meeting, 1998. 1st record since 1970.

124/23.1. *PARENTUCELLIA VISCOSA* *52, Anglesey: Beside new A55 dual carriageway, Caegeiliog, SH306796, R. Birch, 2004. 1st recorded in 2003; very localised, habitat is diminishing; unclear if introduced (casual) or native. 100, Clyde Is. (Bute): Quite abundant in pasture behind Craigmole Hotel, Rothesay, NS104652, A.C. Hannah, 2003. 1st record since 1970.

124/24.2a. RHINANTHUS MINOR subsp. MINOR *81, Berwicks.: Grassland near burn, Threeburnford, NT465529, M.E. Braithwaite, 2004. 1st record critically examined.

124/24.2b. RHINANTHUS MINOR subsp. STENOPHYLLUS *63, S.W. Yorks.: Maltby Low Common, SK5491, E. Ellis, 2003. 110, Outer Hebrides: Bosta, Great Bernera, NB1339, I.M. & P.A. Evans, 2001. 1st record since 1970.

124/24.2c. RHINANTHUS MINOR subsp. MONTICOLA 110, Outer Hebrides: Carnish, Uig, NB03, R.J. Pankhurst, 2001. 1st record since 1970.

124/25.2b. PEDICULARIS SYLVATICA subsp. HIBERNICA 110, Outer Hebrides: St Kilda, NF09, M.J. Crawley, 1993. 1st record since 1970 and only the 2nd record for v.c. 110.

‡124/SUT.cor. SUTERA CORDATA *29, Cambs.: Pavement weed, Wisbech, TF460097, G.M.S. Easy, 2004, herb. G.M.S. Easy.

125/1.1. LATHRAEA SQUAMARIA 106, E. Ross: Several patches under *Corylus*, *Sambucus* and *Ulmus* in mixed woodland, Craig Wood, Dingwall, NH557598, B. & V. Saunders, 1994, det. P. Wortham. 1st record since 1970. Still present 2004.

125/2.8. OROBANCHE HEDERAE *‡63, S.W. Yorks.: Brampton-en-le-Morthen, SE4101, J.R. Comley, 2002.

128/1.1. PINGICULA LUSITANICA 106, E. Ross: Hillside flush, Kilmachalmack, NH506983, M. Dean, B.R. & C.B. Ballinger, 2004. 1st record since 1970.

128/2.4. UTRICULARIA STYGIA *100, Clyde Is. (Arran): SW corner of Loch Iorsa (with weir), NR912379, A.R. Church & A.W. Smith, 1995.

‡129/1.1. CAMPANULA PATULA ‡63, S.W. Yorks.: Thrybergh tip, SK4596, E. Ellis, 2004. 1st record since 1970.

‡129/1.3. CAMPANULA LACTIFLORA [33, E. Gloucs.: Broadwell, SP194272, 1998. Later collections from this locality have been determined as *C. incurva*. As the only record in v.c. 33, *C. lactiflora* should be deleted from the VCCC.] *49, Caerns.: Riverside rocks, Llanrwst, SH7962, W. McCarthy, 2004.

‡129/1.10. CAMPANULA POSCHARSKYANA *42, Brecks.: Established over 20 years on lane bank, 1km NE Llangynidr, SO165198, M. & C. Porter, 2004. 52, Anglesey: Established on roadbank, Trefdraeth, SH408702, I.R. Bonner, 2004. 1st record as a neophyte. *67, S. Northumb.: Fenham, NZ2265, Q.J. Groom, 2003. Increasing and apparently well established in many parts of Newcastle. *68, N. Northumb.: Colony on wall, Castle Terrace, Berwick, NT994535, M.E. Braithwaite, 2003.

129/1.11. CAMPANULA LATIFOLIA *‡100, Clyde Is. (Bute): Little Kilmory, NS045598, A.C. Hannah, 2003. Possibly native, but mostly near habitation.

‡129/1.inc. CAMPANULA INCURVA *33, E. Gloucs.: Naturalised in Jurassic limestone road cutting, Fosse Way, Broadwell, SP194272, H.M. Caddick, 1986, det. E.J. Clement. Recorded as *C. lactiflora* in *Glos. Nats. Journal* vol. 38 no. 6. Subsequent collections by others determined by E.J. Clement as *C. incurva*. Ø Apparently 1st record for Britain and Ireland.

‡129/2.1. LEGOUSIA HYBRIDA 67, S. Northumb.: Amongst dwarf hazel coppice with bark mulch opposite Newburn Country Park Centre, NZ159655, A.J. Richards, 2003. 1st record since 1970. Probably from wildflower seed.

‡129/7.2. LOBELIA ERINUS *‡67, S. Northumb.: Pavement cracks and bases of walls, NZ2665, Q.J. Groom, 2002. Also found in another location (NZ2466). *100, Clyde Is. (Arran): 2 plants self-sown on shingle, Corrie village, NS025432, I.P. Green, 2003.

‡130/6.4. GALIUM CONSTRICTUM *‡63, S.W. Yorks.: Near Shirley Pool, Askern, SE5612, B. Langridge, 1987.

‡131/1.1. SAMBUCUS RACEMOSA *100, Clyde Is. (Bute): 1 bush, self sown on edge of forestry track, Auchintirrie wood, NS051629, A.C. Hannah, 2003.

131/2.2. VIBURNUM LANTANA ‡48, Merioneth: By the Mawddach long-distance footpath (disused railway track), near Penmaenpool, SH71, P.M. Benoit, 2004. 2nd record & 1st since *Atlas of British Flora*. p. 264, 1962 (Bodowen, near Barmouth, SH6.1, P.M. Benoit). Both records were of 'alien' occurrences.

‡131/2.3. VIBURNUM TINUS *40, Salop: Bank, Newport Canal, SJ749197, R.M. Stokes, 2003. 41, Glam.: One well-established bush on a steep limestone cliff, Mumbles Hill, SS625875, A.S. Lewis, 2003. 1st record since 1970. *‡63, S.W. Yorks.: Waste ground, Norfolk Park, SK3686, Sheffield Wildlife Trust, 1996.

- ‡131/3.orb×mic. SYMPHORICARPOS ×CHENAULTII (S. MICROPHYLLUS × S. ORBICULATUS)
 *40, Salop: Market Drayton, SJ691349, R.M. Stokes, 2003, **herb. S.J.W.**, conf. S.J. Whild.
- 131/4.1. LINNAEA BOREALIS *108, W. Sutherland: Birch-wood, NC24, A. Scott (S.N.H.) & R.E.C. Ferraira, 2004. Site confidential. Both time of year (August) and type of woodland are unusual. The V.C. Recorder has seen and photographed the plants.
- ‡131/6.2. LONICERA NITIDA *c100, Clyde Is. (Arran): Auchenhew Wood, NS0221, A.R. Church, 1988. *110, Outer Hebrides: Loch Eynort, NF7828, E. Pilling, 1999. Planted.
- ‡131/6.tat. LONICERA TATARICA *41, Glam.: Well-established shrub in dune grassland, Pennard Burrows, SS552888, A.S. Lewis, 2003. *44, Carm.: Established, Cross Hands, Llanboidy, SN12(W), G.M. Kay, M. Godfrey & S.F. Woodward, 2004.
- †133/1.2. VALERIANELLA CARINATA c63, S.W. Yorks.: Waste ground, Meadowhall, SK3991, A. Woodcock, 1999. 1st record since 1970.
- ‡133/2.2. VALERIANA PYRENAICA 100, Clyde Is. (Bute): Millbank, Ascog, NS105640, A.C. Hannah, 2003. 1st record since 1970.
- 134/1.1. DIPSACUS FULLONUM *c101, Kintyre: 2 plants on road verge, Cambeltown Airport boundary, NR682221, I. Teesdale, 2003. Garden escape.
- 134/1.3. DIPSACUS PILOSUS *67, S. Northumb.: Established with at least 40 plants over a wide area, Ouse Burn, NZ261652, Q.J. Groom, 2003.
- ‡134/2.1. CEPHALARIA GIGANTEA *67, S. Northumb.: Derelict land to the west of Shiremoor, NZ3071, A. & G. Young, 2002. Site has now been built over.
- 134/3.1. KNAUTIA ARVENSIS [c91, Kincardines.: Grassland by car park, Ythsie, NJ882308, J. Malster, 2003. Record to be deleted. Incorrect v.c.] c93, N. Aberdeen: Grassland by car park, Ythsie, NJ882308, J. Malster, 2003. 1st record since 1906, but probably introduced in grass seed.
- 135/4.1. SAUSSUREA ALPINA *102, S. Ebudes: 14 plants by side of burn at altitude of 350 m, Glas Bheinn, Jura, NR587704, S.J. Bungard, 2004.
- 135/6.9x10. CIRSIUM ×CELAKOVSKIANUM (C. PALUSTRE × C. ARVENSE) *70, Cumberland: Gravelly tracksides, SW of Midgeholme, NY632583, F.J. Roberts, 2004, **LANC**.
- †135/7.1. ONOPORDUM ACANTHIUM 67, S. Northumb.: Coast Road, Heaton, NZ279667, A. & G. Young, 2001. 1st record since 1970.
- ‡135/11.2. CENTAUREA MONTANA *106, E. Ross: 1 plant in mixed woodland, Tain, NH785816, B.R. & C.B. Ballinger, 2004.
- †135/11.3. CENTAUREA CYANUS 11, S. Hants.: A dozen plants in margin of oilseed rape field, Lepe Estate, SZ451987, I. L. Ralphs, 2004. No evidence of 'wild flower mix' and the site is remote from houses and gardens. c81, Berwicks.: Municipal flower bed, Gunsgreen, NT944635, M.E. Braithwaite, 2004. Mass planting.
- 135/19.1. TRAGOPOGON PRATENSIS 100, Clyde Is. (Bute): Garroch Head, NS05, B. Simpson, 1975. 1st record since 1970.
- ‡135/19.1a. TRAGOPOGON MINOR subsp. PRATENSIS *70, Cumberland: Several colonies in rough grassland, Hodbarrow Point, Millom, SD179783, G.A. Lines, 2004, photo in **LANC**.
- ‡135/19.2. TRAGOPOGON PORRIFOLIUS *67, S. Northumb.: 3 plants on the side of the pavement in an alley amongst terraced houses next to Metro line, NZ249667, Q.J. Groom, 2002. 3 scattered plants have survived at least 3 years.
- ‡135/21.ten. SONCHUS TENERRIMUS *c38, Warks.: Alleyway, Oxford Place, Leamington Spa, SP319664, J.W. Partridge, 2004, **WARW**, conf. J.P. Bailey. Also seen by E.J. Clement.
- ‡135/22.1. LACTUCA SERRIOLA *48, Merioneth: One plant on platform, Barmouth railway station, SH612158, P.M. Benoit, 2003.
- 135/25.26. TARAXACUM TANYLEPIS *110, Outer Hebrides: Stony track, Borve, Berneray, NF915803, R.J. Pankhurst, 2004, **E**, det. A.J. Richards.
- 135/25.38. TARAXACUM DRUCEI *110, Outer Hebrides: Gerinish roadside, South Uist, NF779418, R.J. Pankhurst, 2004, **E**, det. A.J. Richards.
- 135/25.41. TARAXACUM NAEVOSIFORME *110, Outer Hebrides: Road near Cuier, Barra, NF6703, A.J. Wilmot, 1938, **BM**, det. J.L. van Soest.
- 135/25.42. TARAXACUM NAEVOSUM 110, Outer Hebrides: Waste ground, Stornoway, NB4232, R.J. Pankhurst, 1995, **E**, det. A.J. Richards. 1st record since 1970.
- 135/25.43. TARAXACUM PSEUDOLARSSONII *110, Outer Hebrides: Roadside by lighthouse, Tiumpán Head, NB573376, R.J. Pankhurst, 2003, **E**, det. A.J. Richards.

- 135/25.64. *TARAXACUM GELERTII* ***110**, Outer Hebrides: Ranish, NB396250, R.J. Pankhurst, 2003, **E**, det. A.J. Richards.
- 135/25.80. *TARAXACUM SUBBRACTEATUM* ***110**, Outer Hebrides: Roadside, Stornoway, NB418341, R.J. Pankhurst, 2003, **E**, det. A.J. Richards.
- 135/25.88. *TARAXACUM HAMATULUM* ***100**, Clyde Is. (Arran): Pirmill car park, NR869432, R.J. Pankhurst, 2003.
- 135/25.89. *TARAXACUM HAMATUM* ***110**, Outer Hebrides: Roadside, Balallan, NB270195, R.J. Pankhurst, 2003, **E**, det. A.J. Richards.
- 135/25.96. *TARAXACUM PRIONUM* ***100**, Clyde Is. (Arran): Catacol, rough ground between shore and road, NR910495, R.J. Pankhurst, 2003. ***110**, Outer Hebrides: Roadside, Ranish, NB399248, R.J. Pankhurst, 2003, **E**, det. A.J. Richards.
- 135/25.98. *TARAXACUM PSEUDOHAMATUM* ***63**, S.W. Yorks.: Brierley, SE4011, P. Lukey, det. A.J. Richards, 2003.
- 135/25.122. *TARAXACUM CORYNODES* ***100**, Clyde Is. (Arran): Shiskine, roadside in copse, NR920303, R.J. Pankhurst, 2003.
- 135/25.126. *TARAXACUM STENOGLOSSUM* ***110**, Outer Hebrides: Machair, Eriskay, NF784117, R.J. Pankhurst, 2004, **E**, det. A.J. Richards.
- 135/25.132. *TARAXACUM EXACUTUM* ***110**, Outer Hebrides: Rough ground by restaurant, Balivanich, Benbecula, NF777552, R.J. Pankhurst, 2004, **E**, det. A.J. Richards.
- 135/25.140. *TARAXACUM HORRIDIFRONS* ***33**, E. Gloucs.: Edge of rape field, Broad Marston Crossing, SP147460, T.D. Knight, 1996, det. A.J. Richards.
- 135/25.165. *TARAXACUM MELANTHOIDES* ***110**, Outer Hebrides: Waste ground, Gerinish, South Uist, NF769420, R.J. Pankhurst, 2004, **E**, det. A.J. Richards.
- 135/25.185. *TARAXACUM PLANUM* ***110**, Outer Hebrides: Machair in village, Eriskay, NF785118, R.J. Pankhurst, 2004, **E**, det. A.J. Richards.
- 135/25.189. *TARAXACUM PSEUDORETROFLEXUM* ***110**, Outer Hebrides: Nunton farmyard, Benbecula, NF765534, R.J. Pankhurst, 2004, **E**, det. A.J. Richards.
- 135/25.210. *TARAXACUM SUBUNDULATUM* ***110**, Outer Hebrides: Waste ground, Stornoway, NB431327, R.J. Pankhurst, 2003, **E**, det. A.J. Richards.
- 135/25.220. *TARAXACUM XANTHOSTIGMA* ***110**, Outer Hebrides: Roadside, Haun, Eriskay, NF791121, R.J. Pankhurst, 2004, **E**, det. A.J. Richards.
- 135/26.1. *CREPIS PALUDOSA* ***52**, Anglesey: Stream edge, Cadnant Dingle, SH558738, I.R. Bonner, 2004.
- ‡135/27.6. *PILOSELLA AURANTIACA* ***100**, Clyde Is. (Bute): Ardmaleish, NS075686, A.C. Hannah, 2004.
- 135/28.19. *HIERACIUM EBORACENSE* ***110**, Outer Hebrides: Allt Volagir, NF7930, J.W. Heslop Harrison, 1942, **BM**, det. H.W. Pugsley.
- ‡135/28.74. *HIERACIUM MACULATUM* ***63**, S.W. Yorks.: Thorne Moors, SE7115, P.A. Seccombe, 2002.
- 135/28.83. *HIERACIUM CAESIOMURORUM* **110**, Outer Hebrides: Allt Volagir, NF799295, R.J. Pankhurst, 2000, **E**, det. D.J. McCosh. 1st record since 1970.
- 135/28.112. *HIERACIUM PICTURUM* **108**, W. Sutherland: Traligill Valley, NC255218, V. Jones, 1997, det. D.J. McCosh. 1st record since 1970.
- 135/28.116. *HIERACIUM DURICEPS* ***110**, Outer Hebrides: Glen Beesdale, NB1100, W.F. Miller, 1895, **BM**.
- 135/28.136. *HIERACIUM SUBLEPISTOIDES* ***61**, S.E. Yorks.: Margin of reservoir, Sherburn, SE9675, C.I. Gillings, 2004, det. V. Jones.
- ‡135/28.138. *HIERACIUM GRANDIDENS* ***61**, S.E. Yorks.: Chalk quarry, Staxton, TA0178, C.I. Gillings, 2004, det. V. Jones. May have been recorded previously as *H. exotericum*.
- 135/28.143. *HIERACIUM SUBRUDE* ***110**, Outer Hebrides: Lingadale, N. Harris, NB1601, C. West, 1955, **CGE**, **MNE**.
- 135/28.162. *HIERACIUM JOVIMONTIS* ***110**, Outer Hebrides: Barra, A. Somerville, 1888, **BM**.
- 135/28.209. *HIERACIUM VENNICONTIUM* ***108**, W. Sutherland: In gorge by burn out of Loch Crocach, Strath More, NC433494, I.M. Evans, 2004, det. D.J. McCosh.

‡135/28.wal. *HIERACIUM* cf. *WALDSTEINII* *33, E. Gloucs.: Well established in Jurassic limestone road cutting, Fosse Way, Broadwell, SP1927, M.A.R. & C. Kitchen, 2004, det. E.J. Clement. Deliberately sown. First found in 1995 by A. Underhill and still present in 2004. Ø Apparently 1st record for Britain and Ireland.

135/33.2. *GNAPHALIUM SYLVATICUM* 38, Warks.: One plant in gravel pit, Hampton in Arden, SP216806, J.W. Partridge, 2004, **WARW**. Discovered during Local Change visit.

135/33.6. *GNAPHALIUM LUTEOALBUM* *c38, Warks.: Pavement, Eastfield Road, Leamington Spa, SP324659, J.W. Partridge, 2004, **WARW**, det. E.J. Clement.

†135/35.1. *INULA HELENIUM* 67, S. Northumb.: Rising Sun Country Park, NZ298692, A. & G. Young, 2000. 1st record since 1970.

‡135/36.1. *DITTRICHIA VISCOSA* *67, S. Northumb.: North Sea Ferry Terminal, NZ336693, A. & G. Young, 2002, **herb. G.A.S.**

‡135/41.2. *ASTER NOVAE-ANGLIAE* ‡63, S.W. Yorks.: Smithies Lane, SE3407, J. Lunn, 2004. 1st record since 1970.

‡135/41.4. *ASTER NOVI-BELGII* *agg.* *100, Clyde Is. (Arran): Mouth of Sannox Burn and Bay, NS0145, A.W. Smith, 2002.

‡135/41.5. *ASTER LANCEOLATUS* ‡63, S.W. Yorks.: Moor Hall Reservoir, SE2895, J.P. Flanagan, 2004. 1st record since 1970.

‡135/43.1. *ERIGERON GLAUCUS* *41, Glam.: Large patch, c. 7 × 2 m, on fixed dune, Port Eynon, Gower, SS470853, A.S. Lewis, 2004. *68, N. Northumb.: One plant in flower on sea-wall, Berwick, NU002526, M.E. Braithwaite, 2003.

‡135/44.1. *CONYZA CANADENSIS* *106, E. Ross: Weedy field by conifer nursery, Munloch, NH716597, H.S. McHaffie, 2004.

‡135/44.2. *CONYZA SUMATRENSIS* *c38, Warks.: Garden, Knowle, SP180771, B. Davies, 2004, **WARW**, conf. E.J. Clement. Elsewhere and spreading in v.c. 38.

‡135/44.bil. *CONYZA BILBAOANA* *c38, Warks.: Moatside garden, Maxstoke Castle, SP225892, D. Porter, 2004, **WARW**, conf. E.J. Clement. Elsewhere and spreading in v.c. 38.

‡135/45.2. *OLEARIA MACRODONTA* *c100, Clyde Is. (Bute): Milbank, Ascog, NS105640, A.C. Hannah, 2003. *110, Outer Hebrides: Old garden, Kyles Lodge, NF998878, R.J. Pankhurst, 2002.

‡135/45.3. *OLEARIA TRAVERSII* *41, Glam.: One large tree, in flower, on a low cliff at Bracelet Bay, Mumbles, SS628872, A.S. Lewis, 2003.

‡135/50.6. *ARTEMISIA ABROTANUM* *44, Carms.: On old wall, The Plas, Llansteffan, SN348103, I.K. Morgan, 1993.

135/54.1. *CHAMAEMELUM NOBILE* c100, Clyde Is. (Bute): Quien Farm, NS058591, BSBI Field Meeting, 1998. 1st record since 1970.

‡135/55.1a. *ANTHEMIS PUNCTATA* subsp. *CUPANIANA* *41, Glam.: On pavement, Dunvant, SS593938, A.S. Lewis, 2003.

†135/56.1. *CHRYSANTHEMUM SEGETUM* 106, E. Ross: Approx. 30 plants at edge of arable field, Fearn/Portmahomack, NH861785, B.R. & C.B. Ballinger, 2004. 1st record since 1970.

‡135/58.pal. *LEUCANTHEMUM PALUDOSUM* *41, Glam.: Established for about 5 years in brick paving at Swansea Marina, SS662926, A.S. Lewis, 2004, det. E.J. Clement who described this population as 'the first established colony in Britain'.

†135/59.1. *MATRICARIA RECUTITA* 100, Clyde Is. (Arran): Enclosed garden, 'Asheraig' (former croft), S. Newton, Lochranza, NR935513, A.R. Church, 1991. 1st record since 1970.

135/60.1. *TRIPLEUROSPERMUM MARITIMUM* *c63, S.W. Yorks.: Catcliffe, SK4187, A. Woodcock, 2000.

‡135/61.2. *COTULA AUSTRALIS* *113(S), Channel Is. (Sark): 2 or 3 plants in rut of cart track in field, E of Rue de la Coupée, WV461753, M. & R. Long, 2004, **herb. Société Sercquaise**, det. E.J. Clement. 1st record for Sark and probably for v.c. 113.

‡135/62.3. *SENECIO INAEQUIDENS* *c38, Warks.: Roadside, Oakley Wood, Wellesbourne, SP301597, P.J. Copson, 2000, **WARW**, conf. J.W. Partridge.

135/62.10×11. *SENECIO XOSTENFELDII* (*S. JACOBAEA* × *S. AQUATICUS*) *100, Clyde Is. (Arran): Lenamhor Farm, Kilmory, NR967207, A.W. Smith, 2001.

[135/64.1. *TEPHROSERIS PALUSTRIS* 38, Warks.: Record to be deleted. No voucher specimen. Plant never refound.]

‡135/67.1. *SINACALIA TANGUTICA* *¢70, Cumberland: Laneside rubbish dump in lane off Great Broughton - Broughton Moor road, NY067320, C. Aitchison, 2003, **LANC**.

‡135/69.1×2. *DORONICUM ×WILLDENOWII* (D. *PARDALIANCHES* × D. *PLANTAGINEUM*) *29, Cambs.: One large patch now well-established in woodland beside Shepreth Road, Fowlmere, TL403472, A.C. Leslie, 2004, **CGE**.

135/71.1. *PETASITES HYBRIDUS* 48, Merioneth: With *Tussilago farfara* in the rocky bed of the Afon Ceidiog, at Llandrillo, SJ03, P.M. Benoit, 2004. 1st record of the female plant.

‡135/71.4. *PETASITES FRAGRANS* 100, Clyde Is. (Bute): Rothesay, Craigmore, NS106640, BSBI Field Meeting, 1998. 1st record since 1970.

‡135/73.1. *CALENDULA OFFICINALIS* *110, Outer Hebrides: Barra ferry car park, Eriskay, NF784101, R.J. Pankhurst, 2003.

‡135/74.1. *AMBROSIA ARTEMISIIFOLIA* *¢38, Warks.: Bird feeding site in garden, Coventry, SP361778, G.E. Scott, 2003, det. M.J. Senior. ¢40, Salop: Garden throwout, Waters Upton, SJ630197, S.J. Whild & A.J. Lockton, 2004. 1st record since 1970. *¢42, Brecks.: Edge of garden path (possibly from birdseed), 3 km SW Brecon, SO022261, C. Allum, 2003, **herb. M.P.**

*¢47, Monts.: Garden, a bird seed alien with *Linum bienne*, *Phalaris canariensis* and *Raphanus raphanistrum*, Llanidloes, SN955852, M. Oliver, 2003. ¢85, Fife: On a small dump with several other unusual casuals in grounds of a fruit farm, Balmalcolm, NO321083, G.H. Ballantyne, 2004, **herb. G.H.B.** 1st record since 1919.

‡135/80.1. *GALINSOGA PARVIFLORA* *42, Brecks.: Edge of path, Crickhowell, SO212183, M. & C. Porter, 2004, **herb. M.P.**

‡135/80.2. *GALINSOGA QUADRIRADIATA* *¢52, Anglesey: Single plant beside new A55 dual carriageway, Gwalchmai, SH375759, R. Birch, 2004.

135/81.1. *BIDENS CERNUA* *93, N. Aberdeen: Margin of recently created open water, Loch of Strathbeg, NK0458, H.S. McHaffie, 2002.

‡135/81.4. *BIDENS FRONDOSA* *50, Denbs.: Lock gate, canal basin, Trefor, SJ271422, G. Kay, 2004.

‡135/83.1. *COSMOS BIPINNATUS* *¢61, S.E. Yorks.: Wasteland, Beverley, TA0232, J.K. Dews, 2003, det. J.L. Mason.

‡135/CAR.tin. *CARTHAMUS TINCTORIUS* ¢63, S.W. Yorks.: Heeley, Sheffield, SK3484, G.T. D. Wilmore, 2003. 1st record since 1970.

¢135/GULaby. *GUIZOTIA ABYSSINICA* *61, S.E. Yorks.: On waste, Beverley, TA0238, J.K. Dews, 2003, det. J.L. Mason. *¢63, S.W. Yorks.: Heeley, SK3484, K. Balkow & G.T.D. Wilmore, 2003.

‡135/HEL.ros. *ACROCLINIUM ROSEUM* *29, Cambs.: Refuse tip, Milton, TL478620, G.M.S. Easy, 1987, **herb. G.M.S. Easy**.

¢135/HEL.bra. *HELICHRYSUM BRACTEATUM* *41, Glam.: On rough ground by river, Loughor, SS565983, A.S. Lewis, 2003.

137/2.1. *BALDELLIA RANUNCULOIDES* 106, E. Ross: Edge of Loch Eye, NH820790, B.R. & C.B. Ballinger, 2004. 1st record since 1970.

137/3.1. *LURONIUM NATANS* □40, Salop: Flood-plain pasture, Edgerley, SJ3418, A.K. Thorne, 2003, **herb. S.J.W.**, conf. S.J. Whild.

138/2.1. *STRIATOTES ALOIDES* *‡80, Roxburghs.: Naturalised in pond, Smailholm village, NT646362, L.W. Gaskell, 2002.

‡138/3.1. *EGERIA Densa* *40, Salop: Farm pond, Preston Montford Farm, SJ431142, S.J. Whild & S. Townsend, 2003. *61, S.E. Yorks.: With *Lagarosiphon* in Beverley Canal, TA047393, R. Goulder, 2003, conf. P.J. Cook. *80, Roxburghs.: Introduced in pond, Smailholm village, NT646362, L.W. Gaskell, 2002, **herb. R.W.M.C.**

‡138/4.2. *ELODEA NUTTALLII* *48, Merioneth: Pool at Penrhyndeudraeth, SH63, R.H. Gritten, 2004. *80, Roxburghs.: Introduced in pond, Smailholm village, NT646362, L.W. Gaskell, 2002, **herb. R.W.M.C.** *81, Berwicks.: River Tweed between Norham and Horndean, NT9048, R.V. Lansdown & T.J. Pankhurst, 2004.

142/1.5×6. *POTAMOGETON ×ANGUSTIFOLIUS* (P. *LUCENS* × P. *GRAMINEUS*) *100, Clyde Is. (Bute): Loch Ascog; Loch Fad, NS06, BSBI Field Meeting, 1998.

142/1.6. *POTAMOGETON GRAMINEUS* 100, Clyde Is. (Bute): Loch Ascog, Loch Fad, NS06, BSBI Field Meeting, 1998. 1st record since 1970.

142/1.6×9. *POTAMOGETON ×NITENS* (*P. GRAMINEUS* × *P. PERFOLIATUS*) **100**, Clyde Is. (Bute): Loch Quien, NS05, BSBI Field Meeting, 1998. 1st record since 1970.

142/1.7. *POTAMOGETON ALPINUS* **100**, Clyde Is. (Bute): Coastline from Kilchattan to Hawk's Nib, NS15, J. Mitchell & A. McG. Stirling, 1994. 1st record since 1970.

142/1.7×19. *POTAMOGETON ×OLIVACEUS* (*P. ALPINUS* × *P. CRISPUS*) **81**, Berwicks.: River, Fishwick Mains, NT926498, M.E. Braithwaite, 2003. **81**, Berwicks.: River Tweed between Norham and Horndean, NT9048, R.V. Lansdown & T.J. Pankhurst, 2004.

142/1.8. *POTAMOGETON PRAELONGUS* **100**, Clyde Is. (Bute): Loch Ascog, Loch Fad, NS06, BSBI Field Meeting, 1998. 1st record since 1970.

142/1.9. *POTAMOGETON PERFOLIATUS* **100**, Clyde Is. (Bute): Loch Ascog, Loch Fad, NS06, BSBI Field Meeting, 1998. 1st record since 1970.

142/1.11. *POTAMOGETON FRIESII* **63**, S.W. Yorks.: Chesterfield Canal, SK4681, M.R. Shaw, 1991. 1st record since 1970.

142/1.13. *POTAMOGETON PUSILLUS* **100**, Clyde Is. (Bute): Loch Ascog, Loch Fad, NS06, BSBI Field Meeting, 1998. 1st record since 1970.

142/1.14. *POTAMOGETON OBTUSIFOLIUS* **100**, Clyde Is. (Bute): Loch Fad, NS06, NCC Freshwater Loch Survey, 1996. 1st record since 1970.

142/1.19. *POTAMOGETON CRISPUS* **100**, Clyde Is. (Bute): Loch Ascog; Loch Fad, NS06, BSBI Field Meeting, 1998. 1st record since 1970.

142/1.21×vag. *POTAMOGETON ×BOTTNICUS* (*P. PECTINATUS* × *P. VAGINATUS*) **81**, Berwicks.: River, St Thomas Island, NT922493, M.E. Braithwaite, 2003. Where found earlier by C D Preston but attributed by him to v.c. 68.

146/1.2. *ZOSTERA ANGUSTIFOLIA* **106**, E. Ross: Intertidal mud, Tain, NH789826, B.R. & C.B. Ballinger, 2004. 1st record since 1970.

151/1.5. *JUNCUS TRIFIDUS* **100**, Clyde Is. (Arran): At 775 m, a small colony on peaty ledge at head height at extreme north end of Stacach Ridge, west side, NR991421, A.R. Church & P. Mackie, 1998. 1st record since 1970.

151/1.8. *JUNCUS AMBIGUUS* **63**, S.W. Yorks.: Wath Colliery waste, SE4301, C.G. Varty, 1993. **100**, Clyde Is. (Bute): St Ninian's Bay, NS06, BSBI Field Meeting, 1998. 1st record since 1970.

151/1.11. *JUNCUS SUBNODULOSUS* **70**, Cumberland: Marshy pasture by beck, Burgh by Sands, NY331581, R.E. Groom, 2004, **LANC**. 1st record since 1890s.

151/1.13×14. *JUNCUS ×SURREJANUS* (*J. ARTICULATUS* × *J. ACUTIFLORUS*) **81**, Berwicks.: By the R. Whiteadder at Dyshaugh, NT7159, R.V. Lansdown & T.J. Pankhurst, 2004, **herb. M.E.B.**

151/1.25×26. *JUNCUS ×DIFFUSUS* (*J. EFFUSUS* × *J. INFLEXUS*) **44**, Carms.: Unimproved grassland field, Cross Hands, SN563133, M. & J. Iliff, 2001, **NMW**.

151/1.26×27. *JUNCUS ×KERN-REICHGELTII* (*J. EFFUSUS* × *J. CONGLOMERATUS*) **48**, Merioneth: In quantity with both parents in a meadow near Ystumgwadnaeth, Dolgellau, SH72, P.M. Benoit, 2002. **50**, Denbs.: Moorland flush, Gors Maen Llwyd, SH980583, A.O. Chater, 2004.

151/1.ens. *JUNCUS ENSIFOLIUS* **11**, S. Hants.: Pond, Fair Oak, SU483182, J.P. Poland, 2004, conf. E.J. Clement.

151/2.1×2. *LUZULA ×BORRERI* (*L. FORSTERI* × *L. PILOSA*) **50**, Denbs.: Wooded slope, Trefor, SJ273419, R. Maskew, 2004, conf. C.A. Stace.

151/2.6b. *LUZULA MULTIFLORA* subsp. *CONGESTA* **50**, Denbs.: Pasture, The Cloy, SJ397428, J. Clarke, 2004. 1st record of subspecies. **63**, S.W. Yorks.: Derwent Valley area, SK1791, J. Middleton, 2003. **67**, S. Northumb.: Near Dirt Pot, R. East Allen, NY8546, A. & G. Young, 2002. **100**, Clyde Is. (Arran): Newton, Lochranza, NR9351, J.J. Day, 1998.

152/4.1. *BOLBOSCHOENUS MARITIMUS* **106**, E. Ross: Muddy shore, Ardroy, Alness Bay, NH627670, B.R. & C.B. Ballinger, 2004. 1st record since 1970.

152/7.2. *SCHOENOPLECTUS TABERNAEMONTANI* **100**, Clyde Is. (Bute): Kilchattan and land to south including freshwater habitats, NS15, BSBI Field Meeting, 1998.

152/10.2. *BLYSMUS RUFUS* **106**, E. Ross: Coastal marsh, Munlochy Bay, NH667527, M. Dean, B.R. & C.B. Ballinger, 2004. 1st record since 1970.

152/11.1. *CYPERUS LONGUS* **69**, Westmorland: By stream into saltmarsh, Askam-in-Furness, SD209774, D. Hughes, 2004. **100**, Clyde Is. (Arran): Merkland wood pond, NS020383, A.R. Church, 1994.

‡152/11.2. *CYPERUS ERAGROSTIS* ‡63, S.W. Yorks.: Waste ground, Sheffield Botanic Gardens, SK3386, K. Balkow, 2004. 1st record since 1970.

152/14.1. *CLADIUM MARISCUS* *44, Carms.: Seven flowering stems in 2 distinct clumps, 5 m apart, in vegetated, pulverised fuel ash (pfa) lagoon, developing fen, Pwll Ash Lagoon SSSI, SN471010, R.D. & K.A. Pryce, 2004, NMW.

152/16.3. *CAREX DIANDRA* 100, Clyde Is. (Bute): Flooded limestone quarry to south of Kilchattan, NS105545, J. Mitchell & A. McG. Stirling, 1994. 1st record since 1970.

[152/16.4. *CAREX VULPINA* 63, S.W. Yorks.: Formerly near Fishlake. D.R. Grant reports this species to be extinct in v.c 63.]

52/16.8b. *CAREX MURICATA* subsp. *LAMPROCARPA* 63, S.W. Yorks.: Armthorpe, SE6204, D.R. Grant, 2002. 1st record since 1970.

152/16.13. *CAREX DIVISA* 61, S.E. Yorks.: Haline grassland on the Broomfleet Washlands, Humber Estuary, SE868282, M. Hammond, 2003.

152/16.15. *CAREX REMOTA* 106, E. Ross: Edge of Loch Achnacloich, NH664737, B.R. & C.B. Ballinger, 2004. 1st record since 1970.

152/16.24. *CAREX LASIOCARPA* *100, Clyde Is. (Bute): Bull Loch, NS0073, L. Farrell & B.H. Thompson, 1997.

152/16.25×29. *CAREX* ×*DUCELLIERI* (*C. ACUTIFORMIS* × *C. VESICARIA*) *9, Dorset: Ebblake Bog, SU105068, J.D. Crewe, M.S. Porter & R.M. Walls, 2002, BM, conf. A.O. Chater. Previously reported for v.c. 11 - on both sides of border.

152/16.26. *CAREX RIPARIA* *100, Clyde Is. (Bute): Good colony on raised beach, Port Loddan, NS041588, A.C. Hannah, 2002, det. A.C. Jermy.

152/16.29. *CAREX VESICARIA* *100, Clyde Is. (Bute): Kirk Dam, NS082633, A.C. Hannah, 2004.

152/16.32. *CAREX SYLVATICA* *‡110, Outer Hebrides: Castle Woods, Stornoway, NB419332, R.J. Pankhurst & W.A.J. Cunningham, 1997.

152/16.33. *CAREX CAPILLARIS* □108, W. Sutherland: Maritime cliff and slope, Clachtoll, NC039268, P.A. & I.M. Evans, 2004. First reported by H. Pellant in mid 1980s but never precisely localised before.

152/16.34. *CAREX STRIGOSA* 63, S.W. Yorks.: Margery Wood, SE2709, P.P. Abbott, 1991. 1st record since 1970.

152/16.44×46. *CAREX* ×*FULVA* (*C. HOSTIANA* × *C. VIRIDULA*) 40, Salop: Upland flush, Darnford, SO427977, A.K. Thorne, 2004, herb. S.J.W., conf. A.O. Chater. 1st record since 1970.

*100, Clyde Is. (Bute): Upper Ardroscaire, NS0364, M.E. Braithwaite, 2003.

152/16.47. *CAREX PALLESCENS* 61, S.E. Yorks.: Black Cliff, Speeton, TA1575, C.I. Gillings, 2003. 1st record since 1970.

152/16.64×67. *CAREX* ×*HIBERNICA* (*C. AQUATILIS* × *C. NIGRA*) *85, Fife: Marshy ground by small pond, Hitton of Beath, N of Cowdenbeath, NT156940, G.H. Ballantyne, 1980, det. R.W. David *et al.* 1st confirmed record. Material sent to BM for determination (1980). Identification has only now come to light through research for 3rd edition of *Carex Handbook*.

‡153/3.1. *SASA PALMATA* 50, Denbs.: Estate garden, Hafodunos Hall, Llangernyw, SH869668, J.A. Green, 2004. 1st record as neophyte. *67, S. Northumb.: In woodland on south bank of R. Wansbeck near Bothal, NZ236861, G. Young, 2004. Presumably planted; other aliens present.

153/12.2. *FESTUCA ARUNDINACEA* 110, Outer Hebrides: West Benbecula, NF75, S.J. Bungard, 1998. 1st record since 1970.

153/12.7b. *FESTUCA RUBRA* subsp. *JUNCEA* 110, Outer Hebrides: Muldoanich, NL684939, R.J. Pankhurst & P.A. Smith, 2003, E, det. A. Copping. 1st record since 1970.

153/12.7d. *FESTUCA RUBRA* subsp. *COMMUTATA* *110, Outer Hebrides: Ben Eaval, NF86, W. A. Shoolbred, 1894, BM. Also in Shoolbred, W.A. (1895) *Plants observed in the Outer Hebrides*: in 1894. *J. Bot.* 33 237-249.

153/12.8c. *FESTUCA OVINA* subsp. *OPHIOLITICOLA* *49, Caerns.: Limestone crags, Pen y Dinas, Great Orme, SH7782, W. McCarthy, 2004, det. A. Copping. 1st record for subspecies.

153/12.9. *FESTUCA VIVIPARA* *91, Kincardines.: Riverside grassland, Glenbogle, Strachan, NO6496, D. Elston, 2002.

153/12.10. *FESTUCA FILIFORMIS* *100, Clyde Is. (Arran): Rubha Airigh Dhughaill between Imachar and Dougarie, NR8738, A.R. Church & A.W. Smith, 1996.

153/13.1×2. *LOLIUM* ×*BOUCHEANUM* (*L. PERENNE* × *L. MULTIFLORUM*) *63, S.W. Yorks.: Moss, Askern, SE5813, G.T.D. Wilmore, 2004.

†153/14.3. *VULPIA MYUROS* *100, Clyde Is. (Arran): Arable fields, Torrylinn shore, NR959207, A.R. Church & A.W. Smith, 1998. 106, E. Ross: 10 plants in gravel in station yard, Fearn, NH815782, B.R. & C.B. Ballinger, 2004, **herb. B. Ballinger**. 1st record since 1970.

153/14.4b. *VULPIA CILIATA* subsp. *AMBIGUA* *63, S.W. Yorks.: Treeton Dike, SK4386, M.R. Shaw, 1993, det. C.A. Stace.

153/16.2. *PUCCINELLIA DISTANS* *100, Clyde Is. (Great Cumbrae): NS15, NCC Freshwater Loch Survey, 1996.

‡153/17.3. *BRIZA MAXIMA* *67, S. Northumb.: In a pavement crack at the base of a wall, Heaton, NZ2665, Q.J. Groom, 2002.

153/18.1. *POA INFIRMA* ■11, S. Hants.: Road verge near Longbeech Inclosure, Stoney Cross, New Forest, SU247127, N.A. Sanderson, 2004.

‡153/18.7. *POA CHAIXII* *68, N. Northumb.: Long established in Marshall Meadows Dean, NT978564, M.E. Braithwaite, 2003.

153/18.13. *POA BULBOSA* ■11, S. Hants.: Grassy roadside verge, Stokes Bay Road, Gosport, SZ594985, D.R. Allan & E.J. Clement, 2004.

153/20.1. *CATABOSA AQUATICA* 106, E. Ross: By stream near shore, Tain, NH797880, B.R. & C.B. Ballinger, 2004, **herb. B. Ballinger**. 1st record since 1970.

153/23.1. *PARAPHOLIS STRIGOSA* 100, Clyde Is. (Arran): Clachlands shore, NS047324, A. Young, 2002. 1st record since 1970.

153/24.2×4. *GLYCERIA* ×*PEDICELLATA* (*G. FLUITANS* × *G. NOTATA*) 81, Berwicks.: Riverside, Nisbet Mill, above Blackadder, NT7949, R.V. Lansdown & T.J. Pankhurst, 2004. 1st record since 1960.

‡153/28.2. *AVENA STRIGOSA* 100, Clyde Is. (Arran): Pasture next to shore, Sandbraes, NS053276, A.W. Smith, 2000. 1st record since 1970.

‡153/28.5. *AVENA SATIVA* *68, N. Northumb.: NU21A, Q.J. Groom, 2003.

153/32.1a. *DESCHAMPSIA CESPITOSA* subsp. *CESPITOSA* *100, Clyde Is. (Great Cumbrae): NS15, C. Dixon & J.W. McIntosh, 1999.

153/32.1b. *DESCHAMPSIA CESPITOSA* subsp. *PARVIFLORA* *50, Denbs.: Felled woodland, World's End, Llangollen, SJ228477, A.O. Chater, 2004.

153/33.1×2. *HOLCUS* ×*HYBRIDUS* (*H. LANATUS* × *H. MOLLIS*) *63, S.W. Yorks.: Houghton Common, SE4308, I.D. Rotherham, 2003.

‡153/38.4. *PHALARIS MINOR* *61, S.E. Yorks.: East Heslerton Wold, SE9374, V. Jones, 2001.

‡153/39.3. *AGROSTIS CASTELLANA* *44, Carms.: Sown in restoration seed mix on site of restored coal washery, Pont-y-clerc, Ammanford, SN619116, A.O. Chater & BSBI Field Meeting, 2004, NMW.

‡153/43.1. *LAGURUS OVATUS* *61, S.E. Yorks.: Pavement, Withernsea, TA343278, P.J. Cook, 2001. Seen also in 2003.

‡153/46.2. *POLYPOGON VIRIDIS* *40, Salop: Pavement, Shrewsbury, SJ497132, S.J. Whild, 2004, **herb. S.J.W.**

†153/47.6. *ALOPECURUS MYOSUROIDES* *45, Pembs.: Arable, Great Nash, Trooper's Inn, SM973098, S.B. & A.E. Evans, 2003. Growing with a birdseed mix of sunflower and millet so possibly introduced with these.

‡153/48.1. *BECKMANNIA SYZIGACHNE* *67, S. Northumb.: 2 plants in a pavement crack at the base of a wall, in an alley behind houses, Jesmond, NZ253665, Q.J. Groom, 2002. Introduced with birdseed?

153/50.4d. *BROMUS HORDEACEUS* subsp. *LONGIPEDICELLATUS* *61, S.E. Yorks.: As a marginal plant in a crop of barley, Hollym Carr, TA331244, P.J. Cook, 1999, det. L.M. Spalton. 1st of numerous records throughout the v.c.

†153/50.7. *BROMUS SECALINUS* ■11, S. Hants.: Entrance to grass field, Stockbridge Road, Broughton, SU312335, B. & J.L.E. Goater, 2004, **herb. B.G.** New for SU33 in v.c. 11. ■11, S. Hants.: Grassland, E of Lower Pennington Lane, Lymington, SZ318936, M.W. Rowe, 2001, conf. L.M. Spalton. ■11, S. Hants.: Grassland, Pylewell Park, South Baddesley, SZ349959, M.W. Rowe, 2002, conf. L.M. Spalton.

‡153/51.4. *BROMOPSIS INERMIS* **85**, Kinross: Newly sown roadside verge, Vane Farm, Loch Leven, NT19, H.J. Nolltie, 1986, **E**, conf. D.R. McKean. 1st record since 1904. Vice-county recorder notified in 2004.

‡153/52.3. *ANISANTHA STERILIS* ***110**, Outer Hebrides: Grimsay, NF879553, R.J. Pankhurst, 2000.

‡153/53.1. *CERATOCHLOA CARINATA* ***c40**, Salop: Shrewsbury, SJ510105, S.J. Whild, 2003, **LTR**, conf. C.A. Stace.

153/56.1x2. *ELYTRIGIA xDRUCEI* (*E. REPENS* x *E. ATHERICA*) ***44**, Carms.: With both parents on highest zone of saltmarsh, Tywyn Burrows, SN366050, A.O. Chater & BSBI Group, 2004, **NMW**.

153/56.1x3. *ELYTRIGIA xLAXA* (*E. REPENS* x *E. JUNCEA*) ***100**, Clyde Is. (Arran): Shore below Lenamhor, NR966203, A.R. Church, 1996.

c153/59.1. *HORDEUM DISTICHON* ***100**, Clyde Is. (Arran): Several plants on dumped soil at roadside c100m south of electrical sub-station near Rubha Airigh Dhughail, NR872386, A.R. Church, 1998.

153/59.4. *HORDEUM SECALINUM* **47**, Monts.: Rough bank beside minor road, with *Lamium album*, Llangurig, SN913803, K.C. Austin, 2003, det. S.P. Chambers. 2nd record & 1st since 1970.

c153/60.1. *TRITICUM AESTIVUM* ***100**, Clyde Is. (Arran): On shore, Kilpatrick Point, NR899268, A. Smith & R. Whitla, 2003. ***110**, Outer Hebrides: Aird Uig, NB03, E. Pilling & A.P. Wilson, 2001.

c153/60xSEC. *xTRITICALE* (*TRITICUM* x *SECALE*) ***81**, Berwicks.: Arable field, Birkenside, NT576427, L.W. Gaskell, 2004. Sown crop.

‡153/62.1. *CORTADERIA SELLOANA* ***c100**, Clyde Is. (Great Cumbrae): NS15, D.J. McCosh, 1998. ***110**, Outer Hebrides: Roadside, Tarbert, NB142008, R.J. Pankhurst, 2003.

‡153/62.1c. *CORTADERIA RICHARDII* ***c100**, Clyde Is. (Arran): Self sown about Corrie village, NS0243, I.P. Green, 2003.

c153/65.cil. *ERAGROSTIS CILIANENSIS* ***61**, S.E. Yorks.: On waste, SE9844, J.K. Dews, 2003, det. J.L. Mason.

[153/67.1x3. *SPARTINA xTOWNSENDII* (*S. MARITIMA* x *S. ALTERNIFLORA*) **110**, Outer Hebrides: Record to be deleted. The specimens are all *S. anglica*.]

153/67.2. *SPARTINA ANGLICA* ***110**, Outer Hebrides: Tidal sand at Seilebost, Rubha Reamhar, NG084972, I.C. Hedge & F. Sales, 2004, **E**, det. T.A. Cope. 1st confirmed record; previously recorded as *S. xtownsendii*.

c153/70.adh. *SETARIA ADHAERENS* ***45**, Pembs.: Base of wall opposite harbour car park, Saundersfoot, SN135047, T.C.G. Rich, 2003, **NMW**.

‡153/70.pum. *SETARIA PUMILA* ***c45**, Pembs.: Lower Freystop, SM956123, S. Bosanquet, 2004. Appears identical to an A.O. Chater specimen from v.c. 46.

c153/72.bic. *SORGHUM BICOLOR* ***38**, Warks.: Abundant in arable field, Atherstone on Stour, SP218511, L.C. Dudley, 2004, **WARW**, conf. T.B. Ryves. Sown for pheasants.

c153/PAN.cap. *PANICUM CAPILLARE* ***61**, S.E. Yorks.: Garden weed, Holmpton, TA363242, P.J. Cook, 1999. Birdseed alien.

‡153/PEN.sph. *PENNISETUM SPHACELATUM* ***29**, Cambs.: Pavement weed, Old School Lane, Milton, TL478627, G.M.S. Easy, 2004, **herb. G.M.S. Easy**. Ø Apparently 1st record for Britain and Ireland.

c153/Sec.cer. *SECALE CEREALE* **81**, Berwicks.: Arable field, near Pease Dean, NT795702, M.E. Braithwaite, 2004. 1st record since 1853. Sown crop.

c153/ZEA.may. *ZEA MAYS* ***42**, Brecks.: Two plants near bird feeding station in yard, probably introduced with birdseed, Llangynidr, SO168196, M. Porter, 2003. **63**, S.W. Yorks.: Heeley, Sheffield, SK3484, G.T.D. Wilmore, 2003. 1st record since 1970.

154/1.1b. *SPARGANIUM ERECTUM* subsp. *MICROCARPUM* ***50**, Denbs.: Pond in waste ground, Wrexham, SJ381487, J. Clarke, 2004. 1st record of subspecies.

154/1.1c. *SPARGANIUM ERECTUM* subsp. *NEGLECTUM* ***110**, Outer Hebrides: Balranald NR, North Uist, NF715694, E. Pilling, 2000, **E**, det. R.J. Pankhurst.

154/1.4. SPARGANUM NATANS *100, Clyde Is. (Bute): Kirk Dam, NS06, NCC Freshwater Loch Survey, 1996. *47, Monts.: 150–200 plants with *Sphagnum papillosum* & *S. palustre* in peaty depression in blanket bog, Trannon Moor, SN911975, C. Forster Brown, 2003. Photo & specimen with M. Wainright. An important surviving habitat threatened only by the proximity of Trannon wind-farm.

♂158/3.fis. ASPHODELUS FISTULOSUS *29, Cambs.: One plant on waste ground, Scotland Rd, Cambridge, TL46195997, G.M.S. Easy, 2004, **herb. G.M.S. Easy**. First record since 1875.

♂158/5.1. HEMEROCALLIS FULVA *85, Fife: Old garden of long ruined cottage near Balcomie Golf Club House, Fifeness, NO630098, G.H. Ballantyne, 2004. Long established and spreading. May be a cultivar.

♂158/6.1. KNIPHOFIA UVARIA *♂100, Clyde Is. (Arran): Kilpatrick Road, NR902279, A.W. Smith, 1995. *106, E. Ross: 2 large plants by seashore, Balintore, NH865757, B.R. & C.B. Ballinger, 2004. Probably garden throwout.

♂158/10.3. TULIPA GESNERIANA *♂81, Berwicks.: Dumped soil, Earlston, NT575382, M.E. Braithwaite, 2004. Group of outcasts.

♂158/12.2. LILIUM PYRENAICUM 42, Brecks.: Hedgebank in village, Heol Senni, SN927234, M. & C. Porter, 2003. 1st record since 1970. *♂100, Clyde Is. (Bute): Ettrick Bay, NS06, BSBI Field Meeting, 1998.

[158/13.1. CONVALLARIA MAJALIS *91, Kincardines.: By trackside in birchwood, Ardoe, NJ894011, J. Waddell, 2004, **ABD. Watsonia** Volume 25 Part 4, p 439. Add ♀ (neophyte) to v.c. status.]

158/19.4. SCILLA VERNA *100, Clyde Is. (Arran): Kildonan, NS035209, D. Goldsborough, 2000, det. A.W. Smith.

♂158/20.2×3. HYACINTHOIDES NON-SCRIPTA × HISPANICA *106, E. Ross: 20 flowering spikes on sea shore, Rockfield, NH923827, B.R. & C.B. Ballinger, 2004. Near houses.

♂158/20.3. HYACINTHOIDES HISPANICA *110, Outer Hebrides: Roadside, Carloway, NB214417, R.J. & A. Pankhurst, 2003.

♂158/21.1. HYACINTHUS ORIENTALIS *♂63, S.W. Yorks.: Ecclesall Woods area, SK3282, W.J. Smillie, 1996.

♂158/23.1. MUSCARI NEGLECTUM 41, Glam.: Hendrefoilan, SS612937, A.S. Lewis, 2003. 1st record as a neophyte.

♂158/23.2. MUSCARI ARMENIACUM *52, Anglesey: Roadside lay-by, between Benllech and Marianglas, SH513842, J. Hawksford, 1993. *68, N. Northumb.: Riverside, Berwick, NT994532, M.E. Braithwaite, 2003.

♂158/24.4. ALLIUM NEAPOLITANUM *49, Caerns.: Naturalized on high bank above Marine Drive, Great Orme, SH7682, W. McCarthy, 2004. 1st Welsh record.

♂158/24.7. ALLIUM TRIQUETRUM. *100, Clyde Is. (Bute): Cnoc an rath, NS052672, A.C. Hannah, 2003. *♂101, Kintyre: Neutral grassland, Glen Creggan Estate, NR672186, A.R. Stewart, 2004. Introduced from France into garden and established in wild for 4 years

♂158/24.9. ALLIUM PARADOXUM ♂63, S.W. Yorks.: Edenthorpe, SE6106, G.T.D. Wilmore, 2004. 1st record since 1970.

♂158/24.15. ALLIUM SPHAEROCEPHALON *42, Brecks.: Waste ground, Brynmawr, SO185114, A. & V. Lewis, 2004. 1st Welsh record.

♂158/24.cep. ALLIUM CEPA ♂63, S.W. Yorks.: Sawney Hill, Tickhill, SK6194, G. Coles, 2004. 1st record since 1970.

♂158/28.1. TRISTAGMA UNIFLORUM 41, Glam.: In sandy grassland, Horton, Gower, SS476856, A.S. Lewis, 2003. 1st record since 1970.

♂158/31.2. LEUCOJUM VERNUM *81, Berwicks.: Wet alderwood, Mire Loch, NT913685, M.E. Braithwaite, 2004. Well naturalised for 30 years.

♂158/32.2. GALANTHUS ELWESII *42, Brecks.: Grassland, churchyard, Ystradgynlais, SN787099, M. & C. Porter, 2004, **herb. M.P.**

♂158/32.4. GALANTHUS PLICATUS *♂81, Berwicks.: Parkland, The Hirsell, NT827405, M.E. Braithwaite, 2004. Clump from planting.

♂158/32.4b. GALANTHUS PLICATUS subsp. BYZANTINUS *41, Glam.: Naturalised and spreading in deciduous limestone woodland, Cwm Ivy Wood, Gower, SS440937, A.S. Lewis, 2004.

- ‡158/33.3a. *NARCISSUS POETICUS* subsp. *POETICUS* *42, Brecks.: Lane verge, Partrishow, SO278223, M. & C. Porter, 2002.
- ‡158/33.3×5. *NARCISSUS* ×*INCOMPARABILIS* (*N. POETICUS* × *N. PSEUDONARCISSUS*) *40, Salop: Woodland, Benthall Edge, SJ6503, S.J. Whild, 2003. *42, Brecks.: Road verge, Llyswen, SO132380, M. & C. Porter, 2002. *c81, Berwicks.: Grassland, Milne Graden, NT876440, M.E. Braithwaite, 2004. Group from outcasts.
- ‡158/35.2. *RUSCUS HYPOGLOSSUM* *63, S.W. Yorks.: Waste ground, Brodsworth, SE5007, G.T.D. Wilmore, 2001.
- ‡159/2.3. *SISYRINCHIUM CALIFORNICUM* *c100, Clyde Is. (Arran): 100+ plants in boggy/marshy area between the path and sea, raised beach by Creag nam Maol, NS008479, A.R. Church & P. Mackie, 1998.
- ‡159/2.5. *SISYRINCHIUM STRIATUM* *c41, Glam.: Several flowering plants, source unknown, as pavement weed near Guildhall, Swansea, SS643923, A.S. Lewis, 2004.
- ‡159/5.1. *IRIS GERMANICA* *11, S. Hants.: Grassland, The Folly, Broughton, SU297327, R.M. Veall, 2004.
- ‡159/5.4. *IRIS VERSICOLOR* *11, S. Hants.: Single clump in tall marsh vegetation on N side of bog close to main watercourse, about 40m E of causeway N of Greenberry bridge, Avon Water, Holmsley Bog, New Forest, SU219017, M E Young, 2004, conf. M. Rand. *44, Carms.: Three plants in small area of flushed tall fen under broadleaved trees dominated by *I. pseudacorus*, by Nant Mwrwg, Llangennech, SN557016, R.D. Pryce & K.A. Cottingham, 2002, NMW, det. G. Hutchinson.
- ‡159/5.7. *IRIS ORIENTALIS* *c69, Westmorland: Behind the beach, Earnse Point, Walney Island, SD160170, G.A. Lines, 2004. Photo in LANC.
- ‡159/5.ung. *IRIS UNGUICULARIS* *49, Caerns.: Limestone grassland, near St Petrock's, Great Orme, SH7682, W. McCarthy, 2004. 1st Welsh record.
- ‡159/8.1. *CROCUS VERNUS* *42, Brecks.: Churchyard, Lower Chapel, SO028358, M. & C. Porter, 2002. *c81, Berwicks.: Amenity area by Chirnside, NT877567, M.E. Braithwaite, 2004. Planted.
- ‡159/8.2. *CROCUS TOMMASINIANUS* *42, Brecks.: Lane verge, Llangynidr, SO166197, M. & C. Porter, 2003. *49, Caerns.: One plant on road-verge, with household waste, near Deiniolen, SH5964, S.P. Chambers, 2004. *81, Berwicks.: Roadside scrub, Birgham, Eccles road, NT788392, M.E. Braithwaite, 2004. Well naturalised.
- ‡159/8.3. *CROCUS NUDIFLORUS* *85, Fife: Old deciduous woodland, former Raith Estate, Kirkcaldy, NT271914, G.H. Ballantyne, 2004. Long existing in some quantity but not observed to flower until 2004.
- ‡159/8.6. *CROCUS CHRYSANTHUS* *68, N. Northumb.: Near farmhouse, Berrington Law area, NT989438, J. O'Reilly, 2003. Planted with other bulbs.
- ‡159/8.ang×7. *CROCUS* ×*STELLARIS* (*C. ANGUSTIFOLIUS* × *C. FLAVUS*) *42, Brecks.: Grassland, churchyard, Ystradgynlais, SN787100, M. & C. Porter, 2004. *c81, Berwicks.: Parkland, Hirsell Cow Arch, NT828408, M.E. Braithwaite, 2004. Small clumps from planting.
- ‡160/4.1. *PHORMIUM TENAX* *41, Glam.: Self-sown, mature plants on sea cliff, Little Langland, Mumbles, SS609874, A.S. Lewis, 2004. 1st Welsh record. *H12, Co. Wexford: Clump on waste ground, Tagoat, T104113, P.R. Green, 2003.
- 162/5.1. *NEOTTIA NIDUS-AVIS* *52, Anglesey: Under beech trees near Menai Bridge, SH560728, A. & M. Robinson, 2004. C.18 spikes counted by N. Brown & I.R. Bonner.
- 162/7.1. *SPIRANTHES SPIRALIS* 63, S.W. Yorks.: Marr Hills & Holes, SE5105, G.T.D. Wilmore, 2004. 1st record since 1970.
- 162/16.1c. *GYMNADENIA CONOPSEA* subsp. *BOREALIS* 108, W. Sutherland: Tongue village, NC5856, A.J. Silverside, 1995. 1st record since 1970. 108, W. Sutherland: Roadside bank above Bagh Chalbacaith, Coldbackie, NC611600, A.J. Silverside, 2002.
- 162/16.1×18.2. ×*DACTYLODENIA LEGRANDIANA* (*GYMNADENIA CONOPSEA* × *DACTYLORHIZA MACULATA*) 49, Caerns.: Flushed grassland, near Afon Dulyn, Rowen, SH7468, W. McCarthy, 2004, conf. L.T. Colley. 1st record since 1970.
- 162/17.1×18.1. ×*DACTYLOGLOSSUM MIXTUM* (*COELOGLOSSUM VIRIDE* × *DACTYLORHIZA FUCHSI*) 33, E. Gloucs.: Single spike in Jurassic limestone grassland, SO989234, M.J. Lush & S. Toogood, 2004, conf. M.A.R. Kitchen. 3 spikes recorded here in 1966 but not since. Only v.c. locality.

162/18.1×2. DACTYLORHIZA ×TRANSIENS (D. FUCHSII × D. MACULATA) *100, Clyde Is. (Arran): Corrie cravie, NR9223, A.R. Church, 1991.

162/18.1×5. DACTYLORHIZA ×VENUSTA (D. FUCHSII × D. PURPURELLA) *100, Clyde Is. (Arran): Dippin, NS02, BSBI Field Meeting, 1987.

162/18.2×4. DACTYLORHIZA ×HALLII (D. MACULATA × D. PRAETERMISSA) *40, Salop: Flood meadow, Whiston, SJ784025, S.J. Whild, H.V. Hughes & A.J. Lockton, 2004, herb. S.J.W., conf. R.M. Burton.

162/18.2×5. DACTYLORHIZA ×FORMOSA (D. MACULATA × D. PURPURELLA) ■ 108, W. Sutherland: Wet grassland, Invernaver NNR, NC686609, P.A. & I.M. Evans, 2003. Noted on Site Condition Monitoring Survey.

162/18.3a. DACTYLORHIZA INCARNATA subsp. INCARNATA *38, Warks.: Wet grassland, Depper's Bridge, Harbury, SP400593, D.L. Cole & L. Slack, 2002, det. J.R. Roberts. Colour slide seen by J.W. Partridge.

162/18.3×4. DACTYLORHIZA ×WINTONI (D. INCARNATA × D. PRAETERMISSA) *38, Warks.: With both parents in wet grassland, Depper's Bridge, Harbury, SP400593, J.R. & V.S. Roberts, 2002. Colour slide seen by J.W. Partridge.

Obituaries

DEREK ALMEY RATCLIFFE (1929–2005)

Derek Ratcliffe was one of the outstanding naturalists of the past 50 years. Not only was he a superb field worker, but he was also an eloquent and persuasive writer, a formidable debater, an encouraging boss and very much a human being. His overall contribution to ecology and conservation cannot be overlooked or disregarded.

Derek came, as he would say, from humble beginnings. Although he was born in London, his family soon moved north towards Carlisle and that is the place he considered his first real home. He soon began to explore the Lakeland hills and having covered most of this area, turned his attention to the Scottish Highlands and then the Welsh mountains. Like many other naturalists, he was encouraged and enthused by a local teacher and members of the local natural history society, but his own determination and energy was apparent in his teens, when he often used to cycle and walk miles through Dumfries and Galloway. There he discovered the wild areas where animals and plants existed in abundance and he could learn about their behaviour and requirements.

He went to Sheffield University initially to study zoology, but changed to botany after being inspired by Roy Clapham. His PhD at Bangor was on the mountain vegetation of Snowdonia.

Derek then did his stint of National Service in the Army, where he met John Mitchell and they used to accompany each other on field excursions. Derek's detailed notebooks started from an early age and he encouraged John to write down his observations which led to many papers and a *New Naturalist*.

Then in 1956 Derek obtained a job with the Nature Conservancy based in Edinburgh. His remit was to survey the vegetation of the Scottish Highlands. Whilst this might have intimidated many people, it was just the sort of opportunity Derek relished. As many present day ecologists know, there are not many parts of the British Isles that he did not visit to search out new sites for plants and animals, photograph and record in detail, providing an excellent basis for future observations and monitoring.



Derek Ratcliffe recording Military Orchids in Suffolk in 1984.

During his Scottish explorations his co-worker was Donald McVean and together they wrote the *Plant Communities of the Scottish Highlands* in 1962. But his observations were not restricted to plants and he had already begun his study of the peregrine falcon and ravens.

Derek relocated to the new station at Monks Wood near Huntingdon to lead the first national survey of peregrines in Britain and Ireland. It was there that I first met him when he fleetingly appeared between field trips and I often wondered where this very knowledgeable man was about to explore on his next expedition into the British countryside. All was revealed with the publication in 1977 of the *Nature Conservation Review*, which is still one of the most authoritative sources of the most important sites for conservation. New concepts of naturalness, diversity and fragility were included which described the cornerstones of site selection and rationale. In producing the SSSI Guidelines we debated the importance of mosaic sites where areas did not fit neatly into

habitat categories, but were of undoubted interest. We finally concluded that the sum of the individual elements on these sites added up to a greater value than those sites which had just one main habitat.

Derek became deputy director (science) of the Nature Conservancy from 1970–73 and then the chief scientist of the Nature Conservancy Council until his retirement in 1989. One of his special contributions was in defence of the Flow Country – the large unspoilt tract of peatland in Caithness and Sutherland. These areas became prime targets for investment and tax evasion for pop stars and others. It was also viewed initially as a sensible use of a wilderness area. Derek mobilised his team to collect the scientific evidence and masterminded the production of the report. But more importantly, he clinically presented the eventually undisputed evidence that led to the cessation of conifer planting on these fragile areas.

Just after this, the NCC was split up into the different country agencies and The Joint Nature Conservation Committee, a fact that the then chairman of the NCC, Sir William Wilkinson, sought to hide from him, as he knew that he would feel it a divisive step in conservation terms.

In 'retirement' Derek continued to write landmark books, many in the *New Naturalist* series, *The Peregrine*, *The Raven* and *The Lake District*. He spent many of the summer months touring Norway and Sweden, with Jeanette, his wife, closely observing and enjoying the wildlife, resulting in his latest book on Lapland.

Derek left us suddenly, when about to set off on another summer's tour of Scandinavia, but he leaves us with so much to remember him by. The many readable, informative, erudite volumes, which eloquently describe his enthusiasm for the natural world and explain its continuing value to us today, are just part of his legacy. Although he was perceived by many as a quiet, droll man, to those who were fortunate enough to have time to know him and especially to be with him in the field, he was a total inspiration, an amusing companion, with a depth of knowledge that one felt privileged to share. He has succoured a new generation of ecologists and conservationists who continue to uphold the principles which he held so dear. There is no doubt that future generations will have the opportunity to discover one of Britain's best natural treasures – Derek Ratcliffe.

LYNNE FARRELL

RICHARD CHARLES PALMER 1935–2005

Richard Palmer was born on 21 June 1935 and died at a nursing home in Dorchester, Dorset on 29 March 2005. He became a scholar at Eton College before coming to read Classics at University College, Oxford in 1953 and obtained a first in Mods in 1955 and a second in Greats in 1957.

Richard worked on Oxford dictionaries for 42 years and colleagues respected him as a quiet, conscientious old-style lexicographer with a sense of humour. He worked on the *Oxford Latin Dictionary* until editorial work ended in 1981; he then contributed to the *Supplement to the Oxford English Dictionary*, from 1984 to the shorter *Oxford English Dictionary*, and finally to the revision of the *Full Oxford English Dictionary*, retiring in 2000. The OED had benefited greatly from his botanical knowledge, which found expression in many definitions in this area.

With his severe stammer, which he had difficulty in overcoming, Richard was a shy and private person. This did not stop him from

being a churchgoer and sidesman, being good company with close friends and children, and being generous to the less well-to-do.

Nor did it prevent some brilliant achievements as a botanist. Here he was meticulous, painstaking and thoroughly sound: I came to accept for the *Flora of Oxfordshire* a record tentatively identified by him more readily than firm claims from almost anybody else. His careful observation elucidated some difficult plants such as pondweeds, sedges and hybrid foxtails and docks and, through his grasp of the literature, many unusual aliens. He found Britain's first *Elodea nuttallii* (Nuttall's Waterweed) and refound *Equisetum sylvaticum* (Wood Horsetail), seen by Baxter in 1825–1826 but deemed extinct by Druce. Good as his own judgement was, he referred an unbelievable number of his difficult finds to the acknowledged experts.

His many records came to me ordered alphabetically or by date or tetrad; this was true for his own findings and for the abstracts he

made from the Botanical Exchange Club reports which helped to fill a serious gap in the history of Oxfordshire botany. He recorded in 180 tetrads in the county, an amazing achievement when he relied on public transport to reach almost all of them. He loved natural and above all wetland habitats; I remember on a joint excursion, after we had identified several rewarding aliens and plants of man-made habitats, his obvious pleasure on moving on to a marshy stream.

Perhaps his finest achievement relates to Shetland. During a visit to Scalloway in 1955 he met Walter Scott and they soon conceived the idea of a joint Shetland flora. It was preceded by a check list, a stream of records in *Proc. BSBI* and *Watsonia*, and a contribution to *New Naturalist* 64. They brought different skills to the Flora, Richard his sharp taxonomic skill, evident especially with sedges, grasses, dandelions and eyebrights, his extensive study of herbaria and libraries, and exhaustive study of the originals of references. Walter contributed more practical aspects including producing the MS and typescript, and enlisting a sympathetic local publisher.

In 1987 after 29 years' gestation "*The flowering plants and ferns of the Shetland Islands*" was timely in view of growing threats from the oil industry and farming, and because as it said "nature conservation has got off to a bad start". It documented 827 species including every thing from natives to critical species (13 endemic *Hieracium* (hawkweeds)) to casuals and garden plants. But it is far, far more than a

catalogue; it is a great book to browse. Among the more discursive accounts are variation in *Juncus bulbosus* (Bulbous Rush), a very full key to *Galeopsis tetrahit* and *G. bifida* (the hemp-nettles), the colour patterns of four *Mimulus* (monkeyflowers) and the decline of rowan and oysterplant due to sheep grazing. *Cerastium nigrescens* ssp. *nigrescens* (Shetland mouse-ear) gets three pages. The book was a great success, fully sold out, with second-hand copies now at a premium.

To the Fielding-Druce herbarium in Oxford (OXF) he left a legacy and over 1100 excellent UK specimens, mostly from Oxfordshire but also from Shetland, Cornwall, Sussex and elsewhere. His annotations, in a graceful, highly legible hand, always cited the date, nearby landmarks and tetrad but not the now-fashionable 6-figure grid references, and he never took to computers. There were 50 sheets were of dandelions with the colours of leaves, stems, and styles carefully noted. About 290 foreign plants included 140 from the Balearics and 91 from Turkey. A by-product of his knowledge of Latin was his help to many Oxford post-graduate students in writing Latin descriptions of new taxa. From 1988 onwards, over 1600 Shetland specimens, nearly all gathered by the two authors, were presented to the South London Botanical Institute. The Institute wrote: "their value lies not only in the care with which the specimens have been identified and mounted, but in the detailed notes on the habitats and ecology"

JOHN KILLICK

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Submission of manuscripts

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Plant Records: the appropriate vice-county recorder, who should then send them to Dr C. D. Preston, Biological Records Centre, Monks Wood, Abbots Ripton, Huntingdon, PE17 2LS.
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D. R. McKean, M. S. Porter, C. D. Preston, M. N. Sanford



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The cover illustration of *Meconopsis cambrica* (L.) Viguier (Welsh Poppy) was drawn by Rosemary Wise.

Notes on the water-starworts (*Callitriche*) recorded in Europe

R. V. LANSDOWN*

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ABSTRACT

This article provides information on the nomenclature and taxonomy of some species of water-starwort (*Callitriche*) that have been reported from Europe. In addition, wherever possible names are typified. Two subspecies of *C. hermaphroditica* L. are recognised; the taxonomic status of *C. hamulata* Kütz. ex Koch and *C. brutia* Petagna is revised; and a new species, *C. brevistyla*, currently known only from a commercial greenhouse in Sweden, is described.

KEYWORDS: *Callitriche*, taxonomy, synonymy, typification.

INTRODUCTION

This article presents information on the taxonomy and nomenclature of water-starworts (*Callitriche*) recorded in Europe. Data were collected from herbarium material (BM, CGE, K, L, LE, NMW, NY, P, SEV), a total of 15 taxa grown in cultivation and from wild populations in France, Portugal, Spain and the UK (specimens deposited in NMW). The water-starworts are a poorly studied genus. The one monographic account of all known taxa was published in the 19th century (Hegelmaier 1864 *et seq.*). Since then a single thorough review of information available on the European members of the genus has been published (Schotsman 1967) and subsequently a certain amount of important information has been published in a wide variety of journals (e.g. Schotsman 1968 *et seq.*; Martinsson 1985 *et seq.*; Lansdown & Jarvis 2004).

For the sake of clarity, I have used few abbreviations; authors of plant names follow Brummitt & Powell (1992); the standard acronyms for herbaria of the world follow Holmgren & Holmgren (2005) and the symbol ! following details of a specimen indicates that I have personally verified its identification. For the purposes of this article the definition of Europe follows Tutin *et al.* (1993). Where possible, I have clarified

synonymy myself; where I have not been able to confirm details, I have in some cases accepted the synonymy established by others. In these cases, this is indicated by the term “*fide*” and with the source listed.

INDIGENOUS EUROPEAN TAXA

Callitriche hermaphroditica L., *Centuria I Plant*: 31 (Feb. 1755).

Lectotype (Lansdown & Jarvis 2004): Middle two specimens on sheet 13.1 (LINN!).

Synonymy:

C. palustris var. *bifida* L. *Sp. Pl.* 2: 969 (1 May 1753) (Lansdown & Jarvis 2004). *Lectotype* not designated (Lansdown & Jarvis 2004).

C. autumnalis L., *Fl. Suecica* ed. 2: 2 (Oct. 1755). *Lectotype* (Lansdown & Jarvis 2004): Middle two specimens on sheet 13.1 (LINN!).

C. angustifolia Gilib. *Exerc. Phyc.*: 421 (1792). Illegitimate superfluous name. *Lectotype* (Lansdown & Jarvis 2004): Middle two specimens on sheet 13.1 (LINN!) designated here.

C. sessilis var. δ DC. in Lam. & DC. (1805). *Fl. Franc.*, éd. 3, 4: 414–415. Illegitimate superfluous name. *Lectotype* (Lansdown & Jarvis 2004): Middle two specimens on sheet 13.1 (LINN!) designated here.

C. bifida (L.) Morong, *Mem. Torrey Bot. Club* 5: 215 (1894); basionym: *C. palustris* var. *bifida* L. *Sp. Pl.* 2: 969 1 May 1753.

C. aquatica subsp. *autumnalis* (L.) Bonnier *Fl. Comp. Fr.* 4: 35 (1921). Basionym: *C. autumnalis* L., *Fl. Suecica* ed. 2: 2 (Oct. 1755).

C. hermaphroditica L. var. *bicarpellaris* (Fenley) Mason in H. Mason, *Fl. Calif.*: 557 (1957) *Holotype*: Mason, H.L. 4445 3 May 1928; USA. San Joaquin County, four miles north of Clementes. (GH No: 110063974.48919); Basionym: *C. autumnalis* L. var. *bicarpellaris* Fenley 1936 in *Jeps. Fl. Calif.* 2: 436.

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Gilibert (1792) described two taxa, *C. angustifolia*, citing *C. autumnalis* L. as a synonym and *C. latifolia* citing *C. verna* L. as a synonym, but linking neither name to specimens. The names must therefore be based on the types of Linnaeus' names. I have designated here the lectotype of *C. hermaphroditica* L. as the type of *C. angustifolia* Gilib. and that of *C. palustris* L. as the type of *C. latifolia* Gilib. Similarly, De Candolle (in Lamarck & De Candolle 1805) separated all *Callitriche* into two species: *C. sessilis* with four varieties and *C. pedunculata*. He listed *C. verna* L. as a synonym of his var. α and *C. autumnalis* as a synonym of his var. δ with his other varieties synonymised to other non-Linnaean taxa. These two varieties must therefore be based on the types of Linnaeus' names. I have designated here the lectotype of *C. hermaphroditica* L. as the type of *C. sessilis* var. δ DC. and that of *C. palustris* L. as the type of *C. sessilis* var. α DC.

Previous authors have noted that the species described by Linnaeus as *C. hermaphroditica* shows strong variation in fruit size (Hegelmaier 1867; Schotsman 1958, 1967; Martinsson 1991) and that it probably represents more than one taxonomic entity. Martinsson (1991a) noted three forms of fruits: a large-fruited form, a small-fruited form and a form lacking lignification in the wing which she termed 'aberrant'. There are two clearly distinct taxonomic entities which vary principally in the size of the fruits but also in gross morphology. The differences are consistent between populations. When fruits are dried, the sizes of the two forms scarcely overlap, but there is greater overlap in fresh fruits. The plant with larger fruits was formally recognised as forma *macrocarpa* by Hegelmaier (1867) under *C. autumnalis* L. The plants with fruits lacking lignified cells described by Martinsson (1991a) appear to fall within one or other of the two groups separated on fruit size and I consider that they represent variation within the species as a whole.

C. hermaphroditica L. subsp. *macrocarpa* (Hegelm.) Lansdown, **comb. nov.**

Basionym: *C. autumnalis* forma *macrocarpa* Hegelm., *Verh. Bot. Ver. Brandenburg* 9: 35 (1867).

Holotype: "*Callitriche autumnalis*, Anglesea, Anglia from Charles Babington" (MEL).

Var. *macrocarpa* can be separated from var. *hermaphroditica* by measurement of the dried fruits which are (1.5–)1.6–2.4 $\times$ (1.6–)1.7–2.8

(–3) mm with the wing 0.2–0.7 (–0.8) mm, whereas those of var. *hermaphroditica* are 1.2–1.6 (–1.7) $\times$ 1.2–1.7 mm with the wing 0.1–0.4 mm wide.

The type material was described by Hegelmaier (1867: 35) as "Frucht sehr gross, sehr breit geflügelt [Fruit very large, very broadly winged]" and cited as "Insel Anglesea (Babingt. In Hb. Sond.);" it is in Sonder's herbarium in MEL, and has fruit up to 2.3 mm wide and 2.2 mm long (N. Walsh pers. comm.). In addition to the label by Babington, it has a hand-written note in German by Hegelmaier. C.C. Babington apparently made three collecting trips to Anglesey (Babington 1897) and his herbarium in CGE includes three specimens of *C. hermaphroditica* subsp. *macrocarpa*, one of which has two labels; "Llanfaillog, Anglesey Aug. 1830, W. Wilson" and "Llyn Maelog, Anglesea Aug. 1835 Ex. herb. C. C. Babington". Wilson collected a lot of specimens for Babington (G. Murrell pers. comm.) and it is likely that the material was collected by Wilson for Babington, who then passed a part to Hegelmaier. It is likely, therefore, that this represents an isotype of the material cited by Hegelmaier in Sonder's herbarium; however the latter has no information by which to confirm this.

Callitriche truncata Guss., *Pl. Rar.*: 4, t. 2, f. 2 (1826)

No type has been designated, however it is possible that one could be located through further work.

Synonymy:

C. cruciata Lebel, *Mém. Soc. Imp. Sc. Nat. de Cherbourg* 9: 43 (1863) *nom. nud.* *fide* Schotsman (1967).

C. amblycarpa Scheidw. (1866) in sched. (BRLU, WU) not effectively published, *fide* Hegelmaier (1864).

C. graminea Link in Spreng., *Jahrb. Gew.* 3: 31 (1818–1820); in sched. (Hb. Berol.) *nom. nud.* *fide* Schotsman (1967).

Callitriche autumnalis L. subsp. *truncata* (Guss.) Arcangeli *Comp. Fl. Ital.*: 613 (1882); *Basionym:* *C. truncata* Guss., *Pl. Rar.*: 4, t. 2, f. 2 (1826).

C. aquatica subsp. *truncata* (Guss.) Bonnier *Fl. Comp. Fr.* 4: 35 (1921). *Basionym:* *C. truncata* Guss., *Pl. Rar.*: 4, t. 2, f. 2 (1826).

Callitriche palustris L. var. *truncata* (Guss.) Fiori *Nouv. Fl. Anal. Ital.* 2: 192 (1926); *Basionym:* *C. truncata* Guss., *Pl. Rar.*: 4, t. 2, f. 2 (1826).

C. hermaphroditica subsp. *truncata* (Le Gall) Jahandiez & Maire Catal. *Pl. Maroc*. 2: 470 (1932). Basionym: *C. truncata* Guss., *Pl. Rar.*: 4, t. 2, f. 2 (1826).

C. truncata has been separated from other taxa by the combination of uniform, single-veined leaves; translucent, unornamented pollen; lack of stem and leaf scales; and the width of the fruit being greater than its height. It has also been separated on the basis of exclusively submerged reproduction, although terrestrial plants have recently been shown to produce mature fruit (Lansdown 1999). Schotsman (1967) reviewed herbarium material from throughout Europe and western Asia and separated material with these features into three subspecies: subsp. *truncata* in which the fruits are clearly winged; subsp. *occidentalis* (Rouy) Schotsm., in which the fruits lack a wing; and subsp. *fimbriata* Schotsm., in which the fruits are winged, but the wing is reduced to a fringe of whitish 'hairs'. Subsequently the latter was elevated to species rank as *C. fimbriata* Tzvelev (1975).

The 'hairs' described as fringing the ripe fruits of var. *fimbriata* by Schotsman are actually the fibrils (see Schotsman 1967 Plate F). On many taxa, the outer wall of the wing cells breaks down after the fruits have fallen from the plant, leaving the fibrils resembling a fringe of hairs. However, *C. truncata* subsp. *fimbriata* Schotsm. appears to be the only *Callitriche* in which this occurs before fruits fall. Before degradation of the cell walls, the fruits of this taxon strongly resemble those of *C. truncata* subsp. *truncata*. In fact, the differences between *C. truncata* subsp. *truncata* and subsp. *occidentalis* are greater than those between *C. truncata* subsp. *truncata* and *C. truncata* subsp. *fimbriata*. Accordingly this taxon is returned here to subspecific status within *C. truncata* and all three subspecies are recognised.

Callitriche truncata* subsp. *fimbriata Schotsm., *Les Callitriches: Esp. Fr. et nouv.*: 39 (1967).

Holotype: Sarepta (USSR), 1894. Becker. (P!).

Synonymy:

C. fimbriata (Schotsm.) Tzvelev, *Nov. Syst. Pl. Vasc.* 12: 237 (1975).

Callitriche truncata* subsp. *occidentalis (Rouy) Schotsm., *Les Callitriches: Esp. Fr. et nouv.*: 39 (1967).

Lectotype: Schultz, herb. norm. 658. Vallée de

la Taute à Carentan (Manche), 31-5-1863. Lebel. P (not seen).

Synonymy:

C. truncata proles *occidentalis* Rouy 1910. *Fl. Fr.*, 12: 186 (1910); *Basionym*: *C. truncata* subsp. *occidentalis* (Rouy) Schotsm., *Les Callitriches: Esp. Fr. et nouv.*: 39 (1967).

C. truncata race *occidentalis* (Rouy) Br.-Bl. *Bull. Soc. Linn. Lyon, nouv. sér.*, 75: 17 (1929); *Basionym*: *C. truncata* subsp. *occidentalis* (Rouy) Schotsm., *Les Callitriches: Esp. Fr. et nouv.*: 39 (1967).

Callitriche lusitanica Schotsm. *Bol. Soc. Brot.* 35: 95–127, figs. 1, 2, and 3 (1961).

Holotype: Castelo Branco, rib. Ponsul, VI-1881. A.R. Da Cunha s. n. (LISU).

Synonymy:

C. clausonis Hegelm. in sched. based on: Herb. E. Cosson 18; Bou Ismaël, près Koléah, prov. D'Alger, Clauson (P!).

C. hermaphroditica L. subsp. *clausonis* Maire ex Quézel & Santa, *Nouv. Fl. Algérie* 2: 608 (1963) *nom. inval.* without latin description.

In the herbarium of the Muséum National d'Histoire Naturelle, Paris there is a specimen from the herbarium of E. Cosson (details above) which bears a handwritten label by F. Hegelmaier. The label is difficult to read and my transcription does not agree entirely with that of Schotsman (1977: 14). My transcription is as follows: "Plantula maxime insignis, a me huc usque non visa ideoque, ut videtur rarissima, *C. autumnalis* L. et *C. truncata* Guss. affinis, sed ab utraque diversissima et haud dubia, nisi forte cum *C. capillaris* Parlat. (quam nondum vidi) convenit nova speciei nomma *C. clausoni* salutanda". This can be translated as "An extremely remarkable little plant, not seen hitherto and therefore, as it seems, very rare, akin to *C. autumnalis* L. (= *C. hermaphroditica* L.) and *C. truncata* Guss. but very different from either and, unless perhaps it agrees with *C. capillaris* Parlat. (= *C. brutia* Petagna) (which I have not yet seen), no doubt to be recognised with the name of a new species, *C. clausoni*." (translated by P. Oswald).

Schotsman (1977) stated that the name *C. clausoni* appeared only on the herbarium label and so was not effectively published. She considered that the size of the fruits and width of the wing, combined with the lack of lignification of wing cells were such that she

could not determine the specimen as *C. lusitanica* with absolute confidence. Schotsman annotated the herbarium sheet with the following: "1 mm breed, 0.6 mm hoog, 0.9 mm hoog, breed 1-1.2 mm" [which I take to mean: 1 mm wide, 0.6 mm high, 0.9 mm high, width 1-1.2 mm]. This presumably refers to measurement of two fruits and would give a range of 1-1.2 mm wide $\times$ 0.6-0.9 mm high. Measurement of 53 fresh fruits on specimens of *C. lusitanica* from Spain and Portugal gives a range of 1.2-1.9 mm wide $\times$ 1-1.4 mm high. As noted by Schotsman, the Bou Ismaël material is sparse and composed of only a few shoots bearing flowers and a few fruits which are largely unripe. Even the ripest fruits do not appear fully mature, which may explain the lack of lignification (this becomes apparent only as fruits ripen). This, together with the fact that *Callitriche* fruits shrink on drying, suggests that, although smaller than the fresh fruits measured, these measurements cannot be regarded as significantly different. I do not consider that the differences are sufficient to justify treating this material as a different taxonomic entity from *C. lusitanica* Schotsm. Apart from discussion of this specimen by Schotsman (1967, 1977) the only other reference that I have found to the name *C. clausonis* is that in Quézel & Santa (1963), who gave only a French description which did not validate the name.

Callitriche stagnalis Scop. *Fl. Carniolica.*, ed. 2: 251, n. 1202 (1772).

Neotype: Aberleri Fields, Borth, Cards 22/61209160, 20 July 1998, Chater, A. O. (NMW); designated here.

Synonymy:

C. stagnalis Scop. α and β *vulgaris* Kütz. in Reichenb., *Ic. Plant. Crit.* cent. 9: 36 (1831). *Holotype*: Germany, Schleusingen rec. 1865, W. F. R. Suringar, (L! Sheet No: 91017286 L0486887).

C. palustris subsp. *stagnalis*: (Scop.) Schinz & Thell. *Fl. Schweiz*, ed. 2, 1: 322 (1905). *Basionym*: *C. stagnalis* Scop. *Fl. Carniolica.*, ed. 2: 251, n. 1202 (1772).

C. tholeyreanum Gandoger, in sched. (BC, G) *fide* Schotsman (1967).

Schotsman (1967) stated that "malheureusement l'herbier de Haller (P) ne contient pas de *Callitriche* portant l'indication "Stellaria foliis omnibus subrotundis" et, parmi les échantillons présents, on n'y trouve aucune plante qui montre nettement les caractères de *C. stagnalis*" [unfortunately the Haller herbarium (P) does not contain *Callitriche* labelled "*Stellaria foliis omnibus subrotundis*"

and the samples present do not include plants which clearly show the characters of *C. stagnalis*]. She concluded that Scopoli did base his diagnosis on the taxon that we call *C. stagnalis* but that there is no type specimen for *C. stagnalis* Scop. and that it was not yet possible to prove that material studied by Scopoli existed in collections. A neotype is therefore designated above.

Callitriche obtusangula Le Gall, *Fl. Morb.*: 202 (1852).

Neotype: Le Palais, Belle Ile en mer, Morbihan, 19 Aug. 1958, Raynal, J., Raynal, A. (P!); designated here.

Synonymy:

C. aquatica Hudson subsp. *obtusangula* (Le Gall) Bonnier *Fl. Comp. Fr.* 4: 35 (1921).

Basionym: *C. obtusangula* Le Gall, *Fl. Morb.*: 202 (1852).

C. palustris subsp. *obtusangula* (Le Gall) Jahandiez & Maire *Catal. Pl. Maroc.* 2: 470 (192). *Basionym*: *C. obtusangula* Le Gall, *Fl. Morb.*: 202 (1852).

There is apparently no designated type for *C. obtusangula* Le Gall. Le Gall did not cite one and it has not been possible to trace any of his specimens. The name is based on the statement "Je crois avoir vu dans le Morbihan un *Callitric* (sic) que j'ai souvent recueilli dans le département d'Ille-et-Vilaine. Il a les feuilles, les bractées et les stigmates du *C. des étangs*; (= *C. stagnalis* Scop.), mais il en diffère par le fruit dont les loges ne sont point en carène ailée, mais présentent un dos très obtus. *C. obtusangula* N. C'est au moins une var. fort remarquable du *Callitric* des étangs" [I believe that I have seen a *Callitriche* in the Morbihan that I have often collected in the Department of Ille-et-Vilaine. Its leaves, bracts and stigmas resemble those of the lake water-starwort (= *C. stagnalis* Scop.), but it differs in the fruits of which the edges are at most slightly winged and show a very blunt back. *C. obtusangula* N. It is at least a particularly remarkable variety of the lake water-starwort]. As noted by Schotsman (1967: 55) the description fits the species we now call *C. obtusangula*. Neither she nor I have been able to locate any specimens of this taxon determined by Le Gall. Schotsman (1967: 14) concluded that it was not yet possible to prove that material studied by Le Gall existed in collections. A neotype is therefore designated above.

Callitriche cophocarpa Sendtn., *Veg. Südbayerns*: 773 (March 1854).

Holotype: Wendelstein gegen die Spitzingalpe, 20-VIII-1851. Sendtner. M (isotype K!).

Synonymy:

C. platycarpa b *major* Kütz. *Linnaea* 7: 185 (1832). *Holotype*: Germany, Schleusingen (L! Sheet No: 91017284 L0486872).

C. platycarpa a *minor* Kütz., *Linnaea* 7: 185 (1832). *Holotype*: Germany, Schleusingen (L! Sheet No: 91017282 L0486873).

C. polymorpha Lönnr., *Observationes Crit. Plant. Suec.* (Diss. Uppsala) 19 (May 1854) (Schotsman 1967: 61) *Holotype*: "a.o. ex. Herb. Svanlund, (G)" *fide* Schotsman (1954)

C. transsilvanica Schur, *Enum. plant. trans*: 217 (1866) *Syntypes*: "no. 134 (?) 85" (P and BP) *fide* Schotsman (1967).

C. longistyla Norman, *Fl. Arct. Norv. Sp*: 28 (1893) *fide* Schotsman (1967).

C. palustris subsp. *polymorpha* (Lönnr.) Emberger & Maire *Catal. Pl. Maroc*, 4: 1066 (1941). *Basionym*: Lönnr., *Observationes Crit. Plant. Suec.* (1854).

Callitriche lenisulca Clav., *Actes Soc. Linn. Bordeaux*, 5è. sér., 4: 43 (1890).

Holotype: La Martière-en-Oléron (Char.-Inf.), Réau sheet No. 2847 (P!).

Synonymy:

C. stagnalis Kütz. forma *acroptera* Clavaud, *Bull. Soc. Rochel.*, 12: 45 (1890) *Lectotype*: La Martière-en-Oléron (Char.-Inf.) Réau. 2847 (P!); material annotated by me as *C. lenisulca*, designated here (see notes below).

C. acroptera (Clavaud) Rouy, *Fl. France* 12: 184 (1910).

C. lenisulca was initially described on the 16th April 1890 by Armand Clavaud in a presentation to the Linnaean Society of Bordeaux; an extract of which was published, including a description but no specimens (Clavaud 1890a) (Schotsman & Andreas 1974 Fig. 1–2). Clavaud died shortly after this presentation and never published a full account of *C. lenisulca* (Schotsman & Andreas 1974). The only other references to the name *C. lenisulca* are in an extract from a letter by Clavaud published in a catalogue of plants in the Bulletin of the Rochelaise Botanical Society (1890) (cited in Index Kewensis Add. Suppl. I 1906), under the account of *C. acroptera* Rouy (1910: 184) (see below) and in work by H. D. Schotsman (Schotsman 1967; Schotsman & Andreas 1974). Schotsman (1967) initially considered the plant described

by Clavaud to be *C. cophocarpa* Sendtn. However, a few years later she located live material of *C. lenisulca* and, revisiting Clavaud's herbarium material and illustrations, was able to confirm that his represented an otherwise undescribed species (Schotsman & Andreas 1974). She confirmed that that the account in Clavaud (1890a) constitutes valid publication of the name.

The catalogue of plants includes reference to two specimens (Schotsman & Andreas 1974: 14): 2847 La Martière-en-Oléron (Char.-Inf.) Réau and 2848 *C. lenisulca* Clavaud. St. Georges-d' Oléron (Char.-Inf.) Réau. Specimen No. 2847 is in the Herbarium of the Muséum National d'Histoire Naturelle, Paris (P). It comprises an intimate mixture of *C. lenisulca* Clav. and *C. stagnalis* Scop. According to Schotsman & Andreas (1974), No. 2848 is not *C. lenisulca* Clav., but *C. obtusangula* Le Gall.

Rouy (1910: 184) raised *C. stagnalis* forma *acroptera* Clavaud in *Bull. Soc. Rochel.*, 12 (1890: 45) to specific rank as *C. acroptera* Rouy, citing specimen No. 2847, following Clavaud in suggesting that it may be a hybrid between *C. lenisulca* (which Rouy called *C. verna*) and *C. stagnalis* Scop. His description is largely derived from the account of *C. lenisulca* in Clavaud (1890): "Fruits inégaux, souvent très petits, fréquemment mal venus; aile des loges sensiblement plus large au sommet que dans le reste de son étendue; pollen petit et très inégal, mêlé de grains complètement avortés" [fruits unequal, often very small, frequently poorly developed; wing often wider at the apex than on the remainder; pollen small and very unequal mixed with completely aborted grains]. The impression of unequal fruits is probably due to the combination of *C. stagnalis* Scop. and *C. lenisulca* on the same sheet.

Callitriche platycarpa Kütz. in Reichenb., *Ic. Plant. Crit.* cent. ix: 38 (1831).

Lectotype: Magdeburg, Germany, rec. 1865, W. F. R. Suringar (L Sheet No: 91017293).

Synonymy:

C. platycarpa b *latifolia* Kütz. in Reichenb., *Ic. Plant. Crit.* cent. 9: 41 (1831); *Holotype*: Germany, Schleusingen (L! Sheet No: 91017271 L0486879).

C. platycarpa γ *undulata* Kütz. in Reichenb., *Ic. Plant. Crit.* cent. 9: 39 (1831); *Holotype*: Germany, Schleusingen (L! Sheet No: 91017270 L0486880).

- C. platycarpa* δ *sterilis* Kütz. in Reichenb., *Ic. Plant. Crit.* cent. 9: 40 (1831); *Holotype*: Germany, Schleusingen (L! Sheet No: 91017291 L0486881).
- C. platycarpa* β *rigidula* Kütz. in Reichenb., *Ic. Plant. Crit.* cent. 9: 39 (1831); *Holotype*: Germany, Schleusingen (L! Sheet No: 91017272 L0486882).
- C. platycarpa* α *elongata* Kütz. in Reichenb., *Ic. Plant. Crit.* cent. 9: 41 (1831); *Holotype*: Germany, Schleusingen (L! Sheet No: 91017276 L0486883).
- C. aquatica* Hudson subsp. *platycarpa* (Kütz.) Bonnier & Layens *Fl. Fr.*: 106 (1894). *Basionym*: *C. platycarpa* Kütz. in Reichenb., *Ic. Plant. Crit.* cent. ix: 38 (1831)
- C. font-queri* Allorge, V. & Allorge, P. 1941. *Bull. Soc. Bot. France* 88: 242 *Holotype*: Spain, "In fossis turfaceis lente fluentibus infra lacu « Lago de Ausente » dicot, prope S. Isidro, regn. Legionensi, alt. Ca. 1,680 m." (P).
- In describing *C. font-queri* Allorge & Allorge (1941) cited differences between this, *C. verna* L. (= *C. palustris* L.) and *C. polymorpha* Lönnr. (= *C. cophocarpa* Sendtn.). Schotsman (1967: 70) reviewed the holotype and another specimen collected in the same locality by Lainz in 1961. She concluded that the plants were impoverished specimens of either *C. platycarpa* Kütz. or *C. cophocarpa* Sendtn. and noted that Lainz had collected a specimen of *C. platycarpa* from the Province de Santander in 1962, which she was able to confirm and which is to date the only confirmed specimen of this species from Spain. *C. cophocarpa* has not been confirmed as occurring nearer to Spain than north-western Italy. It therefore seems best to consider *C. font-queri* Allorge & Allorge as a synonym of *C. platycarpa* Kütz.
- Callitriche palustris* L., *Sp. Pl.* 2: 969 (1753)**
Lectotype (Lansdown & Jarvis 2004): Herb. Linnaeus, Sheet No. 13.1, lowermost three specimens (LINN!).
- Synonymy:**
- C. palustris* var. *minima* L., *Sp. Pl.* 2: 969 (1753). *Lectotype* (Lansdown & Jarvis 2004): 3 lower specimens on sheet 13.1 (LINN!).
- C. palustris* var. *natans* L., *Sp. Pl.* 2: 969 (1753). *Neotype* (Lansdown & Jarvis 2004): *C. verna* L. α *genuina* Kütz.; Germany, Schleusingen (L! Sheet No: 91017287 L0486889).
- C. androgyna* L., *Centuria I Pl.*: 31 (Feb. 1755). *Lectotype* (Lansdown & Jarvis 2004): 3 lower specimens on sheet 13.1 (LINN!).
- C. verna* L., *Fl. Suecica*, ed. 2: 2 (Oct. 1755). *Lectotype* (Lansdown & Jarvis 2004): Herb. Linn. 13. 2 (LINN!).
- C. fontana* Scop. *Fl. Carn.* ed. II. 2: 251, illegitimate superfluous name; *Lectotype*: 3 lower specimens on sheet 13.1 (LINN!) designated here.
- C. aquatica* Hudson, *Fl. Ang.* 2:439–440 (1778), illegitimate superfluous name; *Lectotype*: 3 lower specimens on sheet 13.1 (LINN!) designated here.
- C. latifolia* Gilib. *Exerc. Phyc.*: 421 (1792), illegitimate superfluous name. *Lectotype*: 3 lower specimens on sheet 13.1 (LINN!) designated here.
- C. sessilis* var. α DC. in Lam. & DC. *Fl. Franc.*, éd. 3, 4: 414–415 (1805), illegitimate superfluous name. *Lectotype*: 3 lower specimens on sheet 13.1 (LINN!) designated here.
- C. verna* L. α *fontana* Kütz. in Reichenb., *Ic. Plant. Crit.* cent. 9: 33 (1831); *Holotype*: Germany, Schleusingen (L! Sheet No: 91017287 L0486889).
- C. verna* L. β *stellata* Kütz. in Reichenb., *Ic. Plant. Crit.* cent. 9: 33 (1831) *Holotype* the same as *C. verna* L. α *fontana* Kütz.
- C. verna* L. δ *latifolia* Kütz., *Linnaea* 7: 178 (1832); *Holotype* the same as *C. verna* L. α *fontana* Kütz.
- C. caespitosa* Schultz *Prodr. Fl. Starg.* (1819); illegitimate superfluous name. *Lectotype*: 3 lower specimens on sheet 13.1 (LINN!) designated here.
- C. aquatica* δ *caespitosa* Willd. *Enum. Pl.* (1809). *Basionym*: *C. caespitosa* Schultz *Prodr. Fl. Starg.* (1819).
- C. pallens* Gray *Nat. Arr. Brit. Pl.* (1821); illegitimate superfluous name. *Lectotype*: 3 lower specimens on sheet 13.1 (LINN!) designated here.
- C. euverna* Syme *Engl. Bot.* ed. 3(8): 122 (1863), error on Figure label.
- C. verna* L. α *genuina* Kütz., (in sched. and litt.); *Holotype* the same as *C. verna* L. α *fontana* Kütz.
- Scopoli (1772) separated all *Callitriche* into two taxa: *C. fontana* and *C. stagnalis*, but without linking the names to specimens. As a synonym of *C. fontana*, he cited *Callitriche* (1) LINN. *Syst. Nat.* p. 52. In his *Systema naturae*, Linnaeus (1770) lists two taxa, *C. verna*

numbered 1 and *C. autumnalis*, numbered 2. *C. fontana* Scop. must therefore be based on *C. verna* L. (= *C. palustris* L.), with the same type. Hudson (1778) described *C. aquatica*, citing both *C. verna* L. and *C. autumnalis* L. as synonyms, citing *Species Plantarum* 6 but not linking the name to any specimens. The name must therefore be based on the type of one of Linnaeus' two taxa and I have therefore designated that of *C. palustris* L. (= *C. verna*) as the lectotype. The name *C. euverna* Syme is listed by The International Plant Names Index (2004, accessed 2006), however Syme (1963) describes the name as erroneously applied to the illustration on Plate MCCLXXI which should have been labelled *C. verna* L.

Callitriche brutia Petagna, *Institutiones Bot.*, 2: 10 (1787).

Lectotype: Calabria. Ex herb. Petagna (FI). (chosen by Schotsman 1967).

C. brutia and *C. hamulata* have a complex taxonomic history. They were first recognised as different from other taxa by Petagna in 1787. Subsequently the latter was recognised as distinct from *C. brutia* by Kützing (1831) as *C. autumnalis* L. σ *callophylla*. However, various authors have considered them as subspecies (e.g. Syme 1863), varieties (e.g. Babington 1862) or forms (Wahlenberg 1824–1826) of the same species.

Schotsman (1967) provided a detailed description of the morphology of both *C. brutia* Petagna and *C. hamulata* Kütz. ex Koch and carried out an extensive review of their known distribution. She concluded that they were distinct taxa, but that it was not possible to be certain that they were distinct species. "Il résulte de ce résumé que *C. brutia* est sans doute un taxon apparenté à *C. hamulata*. On pourrait se demander s'il agit ici de deux sous-espèces ou de deux espèces. Cependant, selon notre opinion, les différences sont telles que nous préférons considérer *C. brutia* et *C. hamulata* comme des espèces bien séparées." [*C. brutia* is undoubtedly closely related to *C. hamulata* and it is not clear whether they represent two species or two subspecies. In our opinion, the differences are such that we prefer to consider them as two clearly separate species] (Schotsman 1967). She treated them as separate species throughout her subsequent publications (Schotsman 1967 *et seq.*). However, she noted that "pour l'instant, il reste toujours des exemplaires de *C. brutia* et de *C. hamulata* difficiles ou impossibles à séparer, parce qu'à certaines phases

de leur développement, les deux espèces se ressemblent d'une façon telle, que la culture ou le comptage des chromosomes seulement pourrait nous procurer la solution." [there are still examples of *C. brutia* and *C. hamulata* that are difficult or impossible to separate. At certain stages of their development, the two species are so similar that they can only be separated through cultivation or chromosome counts] (Schotsman 1967). In a later publication (Duvigneaud & Schotsman 1977), she notes "la distinction entre certaines formes de *C. hamulata* et de *C. brutia* sera souvent impossible." [the distinction between certain forms of *C. hamulata* and *C. brutia* is often impossible] and "Un problème important reste à résoudre: celui de préciser la distinction entre *C. hamulata* et *C. brutia*. Très souvent en effet, sur du matériel d'herbier provenant de nos régions, il est impossible de distinguer avec certitude ces deux taxons" [the distinction between *C. hamulata* and *C. brutia* remains a problem that it is important to resolve. Very often material of the two taxa from our regions cannot be separated]. Schotsman gave the following identification features for these two taxa:

C. hamulata Kütz ex Koch. Material studied from Austria, Belgium, Czech Republic, Denmark, France, Germany, Hungary, Luxembourg, Poland, Sweden, Switzerland and United Kingdom.

Plant in general robust, often in running or fairly deep water. Linear leaves expanded toward the apex, with a deep notch in the form of an arc. Peltate scales in a circular disk of about 15 cells. Axillary scales have 5–8 longer cells. Fruits orbicular when viewed from the side. Mericarp narrowly winged. Structure of wing (see pl. XIV: IV 2). Fruits (of terrestrial form) sessile (Schotsman, 1967). Fruits suborbicular 1.2–1.5 mm long $\times$ 1.4 mm wide (Duvigneaud & Schotsman 1977).

C. brutia Petagna. Material studied from Belgium, Italy, Norway, Portugal, Sardinia, Spain and United Kingdom.

Plant delicate, in shallow, still water. Lower leaves very narrow, often slightly rigid. Notch irregular, more or less deep. Peltate scales often in an asymmetrical disk of 10–15 cells. Axillary scales with 4–5 fairly short cells. The shape of the fruits of *C. brutia* is less constant than that of the fruits of *C. hamulata*, varying from elliptic to circular (from the side). Mericarps often more broadly winged than those of *C. hamulata*. Structure of wing (compare with pl. XIII: IV 1 b). Fruits (of terrestrial form) clearly pedunculate

(Schotsman 1967). Fruits elliptic or sub-orbicular 1–1.4 mm long $\times$ 1–1.2 mm wide (Duvigneaud & Schotsman, 1977).

I collected and described material from 119 populations of the two taxa. As the aim of the work was to question and clarify identification features, I had to rely on unambiguous characters to identify material. The only apparently unambiguous characters for these two taxa are the long-pedunculate fruits of *C. brutia* and the chromosome numbers. Chromosome counts were not available for many populations and so the presence of long-pedunculate fruits was used to determine 55 populations from France, Ireland, Norway, Spain, Sweden, The Netherlands and the UK identifiable as *C. brutia*, leaving 64 populations that could not be attributed to *C. brutia*. Material of *C. brutia* was described in detail, including but not limited to those features described by Schotsman (1967 *et seq.*). The following features of particular note were recorded: number of peltate scale cells average 13.51 (7–20) [N = 106]; number of axillary scale cells average 6.24 (4–9) [N = 84]; fruit biometrics: width average 1.27 (0.74–1.62) mm [N = 84]; height average 1.23 (0.71–1.83) mm [N = 84]; wing width: side of fruits average 0.1 (0–0.8) mm [N = 146]; top of fruits average 0.13 (0.04–0.23) mm [N = 84].

This clearly shows that on plants that could be unambiguously identified as *C. brutia*, the ranges of all quantifiable parameters included values attributed by Schotsman to both *C. hamulata* and *C. brutia*. Other features are not quantified and the situation is further complicated by the fact that *C. brutia* tends to produce pedunculate fruits only when growing in a terrestrial form. In cultivation, the relative delicacy of plants was found to vary in relation to conditions, particularly water depth; it is therefore similarly too vague a feature on which to base taxonomic separation. The depth and shape of the notch and associated expanded leaf-apices is inconsistent; when terrestrial plants of *C. brutia* were submerged, leaf apices varied from narrowly to broadly expanded, but never produced the 'classic' apices considered typical of *C. hamulata*. However, these are only occasionally present on the latter, generally in fast-flowing water. The peltate scales of *Callitriche* are generally uniform, with a circular disk of few cells when young, gradually developing variation in shape as they mature. No consistency was found in the shape of the peltate scales of confirmed *C. brutia* or the length of axillary scale cells. Comparison of

the width and height of individual fruits showed that they varied from higher than wide to wider than high and, therefore, the relative proportions cannot be useful. Similarly, the features of the fibrils in the wing cells illustrated by Schotsman (1967) were found to vary not just between plants, but occasionally on the same fruit. In conclusion, none of the gross morphological features cited by Schotsman (1967 *et seq.*) for separation of *C. brutia* and *C. hamulata* are reliable. Even the long-pedunculate fruits are of uncertain value as *C. hamulata* is described as occasionally having pedunculate fruits (Schotsman 1967), while most plants of *C. brutia* with long-pedunculate fruits will have some that are subsessile.

During the study outlined above, isozymes were analysed from material from a number of the same populations by B. Demars at the University of Leicester. No difference was found between the isozymes of the two taxa, although those of all other British taxa were clearly different (Demars & Gornall 2003: 391), while Philbrick & Les (2000) found no molecular (*rbcL*) apomorphies that would distinguish the two taxa. Thus, the only consistent, unambiguous difference that can be confirmed between the two taxa is the difference in chromosome number ($2n = 28$ for *C. brutia* and $2n = 38$ for *C. hamulata* (Schotsman 1967 *inter alia*). There is no obvious way in which plants with $2n = 28$ and $2n = 38$ could evolve one from the other directly (C.A. Stace pers. comm.). However there are at least two plausible explanations as to how these could arise. A common base number in *Callitriche* is 5; it is possible that *C. brutia* is a hypoheptaploid and *C. hamulata* a hypooctoploid, where the numbers are derived through chromosome multiplication, followed by a loss of two chromosomes in each case. Alternatively, it is possible that the numbers evolved through hybridisation, which, although rare, is known to occur in *Callitriche* (Martinsson 1991), with subsequent backcrossing. Following this hypothesis, *C. brutia* has an allopolyploid origin from two parental species, one with $2n = 8$ and the other with $2n = 10$ chromosomes, with chromosome number doubling which restores fertility: $2n = 18$. Backcrossing with the parent with $2n = 10$, again with chromosome doubling achieves $2n = 28$. *C. hamulata* could then be produced if $2n = 28$ backcrossed again with a species with $2n = 10$, again involving chromosome doubling to derive $2n = 38$. Neither of these hypotheses can

be considered very likely and the true situation could only be explained through detailed cytological analysis. The isozyme evidence strongly suggests that *C. brutia* and *C. hamulata* share an identical chloroplast genome (R. J. Gornall, pers. comm.).

The two taxa are undoubtedly extremely close, and not reliably distinguishable in the field or herbarium except under particular environmental conditions, when *C. brutia* produces long-pedunculate fruits. Given the different chromosome numbers and the fact that only some plants appear to produce long-pedunculate fruits when they become terrestrial, it is not reasonable to combine the two taxa as one subspecies. Therefore, they are retained here as varieties of a single species. Schotsman (1967) showed that a plant described by Petagna (*Institutiones Botanicae* II, 9) in 1787 as *C. brutia*, and supported by good specimens, was clearly of this species and concluded that, if they were considered synonymous, *C. brutia* had priority over *C. hamulata* at species rank. Therefore the two taxa are considered here as varieties of *C. brutia* Petagna.

According to the International Code, Article 35.4 "if only one infraspecific rank is admitted, it is considered to be that of variety". However, Kützing (1831 *et seq.*) recognised four ranks below that of species but did not designate any of them as being at varietal rank. There is therefore no established name for this taxon at varietal level and I have applied the name *C. brutia* var. *hamulata*, with *C. hamulata* Kütz. ex. Koch as the basionym. Schotsman (1967: 92) designated a specimen which is now in the Leiden herbarium: labelled "*C. autumnalis* L. σ *callophylla* Kütz.; Germany, Schleusingen (L! Sheet No: 91017266 L0015953), as the lectotype of the name *C. hamulata* Kütz. ex. Koch.

C. brutia Petagna var. *brutia*

Synonymy:

- C. pedunculata* DC. In Lam. & DC., *Fl. Fr.*, éd. 3, 4: 415 (1805). *Holotype*: "3656. Pedunculata. Fructibus pedunculatis. In aquilegis Fontisbleaudi" (possible isotype P! see note below).
- C. hamulata* subsp. *pedunculata* (DC.) Syme *Engl. Bot. Ed. 3B* (1863). *Basionym*: *C. pedunculata* DC. In Lam. & DC., *Fl. Fr.*, éd. 3, 4: 415 (1805).
- C. capillaris* Parl., *Fl. It.* 4: 42 (1867) *Holotype*: "*Callitriche tenuifolia* (Fries ex

auctoris folio); – *hamulata* (*Fl. Sard?*); – *capillaris* Parl. (*Fl. It.*); Maddalena. Maggio 1861. (N. Genn.)" with another label saying "Da Gennari in Ott. 1861" (FI).

- C. aquatica* subsp. *pedunculata* (DC.) Bonnier *Fl. Comp. Fr.* 4 : 35 (1921). *Basionym*: *C. pedunculata* DC. In Lam. & DC., *Fl. Fr.*, éd. 3, 4: 415 (1805).
- C. palustris* subsp. *pedunculata* (DC.) Jahandiez & Maire *Catal. Pl. Maroc*, 2: 470 (1932). *Basionym*: *C. pedunculata* DC. In Lam. & DC., *Fl. Fr.*, éd. 3, 4: 415 (1805).

There is a specimen in the herbarium of the Muséum National d'Histoire Naturelle, Paris donated by A. P. De Candolle in 1822, on which the original label simply says "*Callitriche pedunculata* DC. Fontainebleau". It was annotated "serait-ce le type? ou un cotype?" [is this the type? or a cotype?] by H. D. Schotsman in 1967. Prof. G. G. Aymonin of the Museum suggests that the type is likely to be in Geneva (pers. comm. 2002), however, this material could represent an isotype. I was unable to locate the material cited by Schotsman (1967: 84).

C. brutia var. *hamulata* (Kütz. ex W. D. J. Koch) Lansdown, **comb. nov.**

Basionym: *C. hamulata* Kütz. ex W. D. J. Koch 1837 *Syn. Fl. Germ.* ed. 1: 246.

Lectotype: Germany, Schleusingen (L!) Sheet No: 91017266 (L0015953) designated here.

Synonymy:

- C. intermedia* Hoffm. *Fl. Germ. Ed.* 1:2 (1791); *type*: Schkuhr *Taschenbuch f.d. Erlangen*, t. 1, fig. e (1791) *Epitype*: River Wye, nr. Llangurig, 22/908797, 8 August 1995 (NMW); designated here.
- C. autumnalis* L. δ *goldbachii* Kütz. in Reichenb., *Ic. Plant. Crit.* cent. 9: 43 (1831) *Holotype*: Germany, Schleusingen (L! Sheet No: 91017260 L0486908).
- C. autumnalis* L. α *brutia* Kütz. in Reichenb., *Ic. Plant. Crit.* cent. 9: 45 (1831); *Holotype*: Germany, Schleusingen (L! Sheet No: 91017251 L0486892).
- C. autumnalis* L. δ *minuta*, Forma b. *halleri* Kütz. in Reichenb., *Ic. Plant. Crit.* cent. 9: 44 (1831); *Holotype*: Germany, Schleusingen (L! Sheet No: 91017267 L0486893).
- C. autumnalis* L. τ *callophylla* Kütz. in Reichenb., *Ic. Plant. Crit.* cent. 9: 44 (1831); *Holotype*: Germany, Schleusingen (L! Sheet No: 91017266 L0015953).

- C. autumnalis* L. α *lacustris* Kütz. in Reichenb., *Ic. Plant. Crit.* cent. 9: 44 (1831); *Holotype*: Germany, Schleusingen (L! Sheet No: 91017266 L0015953).
- C. autumnalis* L. α *heterophylla* Kütz., *Linnaea* 7: 191 (1832) *Holotype*: Germany, Schleusingen (L! Sheet No: 91017265 L0486909).
- C. autumnalis* L. ξ *platyphylla* Kütz., *Linnaea* 7: 191 (1832) *Holotype*: Germany, Schleusingen (L! Sheet No: 91017264 L0486899).
- C. hamulata* Kütz. ex W. D. J. Koch 1837 *Syn. Fl. Germ.* ed. 1: 246. *Lectotype*: Germany, Schleusingen (L!) Sheet No: 91017266 (L0015953) designated here.
- C. aquatica* Hudson subsp. *hamulata* (Koch) Bonnier & Layens *Fl. Fr.*: 106 (1894). *Basionym*: *C. hamulata* Kütz. ex W. D. J. Koch 1837 *Syn. Fl. Germ.* ed. 1: 246
- C. naftolskyi* Warb. & Eig., *Rep. Spec. Nov. Regni Veg.* 26: 84 (1929)
Lectotype: Sharon Plain, NE of Tel Aviv, 23.4.1927. Naftolsky (HUJ 01853).
- C. naftolskyi* Warb. & Eig. (1929: 84) was described as a new species, based on material from Israel. It differs from all European and Mediterranean taxa, except *C. brutia* Petagn., in its combination of more or less isodiametric fruits borne on long pedicels and heterophylly. According to the authors, it differs from *C. brutia* Petagn. by the larger fruits with a broader wing and its persistent stigma. In addition they suggested that the fruits of *C. naftolskyi* penetrate the soil vertically which they considered to be unlike *C. brutia* Petagn. and to resemble *C. deflexa* A. Br. ex Hegelm. more closely (Schotsman 1967: 97–98). However, this does not seem to me to be a very reliable difference. Warburg & Eig (1929: 84) stated that mature fruits are 1.33–1.5 mm wide $\times$ 1.25–1.5 mm high. My own biometric data show that the fruits of *C. brutia* (including var. *brutia* and var. *hamulata* (Petagna) Lansdown) are (0.7–)1–1.5(–1.6) wide $\times$ (0.7)1–1.5(–1.8) high, thus *C. naftolskyi* fruits fall within this range. Warburg & Eig described the wing of *C. naftolskyi* as narrow, without providing measurements. They describe the style as persistent in open air, presumably as opposed to when buried in the substrate; part of the style of *C. brutia* is persistent, but generally only the lower quarter.
- Schotsman (1967: 97–98 and 1977: 248–249) reviewed material collected by the authors. She noted another potential difference: the veins on the leaves of *C. naftolskyi* are sinuous, rather than straight or curved. However, a specimen determined as *C. brutia* Petagn. in SEV (no details retained) has similarly sinuous veins, highlighted in a handwritten note by Schotsman. I have also found material of *C. brutia* var. *hamulata* in the UK with sinuous veins and suspect that this may be a response to environmental conditions, rather than a genetic factor. Schotsman also found material from Sardinia ("Marais sales près Villacerde (Sard. Merid.) III 1854. Huet de Pavillon" P) (1967: 98; pl. X: IV3b) and Portugal (with no locational details (Schotsman 1967: 89 under *C. brutia*); this may be the SEV specimen), that she considered could belong to *C. naftolskyi*. However, she later concluded that material from Syria (no details) and Israel should be assigned to *C. naftolskyi* and other populations to *C. brutia* (Schotsman 1977).
- Schotsman considered that, without further research, it would not be possible to establish whether *C. naftolskyi* is a separate species, or simply a representation of regional variation within the *C. brutia* complex. My own data suggest that the cited differences are less important than was considered by prior authors; certainly I would not consider them sufficient to justify description of a new species. However, it is clear that there is insufficient information on this taxon. Not only is it not possible to decide whether it should be considered a separate species, subspecies or variety, or even simply an indication of regional variation, but it is not possible to establish conclusively whether or not it occurs in Europe.

AMERICAN TAXA REPORTED FROM EUROPE

Three terrestrial *Callitriche* taxa native to America have been reported from Europe. Of these, *C. deflexa* A. Braun ex Hegelm. occurs on São Miguel in the Azores, *C. terrestris* Raf. has been reported once from central France and *C. peploides* Nutt. once from the Pyrenees (Schotsman 1967). Records of terrestrial *Callitriche* taxa are increasing, both naturalised outside Europe and associated with cultivated plants in Europe. There is an increasing risk that they will occur in the wild and for this reason they are discussed here.

C. deflexa A. Braun ex Hegelm. 1864. *Mon. Gatt. Call.* 58, t. 3.

Type: Brazil. Rio de Janeiro 1859–1860, F. Rudio (ex herb. A. Braun) (**MO**, **CM** and **GH** Nos: 110020570.48927; 110073465.48928; and 110076391.48929 *vide* Fassett 1951), it is not however clear whether one of these can be recognised as a nomenclatural type.

Material collected in 2001 from the Azores (Ponta Delgada, São Miguel harbour, Azores, Portugal. September 2001, Rumsey, F.J. (**NMW!**) differs from published biometrics on the species in only very minor ways and I have determined this material as *C. deflexa* Braun ex Hegelm., therefore agreeing with Schotsman's conclusion that the material from the Azores constitutes an occurrence of this species in Europe. The population of this species growing in the Botanic Garden at Coimbra, Portugal (Schotsman 1961: 124) appears to have died out and I have been unable to locate specimens, therefore this material cannot be compared with material from other populations.

C. terrestris Raf. 1808. *Med. Reposit.* (New York) 5: 358.

Holotype: USA, Pennsylvania, Adrius fluvii Lecha prope Philadelphiam, August 1832, Moser, C. J.; (**NY!** No. 248730), Ex Herb. Meisner.

Synonymy:

C. austinii Engelm. in A. Gray, *Mon. Bot.* Ed. 5, 428 (1867); *Holotype:* USA, New Jersey, on damp soil in open woods, fields and roads, 1864, Austin C. F. (**MO**).

C. deflexa var. *austinii* (Engelm.) Hegelm., *Verh. Bot. Vereins Prov. Brandenburg*: 15 (1867).

C. pedunculata A. Gray (non DC) Man. (taken to indicate Gray's Manual neither volume nor date specified *vide* Hegelmaier (1864).

C. terrestris subsp. *subsessilis* (Fassett) N. M. Bacig. *Darwiniana* 22(1): 392 (1979.).

Holotype: Norte de Santander, Valley of Rio Chitaga, southwest of Pamplona, Colombia, 6500 ft. alt., 13 October 1944, Fassett, N. C. 25932 (**GH** No: 110076392.48930) (isotypes **MO**, **CM**, **GH**, **US**, **NY!**, **WIS**).

Synonymy:

C. deflexa var. *subsessilis* Fassett, *Rhodora* 53: 150 (1951).

C. terrestris subsp. *turfosa* (Bert.) Bacig. *Darwiniana* 22(1–3): 393 (1979).

Holotype: *C. turfosa* Bert. ex. Hegelm. in Andibus Ecuadorensibus, Ecuador, 1857–1859, Spruce, R. No. 5053 (**GH** No: 110003851.48938).

Synonymy:

C. turfosa Bert., *Amer. J. Sci.* 19: 308 (1831) *nom. nud.*

It appears likely that the specimen reported from France (Herb. M. Weill (**P**) 11.6.1930 Clairefontaine [Seine-et-Oise], "Forêt des Yvelines, dans des mares asséchées à proximité du Carrefour des marais" [in dried-out marshes close to the Carrefour des marais]; determined by Schotsman 1967 p: 99) was of subspecies *turfosa*. Prof. G. G. Aymonin (pers. comm.) has suggested that it is likely that this specimen is now in Geneva but I have been unable to trace it.

C. peploides Nutt., *Trans. Amer. Philos. Soc. nov. ser.* 5: 141 (1835).

Lectotype: Nuttall, T. [undated]; USA, Arkansas; Fertile (**NY!** designated here) No. 248737: Ex herbarium Torrey. Three collections are mounted on sheet NY bar-codes 248738 and 248739 are other taxa not determined.

C. peploides occurs naturally in coastal southern North America, south to Costa Rica, where it often occurs as a weed in damp areas of arable fields and around floodplain pools, mainly at low altitude (T. Philbrick pers. comm.). It has been reported once from Europe, in 1948 in a peat bog called Despax-Estibière, near Lac d'Orédon in the Pyrenees (Kapp, M. "dans la tourbière Despax-Estibière, près du lac d'Orédon, près de la localité de Fabian dans les Hautes-Pyrénées" 1948 herb. pers. M. Kapp) (Schotsman 1967: 100). The bog is at 2600 m altitude and very isolated. In spite of an extensive search in 2001, no *Callitriche* was found at the site, although *C. palustris* was found nearby. At the time of the record, there was no road to the site, although one was under construction. The degree of isolation of the site, together with its altitude, raise doubts over the record. A specimen in the herbarium of the Muséum National d'Histoire Naturelle (Estibière, nr. Col d'Aumar, 1918–1919, Chouard, P. (**P!**), shows that *C. palustris* occurred at the site well before the record.

Comparison of the descriptions and illustrations provided for type material of *C. peploides* by Fassett (1951) with those of the material from Despax-Estibi re (Schotsman 1962, 1967) does not support the identification and, in fact, the illustration in Schotsman (1967, pl. VIII V₂) more closely resembles *C. palustris* L. The original material must be compared with confirmed material of *C. peploides* var. *semialata* and var. *media* before the record can be considered valid.

C. brevistyla Lansdown sp. nov. (Fig. 1).

Holotype: S sdala stn., Sk ne, Sweden, 08 February 2001, Karlsson, T. (NMW!).

Planta terrestris, in limo udo. Folia 2.5–6.2 × 1.6–3.0 mm, elliptica vel elongatoelliptica, integra, ad apicem incisura parva vel nulla praedita, omnia nervos tres (unum primarium medium, duo secundarios), aliquot venas additas anastomosantes a nervis secundariis inter has et folii marginem exorientes ferentia. Bracteolae 0.3–0.4 mm, in axillis omnibus flores continentibus effectae, translucidae, exalbidae ut videntur, falcatae, persistentes. Utraque axilla geminata paene semper (93%) florem unum masculum unumque feminium, paris una rarius feminium solitarium vel rarissime masculum solitarium continens. Filamentum cum floris femini pedunculo exoriens. Pollinis granum 20–30 × 20–30 µm, ovoideoellipsoideum vel sphaericum, luteum, ornamentis valde (sed mihi ignote) notatum. Stylus brevissimus, 0.17–0.29(–0.32) mm, erectus. Fructus 0.65–0.84 × 0.86–1.12 mm, aliquantum latior quam altior, ad basin paulo attenuatus, sessilis, mericarpiis 1–4, parallelis; fructus maturus niger, mericarpiis ad basin quam ad apicem valde crassioribus; testae cellulae in annulis ordinatae, crystallae (ex conjectura calcii oxalatis) continentes. Ala 0.04–0.08(–0.16) mm in latere, 0.05–0.14(–0.16) mm in apice, ad apicem latior. Fibrillae validae, simplices vel non tortuose dendroideae, solum in alarum cellulis effectae.

Plant terrestrial, on wet mud. Leaves 2.5–6.2 × 1.6–3.0 mm, elliptic to elongate-elliptic, entire and with little or no notch at apex, all with three veins (a primary midrib and two secondary veins) and a few with additional anastomosing veins arising from the secondary veins between these and the leaf margin. Bracts 0.3–0.4 mm, in all axils containing flowers, translucent, appearing whitish, falcate, per-

sistent. Each of a pair of axils almost always (93%) containing one staminate and one carpellate flower, less often one of a pair containing a solitary carpellate flower or very occasionally a solitary staminate flower. Filament arising with pedicel of carpellate flower. Pollen grain 20–30 × 20–30 µm, ovoid-ellipsoid to spherical, yellow, strongly ornamented. Style very short, 0.17–0.29(–0.32) mm, erect. Fruits 0.65–0.84 × 0.86–1.12 mm, somewhat wider than high, tapering slightly to base, sessile, with 1–4 parallel mericarps; mature fruits black, with mericarps distinctly thicker at base than at apex; testa cells in rings, containing crystals (presumably of calcium oxalate). Wing 0.04–0.08(–0.09) mm on side, 0.05–0.14(–0.16) mm at apex, wider at apex. Fibrils strong, simple to mildly dendroid, only developed in wing cells.

In 1992 a terrestrial *Callitriche* was found growing as a weed in a commercial greenhouse in Sweden and identified as *C. deflexa* A.Br. ex Hegelm. (Martinsson 1994). I obtained live material from the population and cultivated it for a year, to prepare a botanical description. Morphological characters showed that it could not be *C. deflexa* A.Br. ex Hegelm. and, in fact, did not conform to any described taxon. It is therefore described here as a new species, named *C. brevistyla* Lansdown because of its strikingly short style.

The plant belongs to the group of strictly terrestrial *Callitriche* taxa as, when inundated, it does not produce flaccid submerged leaves lacking stomata and does not form rosettes at the water surface. It also bears crystals within the cells of the fruits, a feature peculiar to terrestrial members of the genus (Fassett 1951, Schotsman 1967). The diagnostic features of *C. brevistyla* Lansdown are the large, persistent bracts, which appear whitish and are clearly visible to the naked eye, and the extremely short style. Although information on the terrestrial members of the genus is at best poor, *C. brevistyla* Lansdown appears to be most closely related to the terrestrial taxa occurring naturally in Australasia (*C. aucklandica* Mason, *C. brachycarpa* Hegelm., *C. capricorni* Mason and *C. sonderi* Hegelm.) which are unusual among terrestrial *Callitriche* taxa in bearing bracts.

In all but seven of the described *Callitriche* taxa for which data are available the fully developed style exceeds 1 mm. Of the seven in which the style is equal to or less than 0.5 mm,

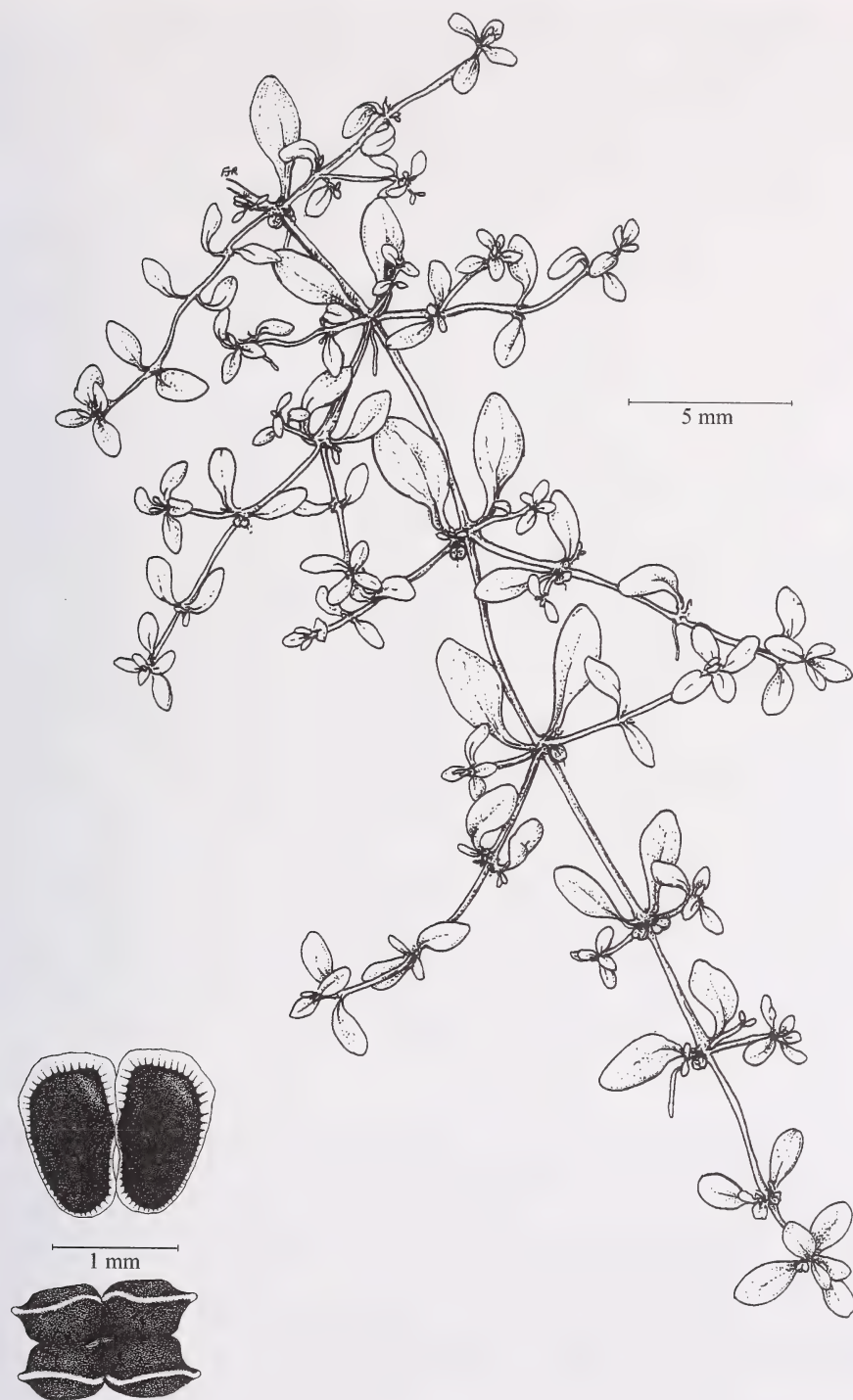


FIGURE 1. *Callitriche brevistyla* showing growth form and details of ripe fruits.

the filament of *C. capricorni*, *C. cycloptera* Schotsm. and *C. sonderi* arises from the pedicel of the carpellate flower (Schotsman 1985); *C. deflexa* Br., *C. peploides* Nutt. and *C. japonica* Hegelm. lack bracts; the fruit of *C. deflexa* is long-pedunculate; that of *C. peploides* is winged only at the apex or unwinged (Fassett 1951); in *C. japonica*, ripe fruits are widest at the apex, tapering toward the base and *C. compressa* N. Brown is amphibious; the plant described here as *C. brevistyla* clearly does not belong to any of these taxa. Of the taxa for which no data on style length are available, all except *C. lechleri* Fassett are amphibious; *C. lechleri* has fruits 1–1.2 mm × 1–1.4 mm and significantly larger than those of *C. brevistyla*.

All known material of *C. brevistyla* derives from a population found in a glasshouse near Sösdal in Skåne, Sweden (Martinsson 1994). It was growing on wet soil under pot-shelves and had probably arrived with plant material from abroad. The glasshouse was empty at the time, but had at times been used for the cultivation of *Pelargonium* and *Impatiens* imported from Denmark, as well as azaleas imported from Belgium. The population was still growing in 2001 when Thomas Karlsson sent me material and I have successfully germinated abundant plants from seed stored for over a year in soil. I am not aware of any immediate cause for concern regarding the future of the species, but it is very important to try to locate wild populations. Review of herbarium specimens has shown that many terrestrial *Callitriche* plants are recorded as *C. deflexa*, almost by default. A first step toward location of natural populations of *C. brevistyla* would be to carry out a comprehensive review of material of terrestrial *Callitriche* in herbaria.

NEW TAXA AND COMBINATIONS

C. hermaphroditica L. subsp. *macrocarpa* (Hegelmaier) Lansdown, **comb. nov.**; *C. brutia* Petagna var. *hamulata* (Kütz. ex W. D. J. Koch) Lansdown, **comb. nov.**; *C. brevistyla* Lansdown, **sp. nov.**

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REFERENCES

- ALLORGE, V. & ALLORGE, P. 1941. Plantes rares ou intéressantes du NW de l'Espagne, principalement du Pays basque. *Bulletin de la Société Botanique de France* **88**: 226–254.
- ARCANGELI, G. 1882. *Compendio della flora Italiana Ossia Manuale per la determinazione della pianta*. Ed. I. Loescher, Turin.
- BABINGTON, C. C. 1862. *Manual of British botany*. 5th Ed. John van Voorst, London.
- BABINGTON, A.M. (Ed.) 1897. *Memorial journal and botanical correspondence of Charles Cardale Babington*. Macmillan & Bowes, Cambridge.
- BACIGALUPO, N. M. 1979. El genero *Callitriche* en la flora Argentina. *Darwiniana* **22**: 377–396.
- BERTERO, C. L. G. 1831. List of the plants of Chile; translated from the 'Mercurio Chileno,' by W. S. W. Ruschenberger. *American Journal of Science* **19**: 308.
- BONNIER, G. 1921. *Flore complète de France, Suisse et Belgique*. Librairie Générale de l'Enseignement, Paris.
- BONNIER, G. & LAYENS, G. 1894 *Flore complète portative de la France, de la Suisse et de Belgique*. Librairie Générale de l'Enseignement, Paris.
- BRUMMITT, R. K. & POWELL, C. E. 1992. *Authors of plant names*. Royal Botanic Gardens, Kew, UK.
- CLAVAUD, A. 1890. *C. lenisulca* Clav. (in litt.). *Bulletin de la Société Botanique Rochelaise* **12**, **14**: 44–45.

- CLAVAUD, A. 1890a. Sur une nouvelle espèce de *Callitriche* (*C. lenisulca* Clvd.) et sur une autre forme à distinguer comme variété, soit comme espèce. *Actes de la Société Linnéenne de Bordeaux*, 44, 5^e. série, tome 4: 43–44.
- DEMARS, B. O. L. & GORNALL, R. J. 2003. Identification of British species of *Callitriche* by means of isozymes. *Watsonia* 24: 389–399.
- DUVIGNEAUD, J. & SCHOTSMAN, H. D. 1977. Le genre *Callitriche* en Belgique et dans les régions avoisinantes: Nouvelles contributions et clé de détermination. *Natura Mosana* 30(1): 1–22.
- EMBERGER, L. & MAIRE, R. 1941. *Catalogue des plantes du Maroc (Spermatophytes et ptéridophytes)*. Volume IV Supplément aux volumes I, II et III. Imprimerie Minerva, Alger.
- FASSETT, N. C. 1951. *Callitriche* in the New World. *Rhodora*: 137–155; 161–182; 185–194; 209–222.
- GILBERT, J.-E. 1792 *Exercitia Phytologica*. Quibus Omnes Plantae Europaeae. 2: 421.
- GRAY, S. F. 1821. *A natural arrangement of British plants according to their relationship to each other*. Vol. II. Baldwin, Cradock & Joy, London.
- GUSSONE, J. 1826. *Plantae rariores Ion. Adriat. coll. Neapoli*.
- HALLER, A. V. 1742. *Enumeratio methodica stirpium helvetiae indigenarum*. Tomus 1. Gottingae: 199.
- HEGELMAIER, F. 1864. *Monographie der Gattung Callitriche*. Verlag von Ebner & Seubert, Stuttgart.
- HEGELMAIER, F. 1867. Zur Systematik von *Callitriche*. *Verhandlungen Botanischen Vereins Province Brandenburg* 9: 1–41.
- HEGELMAIER, F. 1868. Beitrage zur Kenntniss der Wassersterne. *Verhandlungen Botanischen Vereins Province Brandenburg* 10: 100–121.
- HEGELMAIER, F. 1882. *Callitriche* in MARTIUS, C. P. F. von *Flora Braziliensis* 13(2): 13–14.
- HOFFMANN, G. F. 1791. *Deutschlands flora oder botanisches Taschenbuch für das jahr 1791*. Rey Johann Jacob Palm, Erlangen Ed. 1: 2.
- HOLMGREN, P. K. & HOLMGREN, N. H. 2005. *Index Herbariorum*. New York Botanical Garden, New York.
- HUDSON, W. G. 1778. *Hudsoni Flora Anglica: exhibens plantas per regnum Angliæ sponte crescentes distributas secundum systema sexuale*. Editio altera, emendata et aucta London. Ed. 2: 439–440.
- JAHANDIEZ, E. & MAIRE, R. 1932. *Catalogue des plantes du Maroc (spermatophytes et ptéridophytes)*. Imprimerie Minerva, Alger.
- KOCH, W. D. J. 1837. *Synopsis Florae Germanicae et Helveticae*. Lipsiae, Frankfurt am Main.
- KÜTZING, F. T. 1831. Monographia *Callitricharum Germanicarum*, in REICHENBACH, H.G.L. *Iconographia botanica seu plantae criticae* 9: 33–47.
- KÜTZING, F. T. 1832. Über die deutschen *Callitrichen*. *Linnaea* 7: 174–192.
- LAMARCK, J. B. A. P. de MONNET de & CANDOLLE, A. P. De 1805. *Flore Française* 3(5): 414–415
- LANDSOWN, R. V. 1999. A terrestrial form of *Callitriche truncata* (Guss.) subsp. *occidentalis* (Rouy) Braun-Blanquet (*Callitrichaceae*). *Watsonia* 22(3):283–286.
- LANDSOWN, R. V. & JARVIS, C. E. 2004. Linnaean names in *Callitriche* L. (*Callitrichaceae*) and their typification. *Taxon* 53(1): 169–172.
- LEBEL, E. 1863. *Callitriche*, Esquisse monographique. *Mémoires de la Société Imperiale des Sciences Naturelles de Cherbourg* 9: 1–48.
- LE GALL, M. 1852. *Flore du Morbihan*. J. M. Galles, Vannes.
- LINNAEUS, C. 1753. *Species Plantarum*. Ed. 1. Holmiae.
- LINNAEUS, C. 1755. *Centuria I Plantarum*. Uppsaliae.
- LINNAEUS, C. 1755. *Flora suecica*. Ed. 2. Holmiae.
- LINNAEUS, C. 1770. *Systema naturae*. Regnum Vegetabile. 2. Vindobonae.
- LÖNNROTH, C. J. 1854. *Observationes Criticae Plantas Suecicas illustrantes, quarum decadem primam*. (Diss. Uppsala).
- MARTINSSON, K. 1985. Problem kring *Callitriche platycarpa*, plattlånke. *Svensk Botanisk Tidskrift*. 79: 165–174.
- MARTINSSON, K. 1991. Natural hybridisation within the genus *Callitriche* (*Callitrichaceae*) in Sweden. *Nordic Journal of Botany* 11: 143–151.
- MARTINSSON, K. 1991a. Geographical variation in fruit morphology in Swedish *Callitriche hermaphrodita* (*Callitrichaceae*). *Nordic Journal of Botany* 11: 497–512.
- MARTINSSON, K. 1994. Ein kulturspridd lanke *Callitriche deflexa*. *Svensk Botanisk Tidskrift*. 88: 299–301.
- MASON, H. 1957. *A flora of the marshes of California*. University of California Press. Berkeley and California.
- MILLER, N. G. 2001. The *Callitrichaceae* in the southeastern United States. *Harvard Papers in Botany* 5(2): 277–301.
- MORONG, T. 1894. List of pteridophyta and spermatophyta growing without cultivation in Northeastern North America. Prepared by a committee of the Botanical Club, American Association for the Advancement of Science. *Mem. Torrey Bot. Club* 5: 215.
- NORMAN, J. M. 1893. *Floræ arcticæ Norvegiæ: species et formæ nonnullæ novæ v minus cognitæ Plantarum Vascularium. Forhandlingar i Videnskabselskabet i Kristiania* 16: 28.

- NUTTALL, T. 1835. Collections towards a flora of the territory or Arkansas. *Transactions of the American Philosophical Society*. nov. ser. **5**: 141.
- PARLATORE, F. 1867. *Callitriche*: 429 in *Flora Italiana* 4. Le Monnier, Florence.
- PETAGNA, V. 1787. *Institutiones Botanicae* 2: De plantis in specie. Neapoli.
- PHILBRICK, C. T. & LES, D. H. 2000. Phylogenetic studies in *Callitriche*: implications for interpretation of ecological, karyological and pollination system evolution. *Aquatic Botany* **68**: 123–141.
- QUEZEL, P. A. & SANTA, S. 1963. *Nouvelle flore de l'Algérie et des régions désertiques Méridionales* 2. Editions du Centre National de la Recherche Scientifique, Paris.
- RAFINESQUE, C. S. 1808. Prospectus of two intended works on North – American botany; the first on the new genera and species of plants discovered by himself, and the second on the natural history of the funguses, or mushroom-tribe of America. *Medical Repository* (New York) **5**: 358.
- ROUY, G. C. C. 1910. *Flore de la France ou description des plantes qui croissent spontanément en France, en Corse et en Alsace-Lorraine*. Les Fils d'Émile Deyrolle, Paris. Tome 12.
- SCHINZ, H. & THELLUNG, A. 1905. in SCHINZ, H. & KELLER, R. *Flora der Schweiz: zum Gebrauche auf Exkursionen, in Schule, und beim Selbstunterricht*. II Kritische Flora. A. Raustein, Zurich.
- SCHKUHR, C. 1791. *Botanisches Handbuch der mehresten Theils in Deutschland wildwachsenden, theils ausländischen in Deutschland unter freyem Himmel ausdauernden Gewächse*. Kosten des Verfassers, Wittenberg.
- SCHOTSMAN, H. D. 1954. A taxonomic spectrum of the Section Eu-*Callitriche* in the Netherlands. *Acta Botanica Neerlandica*. **3**: 313–384.
- SCHOTSMAN, H. D. 1958. Notes on *Callitriche hermaphroditica* Jusl. *Acta Botanica Neerlandica*. **7**: 519–523.
- SCHOTSMAN, H. D. 1961. Notes on some Portuguese [sic] species of *Callitriche*. *Boletim da Sociedade Broteriana*. **35**: 95–127.
- SCHOTSMAN, H. D. 1962. Deux *Callitriche* nouveaux pour la France. *Bulletin du Muséum National d'Histoire Naturelle* **34**(6): 479–482.
- SCHOTSMAN, H. D. 1967. *Les Callitriches: Espèces de France et taxa nouveaux d'Europe*. Éditions Paul Lechevalier, Paris.
- SCHOTSMAN, H. D. 1968. Le nombre chromosomique de *Callitriche cribrosa* Schotsm. *Bulletin du Centre d'Etudes et de la Recherche Scientifique, Biarritz* **7**: 87–88.
- SCHOTSMAN, H. D. 1977. *Callitriche* de la région Méditerranéenne: Nouvelles observations. *Bulletin du Centre d'Etudes et de la Recherche Scientifique, Biarritz* **11**(3) p: 241–312.
- SCHOTSMAN, H. D. 1985. Une nouvelle espèce de *Callitriche* (Callitrichaceae) de Papoua-Nouvelle-Guinée: *C. cycloptera* Schotsm. *Bulletin du Muséum National d'Histoire Naturelle Sect. B* **7**(2): 115–121.
- SCHOTSMAN, H. D. & ANDREAS, C. H. 1974. *Callitriche lenisulca* Clav. espèce méconnue. *Bulletin du Centre d'Etudes et de la Recherche Scientifique, Biarritz* **10**(2): 285–316.
- SCHULTZ, C.F. 1819. *Prodromus Florae Stargardiensis continens plantas in Ducatu Megapolitano-Stargardiensi S. Strelitzensi sponte provenientes: Supplementum primum Neobrandenburgi*.
- SCHUR, J. F. 1866. *Enumeratio plantarum transsylvanie*. Vindobon, Vienna.
- SCOPOLI, J. A. 1772. *Flora carniolica*. 2. Vindobon, Vienna.
- SPRENGEL, K., von, SCHRADER, A. H. & LINK, H. F. 1818–1820. *Jahrbücher der Gewächskunde* **3**: 30.
- SYME, J. T. I. B. 1863. *English Botany; or, Coloured Figures of British Plants, with Their Essential Characters, Synonyms, and Places of Growth. To Which will be added, Occasional Remarks*. ed. **3**(8): 119.
- THE INTERNATIONAL PLANT NAMES INDEX (2004). <http://www.ipni.org> [accessed 2005–2006].
- TORREY, J. 1826. *A Compendium of the Flora of the northern and middle States, containing descriptions of all the Plants, exclusive of the Cryptogamia, hitherto found in the United States, north of the Potomac*. J. & J. Harper, New York.
- TUTIN, T. G., BURGESS, N. A., CHATER, A. O., EDMONDSON, J. R., HEYWOOD, V. H., MOORE, D. M., VALENTINE, D. H., WALTERS, S. M. & WEBB, D. A. (Eds.) 1993. *Flora Europaea*. Vol. 1: *Psilotaceae* to *Platanaceae*. 2nd Ed. Cambridge University Press, Cambridge.
- TZVELEV, N. N. 1975. Nota de genere *Callitriche* L. in URSS. *Novosti sistematiki vysshikh rastenii = Novitates systematicae plantarum vascularium* **12**: 237–238.
- WAHLENBERG, G. 1824–1826. *Flora Svecica, enumerans Plantas Sveciae indigenas cum synopsi classium ordinumque nomina incolarum et qualitates Plantarum illustrantibus*. Upsalæ.
- WARBURG, O. & EIG, A. 1929. *Callitriche nafiolskyi* spec. nov. *Repertorium Specierum novarum Regni Vegetabilis*. **26**: 84–87.
- WILLDENOW, C. L. von 1809. *Enumeratio Plantarum Horti Regii Botanici Berolinensis, continens descriptiones omnium Vegetabilium in Horto dicto cultorum*. Berolini **1**: 8.

Assessment of genetic diversity in populations of *Crepis foetida* L. (Asteraceae)

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ABSTRACT

In 1980 *Crepis foetida* became extinct in Britain. Although several attempts have been made to re-introduce plants from native *ex-situ* collections into its formerly known locations, these attempts have largely been unsuccessful. We have used Amplified Fragment Length Polymorphisms (AFLPs) to assess levels of genetic diversity in these *ex-situ* populations by comparing them to *in-situ* European populations. Although the proportion of polymorphic loci in the British *ex-situ* populations was lower than in the French populations, gene diversity estimates in the British *ex-situ* and European *in-situ* populations were of a similar magnitude. British *ex-situ* plants were genetically more similar to Dutch plants than to those from French populations. There was no indication of a major bottleneck in the *ex-situ* populations or indication that limited genetic variation in these populations has been a major factor in the repeated failure of the re-introduction programmes.

KEYWORDS: AFLPs, *ex-situ*, extinction, re-introduction, Stinking Hawk's-beard.

INTRODUCTION

During 1980 the last remaining British population of *Crepis foetida* L. (Asteraceae), the Stinking Hawk's-beard, became extinct. *C. foetida* probably has never been common in Britain and is only known from a few coastal sites in south-east England (Preston *et al.* 2002). Globally, Britain represents the north-western limit of its range. Its distribution extends through Europe, where it is widespread, although it is more common in southern and eastern parts, to central Asia and the north-western Himalayas (Ferry 1999). Outside Britain it is not considered threatened, although populations are generally in decline (Anon 1998). It grows in open, well-drained sites in Britain, typically on disturbed shingle or chalk and reproduces sexually. The subspecies present in Britain and most of Europe (*C. foetida* subsp. *foetida*) is considered to be self-compatible (Babcock 1947), unlike the two southern and eastern European subspecies

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C. foetida subsp. *commutata* and *C. foetida* subsp. *rhoeadifolia*, which are self-incompatible (Babcock 1947; Hughes and Babcock 1950)

A recovery plan was initiated by the Nature Conservancy Council (now English Nature) in 1992, and *C. foetida* subsequently became a UK Biodiversity Action Plan (BAP) priority species in 1998, with the RSPB as Lead Partner. The Species Action Plan aimed to re-establish populations of *C. foetida* in former and new sites in south-east England. Plants cultivated at Cambridge Botanic Garden, originating from seeds collected from the last remaining plants at Dungeness, were used for the re-introduction programme. Funded in part by the RSPB and English Nature's species recovery programme, several attempts were made to re-establish populations at Dungeness and Rye during the 1990s and onwards (Sears 2004). Following visits to the Netherlands, where large populations exist in chalk quarries near Maastricht, populations were also established in three chalk quarries in Kent where the habitat reflected the conditions observed in the Netherlands. Although re-establishment appeared initially successful at Dungeness and Rye, the populations rapidly declined to a stage where there were no longer any plants remaining in the original re-establishment plots; a few new plants continue to be found each year at Rye. The populations in the Kent quarries were more recently introduced and their progress is still being monitored (Sears 2004).

The reason for the local extinction of *C. foetida* and apparent failure to survive re-introduction programmes remains unclear. It has been proposed that climatic and biotic factors have both played a role in its decline (Ferry 1999). On-going work at the Royal Holloway College is investigating which ecological conditions *C. foetida* requires for its survival. Seed set is good and long term seed viability remains high, to an extent that there is a good probability that a seed bank may exist at its former sites (Ferry 1999).

To contribute to this on-going work the aim of this paper has been to compare levels of genetic diversity in *ex-situ* British and *in-situ* European populations of *C. foetida*, to assess the extent to which genetic factors are likely to be contributing to the decline of UK populations of this species and to the difficulties with the reintroduction programmes.

MATERIALS AND METHODS

Plant material

During 2004, leaf samples of *C. foetida* were collected from 30 plants from the *ex-situ* population maintained in the Royal Holloway College. The plants from this collection were maintained in pots within a greenhouse and originated from seed originally collected from Dungeness. Leaves from 20 plants were also sampled from a second *ex-situ* collection, consisting of first generation self-sown plants, originating from three pot grown plants from the Dungeness/Royal Holloway College collection and maintained in a private garden.

To compare levels of genetic diversity, two French populations were sampled south of Clermont-Ferrand, Auvergne, a region where this species is widespread. The Saurier population was found in a small cutting at the foot of a cliff beside a road, while the plants from the St. Floret population were growing on bare ground beside a track. 25 plants were sampled from both populations. Samples were also obtained from the Netherlands. Two populations were sampled from quarries (ENCI and 't Rooth, 25 and 20 plants sampled respectively) near Maastricht, and five plants from an *ex-situ* population in the garden of the Maastricht Natural History Museum which originated from plants from the ENCI quarry population.

DNA extraction and AFLP analysis

DNA was extracted from approximately 25 mg of leaf material that had been previously dried in silica gel, using a miniprep version of the 2xCTAB (cetyltrimethyl-ammonium bromide) method of Doyle & Doyle (1987). Genetic diversity was assessed using Amplified Fragment Length Polymorphisms (AFLP; Vos *et al.* 1995). AFLP analysis was performed using method adaptors and pre-amplification primers described in Woodhead *et al.* (2005). The resulting fragments were separated using a CEQ 800 system (Beckman Coulter) and subsequent output files were analysed using the associated fragment analysis software (Beckman Coulter). Twelve selective primer pair combinations were initially screened for suitable fragment amplification, scorability and reproducibility, using four individuals each from France and Britain.

Of these, three primer pairs were selected for large scale screening of individuals:

E-AGC (5'GACTGCGTACCGGTTTCAGC)

with

M-CTT (5'GATGAGTCCTGCGTAACTT)

E-AAC (5'GACTGCGTACCGGTTCAAC)

with

M-CTA (5'GATGAGTCCTGCGTAACTA)

E-ACC (5'GACTGCGTACCGGTTTACC)

with

M-CAA (5'GATGAGTCCTGCGTAAACAA).

The primers E-AGC and E-AAC were labeled with the fluorescent dye D4-PA, and the primer E-ACC with the dye D3-PA (WellRED oligos, Proligo). Bands were scored as either present (1), absent (0) or ambiguous (?) to generate a binary matrix.

Data analysis

A Bayesian approach was used to estimate allele frequencies using the program AFLP-SURV (Zhivotovsky 1999). The percentage of polymorphic loci (5% level) was calculated and unbiased estimates of gene diversity (H_j) were made following the method of Lynch and Milligan (1994) at the level of the population, country and for the species. Estimates of population differentiation (F_{ST}) were also calculated, and significance tested, using AFLP-SURV. Multilocus similarities between individuals were assessed using Jaccard's similarity co-efficient and subjected to principle co-ordinate (PCO) analysis using R-Package version 4.0 (available from <http://www.bio.umontreal.ca/casgrain/en/labo/R/v4/index.html>) and visualised graphically using Excel.

RESULTS

79 individuals were successfully genotyped using the three primer pair combinations. Only six individuals of the 130 samples collected from the three Netherlands populations in total were successfully genotyped, in spite of repeated DNA extraction and AFLP analysis. For AFLPs to work successfully, large amounts of high quality DNA are required, so the continual failure of some samples suggests that the initial leaf material collected was of non-optimal quality. As a result, the six individuals were grouped together into a single population representing the Netherlands.

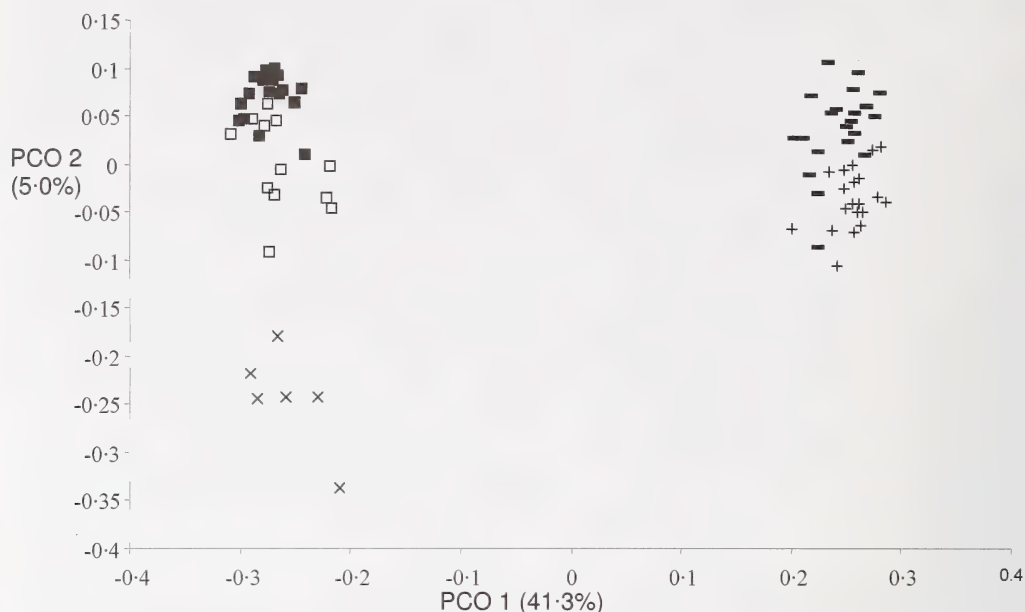
In total 298 bands were scored from the three primer pair combinations (E-AGC + M-CTT 102 bands between 60 and 300 bp; E-AAC+M-CTA 91 bands between 55 and 205 bp; E-ACC+M-CAA 105 bands between 80 and 286 bp) of which 93.3% (95% level) were polymorphic.

The percentage of polymorphic loci ranged from 46.6% in the private garden to 62.4% in the St. Floret population (Table 1). At the country level, France had more polymorphic loci compared to the British populations (63.1% vs 46.6% respectively). Gene diversity estimates ranged from 0.139 (private garden) to 0.204 (St. Floret) and at the country level was higher in France compared to Britain (0.196 vs 0.173 respectively). Significant levels of population differentiation were observed between British and French populations, and at the global level (Table 1).

TABLE 1. GENETIC DIVERSITY PARAMETERS OF *IN-SITU* AND *EX-SITU* POPULATIONS OF *CREPIS FOETIDA* BASED ON 298 AFLP LOCI, AT THE POPULATION, COUNTRY AND GLOBAL LEVEL

Population	n	P	H_j	F_{ST}
<i>Britain ex-situ</i>				
Private garden	20	46.6	0.139	
Royal Holloway	12	47.7	0.201	
mean	15.5	47.2	0.170	
<i>France in-situ</i>				
Saurier, Auvergne	20	57.7	0.185	
St. Floret, Auvergne	21	62.4	0.204	
mean	20.5	60.5	0.195	
<i>Netherlands</i>				
Maastricht	6	48.8	0.155	
<i>Countries</i>				
Britain	32	46.6	0.173	0.106*
France	41	63.1	0.196	0.066*
Netherlands	6	48.8	0.155	-
mean	26.3	52.8	0.175	0.086
Global overall	79	68.1	0.235	0.336*

n, number of individuals genotyped; P, percentage polymorphic loci; H_j , expected gene diversity; F_{ST} , population differentiation; *, $p < 0.01$.



Britain: □ Royal Holloway College, ■ Private Garden. France: — Saurier, + St. Floret. × The Netherlands.

FIGURE 1. Principal co-ordinates plot based on the similarity matrix between individuals from both *in-situ* and *ex-situ* populations of *Crepis foetida*, calculated using 298 AFLP bands. Axes explain 46.3% of the variation.

Results of the principal co-ordinates analysis are presented in Fig. 1. Combined axes *x* and *y* explained 46.3% of the variation. The *x* axis clearly distinguished the French populations from the British and Dutch samples and, to a lesser degree, the *y* axis distinguished the British from the Dutch samples. Within France there was some overlap between populations, while the private garden population formed a tight cluster with the individuals from the Royal Holloway population (Fig. 1).

DISCUSSION

The main outcome of this research, although based on only a limited number of plants, is that the *ex-situ* plants of *C. foetida* maintained at the Royal Holloway College still harbour genetic variation and that extensive loss of genetic diversity has not occurred. Although the proportion of polymorphic loci was about 17% lower than in French populations with equivalent sampling, there was no major difference in genetic diversity as assessed by *H_j*. Taken together, these results suggest that the loss of genetic diversity in the Royal Holloway population compared to the French populations is at present limited.

Previous studies have shown that loss of genetic diversity can be directly linked to population extinctions (Sacherri *et al.* 1998) and that populations at the edges of distribution ranges tend to exhibit less genetic diversity compared to populations in the centres of their ranges. However, populations that are isolated or are at the edge of ranges can exhibit levels of genetic diversity that are higher than expected. For example, two small isolated range edge populations of *Lloydia serotina* in Wales had unexpectedly high levels of genetic diversity (Jones *et al.* 2001). The Welsh populations showed diversity levels similar to European Alp populations and even exhibited higher levels than some North American populations. Our data suggest that prior to the extinction of *C. foetida* in 1980 comparable levels of genetic variation to European populations were present in the UK and that the majority of this variation has been maintained in the *ex-situ* collection.

In contrast to the Royal Holloway population, there is more limited variability in the second *ex-situ* population from the private garden. This lack of genetic variation was not unexpected and resulted from the fact that they originated from seed from just three plants grown at the Royal Holloway College. Ideally,

re-introductions should be made up from plants containing high levels of genetic diversity to maximise the chances of including plants containing genes suitable for the survival and adaptation of the population, as well as avoiding inbreeding depression. Re-introductions using the plants solely from the private garden population should therefore be avoided.

Ideally, re-introductions should be made from donor populations that match as closely as possible the ecological and genetic make-up of the original population. Given the lack of evidence for an extreme genetic bottleneck in the UK *ex-situ* material, there appears no clear-cut and strong reason to introduce Continental material to the former sites in the UK. It would, however, be interesting to establish new sites based on continental material, to compare its performance with the UK material. Establishing new sites, rather than supplementing the existing site would remove concerns about harming the UK population via outbreeding depression either by (a) introducing genes not adapted to the local environment, or (b) disrupting any co-adapted gene complexes.

Our results suggest that the Dutch plants are more similar genetically to the British *ex-situ* population than the French population, albeit with the qualifier that only a limited number of populations have been examined. Specimens from the Auvergne region are reported to be the same subspecies as that formerly present in Britain (Babcock 1947) and it is considered

that the dissimilarity between populations is indicative of their geographical isolation rather than taxonomic differences between the UK and European populations.

CONCLUSION

In the absence of comparative tests of fitness and adaptation via reciprocal transplant and common garden experiments our results need interpreting with some caution. However, what can be said is that no evidence for a severe genetic bottleneck has been detected in the Royal Holloway population. A tentative interpretation of this is that levels of genetic variation in British *C. foetida* have not been the main contributing factor that has led to its extinction and continual re-introduction failure, and that these plants represent a potentially useful source for future re-introduction of the native genotypes. Instead a combination of ecological factors, such as habitat change and climatic conditions, may potentially have played a greater role in the decline of this species in Britain than have genetic factors.

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REFERENCES

- ANON. (1998) *UK Biodiversity Group: Tranche 2 Action Plans. Volume 2*. pp 87–88. English Nature, Peterborough.
- BABCOCK, E. B. (1947). *The genus Crepis*. University of California Press, Berkeley and Los Angeles.
- DOYLE, J. J. & DOYLE, J. L. (1987). A rapid DNA isolation procedure for small quantities of fresh leaf material. *Phytochemical Bulletin* **19**: 11–15.
- FERRY, B. W. (1999). *Crepis foetida* L. (Asteraceae), in M. J. WIGGINGTON ed. *British Red Data Books*, pp 108. JNCC, Peterborough.
- FRANKHAM, R. (2003) Genetics and conservation biology. *Comptes Rendus Biologiques* **326**: S22–S29.
- HUGHES, M. B. & BABCOCK, E. B. (1950). Self-incompatibility in *Crepis foetida* (L.) subsp. *rhoadifolia* (Bieb.) Schinz et Keller. *Genetics* **35**: 570–588.
- JONES, B., GLIDDON, C. & GOOD, J. E. G. (2001). The conservation of variation in geographically peripheral populations: *Lloydia serotina* (Liliaceae) in Britain. *Biological Conservation* **101**: 147–156.
- PRESTON, C. D., PEARMAN, D. A. & DINES, T. D. (2002). *New Atlas of the British and Irish flora*. Oxford University Press, Oxford.
- SACCHERI I., KUUSAAARI, M., KANKARE, M., VIKMAN, P. *et al.* (1998). Inbreeding and extinction in a butterfly metapopulation. *Nature* **392**: 491–499.
- SEARS, J. (2004). *The Stinking Hawk's-beard*. http://www.rspb.org.uk/biodiversity/RSPBandbiodiversity/lead_partner/plants/hawksbeard/index.asp (as of April 2006).

- WOODHEAD, M., RUSSELL, J., SQUIRRELL, J., HOLLINGSWORTH, P. M. *et al.* (2005). Comparative analysis of population genetic structure in *Athyrium distentifolium* (Pteridophyta) using AFLPs and SSRs from anonymous and transcribed gene regions. *Molecular Ecology* **14**: 1681–1695.
- VOS, P., HOGERS, R., BLEEKER, M., REIJANS, M. *et al.* (1995). AFLP: a new concept for DNA fingerprinting. *Nucleic Acids Research* **23**: 4407–4414.
- ZHIVOTOVSKY, L. A. (1999). Estimating population structure in diploids with multilocus dominant DNA markers. *Molecular Ecology* **8**: 907–913.

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A Shoddy Tale: perspectives on the wool alien flora of West Yorkshire in the twenty-first century

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ABSTRACT

The terminology traditionally associated with the study of the wool alien flora of Britain is discussed from a historical perspective and clarification provided on the diverse nature of wool wastes. Changes in the production of wool wastes and their uses in agriculture over the past fifty years are presented as a background to an understanding of the increasing rarity and decreasing geographical distribution of wool aliens in the twenty-first century. Results are presented from a five years study of selected species in the rhubarb fields and livestock waste dumps in West Yorkshire (v.c. 63). Recommendations are put forward for research into the conservation of the wool alien flora.

KEYWORDS: wool waste, shoddy, decline of textile manufacture and agriculture, rhubarb fields, livestock waste dumps.

INTRODUCTION: ALIEN AND/OR CASUAL

An awareness of the various industrial activities that contributed to the diversity of the flora of West Yorkshire was probably initiated by Lees (1888) who incorporated the records of several amateur botanists of aliens from wool and grain waste tips into his benchmark volume *The Flora of West Yorkshire*. Lees (1941) emphasized the continuity of wool alien recording in West Yorkshire in the early twentieth century, summarizing additional records in a supplement to his original flora. Meanwhile, it was probably the seminal work of Hayward and Druce (1919), more than any other, which alerted botanists to the increasing importance of an adventive flora in contributing to the national floristic diversity. In many ways, the lineage of adventive and alien study witnessed a sublimation in the publication of the *Flora of Bedfordshire* (Dony 1953). This work stimulated a nationwide interest amongst botanists in those species

which were allegedly introduced through the agency of the wool manufacturing industry and the use of wool waste as manure in market gardening. A primary crop was brussels sprouts for which Bedfordshire with its 17,467 acres in 1938 in the area around Biggleswade was the major UK producer (Fitchett 1943). The source of these plants was traced to the woollen manufacturing districts of West Yorkshire by Lousley & Dony (1952) and the study of this peculiar flora taken up by Lousley (1958, 1960, 1961). A lifetime of dedication is to be seen in the work of John Dony, first in his county flora, the result of eighteen years of field study, followed by additional records and notes on changes (Dony 1969), then his *Bedfordshire plant atlas* (Dony 1976) and finally, some further notes (Dony and Dony 1986), records that tell the story of the establishment and gradual decline of 'wool shoddy aliens' in his native county. Dony (1976) recognised the shortcomings of such a term: 'The interpretation of the wool alien flora presents some difficulties as some native species occur as wool aliens, usually Mediterranean strains, and the use of wool waste is not of necessity the sole means of their introduction'. He also acknowledged that the wool alien species were not permanent and contended that their distribution was 'a matter of only passing interest, one however, that extended to the mapping of tetrads in which over 250 such species had been recorded. By the mid-1980s, Dony & Dony (1986) noted that few of the remaining market gardeners used wool waste but were able to record that its diminishing use had shown 'that wool aliens may continue to occur in fields for as long as eight years after the application of shoddy'. The term wool alien had been popularised by Lousley (1961) in his census list of all such species found in Britain in the period 1946–1960, and although it is implied in *Alien Plants of the British Isles*

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(Clement & Foster 1994), the term wool casual is generally used. The authors define casual as 'not persisting in a locality for more than two years without re-introduction'. Finally, in this context, the extremely detailed and dedicated catalogue of the *Alien Plants of Yorkshire* (Wilmore 2000) is consistent in its use of the term wool alien. It is a discussion on the alien and casual status of certain species originating as seed in wool waste that forms the core of this paper, based on five years of recording and observation in the so-called Rhubarb Triangle of West Yorkshire. Additionally, the results of five years recording on five waste dumps in which wool waste is a component are presented. These are set in the context of research into the current availability of wool waste as an agricultural manure, and a review of the several technological, industrial economic, agricultural and environmental factors that have governed the sporadic occurrence of wool aliens.

THE NATURE OF WOOL WASTE AND SHODDY

Until the last two decades of the twentieth century, the textile waste that was the source of many of the seeds was of several different types and the different types had varying sized seed banks. There were *brokes* and *daggings* or *clarts* which comprised the dirty waste wool trimmed from imported fleeces; and there were *noils* and *carding waste*, fine, almost granular accumulations of short fibres, rich in seeds, the residue of the scouring, combing and carding processes in which the raw wool was prepared and cleansed, prior to spinning. Collectively, these waste products became known simply as 'wool waste' or 'shoddy manure' and together they provided the main seed bank for wool casuals. There was also *shoddy waste*, the residue of shoddy, a cheap, rough, fibre recovered from ground rags either collected throughout Britain or imported from Europe and the Middle East and itself the most fibrous of the wastes. Then finally, there was *mungo waste*, left after the extraction of mungo or the short fibres recovered from heavily felted woollen waste. Shoddy provided coarse fibre for the manufacture of heavy woollen clothing, such as army uniforms and blankets and industrial textiles. It was this aspect of the manufacturing industry that led to the adoption of the word 'shoddy' to refer to anything coarse or of lower quality in a general, everyday context. In a similar manner, the descriptive

term 'shoddy field' as used by botanists and ecologists (e.g. Wilmore 2000) is used to describe arable fields that have been fertilized with wool waste and shoddy manure. The market gardeners of Bedfordshire and the rhubarb growers of West Yorkshire often used more than one type of waste according to availability and because of the variety of types used and their diverse provenances, the alien flora varied from year to year. Until the last decade of the twentieth century, daggings and carding waste were acquired from Halifax and shoddy waste from Mirfield for the 150 acres of rhubarb grown each year in the so-called 'Rhubarb Triangle' north of Wakefield, West Yorkshire. This area is essentially the country around the intersections of M1 and M62 motorways between Wakefield, East Ardsley, and Rothwell and within 10 km grid squares SE22 and SE32. Nowadays, the only sources of wool waste are two commission wool scouring companies in the United Kingdom, at Dewsbury and Bradford.

CHANGES IN THE PRODUCTION OF THE SOURCE MATERIAL

Scouring is the process of washing wool in hot water and detergent to remove contaminants such as dirt, seeds and grease and to prevent entanglement or felting. The greatest technological development in the process came from the Wool Research Organisation of New Zealand (WRONZ), which through the invention of scouring machinery, made the country the most popular source for scoured and cleaned wool worldwide. The WRONZ Comprehensive Scouring System was first patented and installed in its country of origin in August 1972. By 1981, over fifty plants in New Zealand and other parts of the world had been converted to operate the WRONZ comprehensive system. It is estimated that, in the twenty-first century, plant supplied by a New Zealand manufacturer scours an estimated 70% of the world's wool. Because of the efficiency of the new technology, scouring costs rose less than other wool processing related production costs and New Zealand wool scourers costs became the lowest in the world (WRONZ 2005). Thus, by the 1980s, many UK woollen manufacturers were changing to the importation of scoured wool from New Zealand and Australia rather than import raw, unscoured wool to clean as a stage in their own production

processes. Although there are between fifty and sixty woollen manufacturers in West Yorkshire, most rely upon imported wool that has been scoured and cleaned in the country of its origin. Even the primary processing wool blending companies use New Zealand wool and the only waste product is dust which accumulates in the extractor fans and is then combusted at municipal incineration plants. There are, however, still some manufacturers who import raw wool and commission its scouring at either of two remaining wool scouring companies in the United Kingdom, Thomas Chadwick & Sons, Eastfield Mills, Dewsbury and Haworth Scouring Co., Cashmere Works, Bradford, both in West Yorkshire. A third is established at Buckfast in Devon, scouring wool exclusively for the Axminster Carpet Company. There has thus been a drastic reduction in the diversity of woollen wastes used in agriculture.

There has also been a great reduction in the quantity of imported raw wool and an inevitable reliance on the home clip. Whereas a large proportion (c. 75%) of the Dewsbury scouring company's wool was imported before 1980, 75–80% now comes from the UK clip, the remaining 20–25% wool originating in Scandinavia (mainly Norway), the Middle East (Syria and Egypt), Argentina, Australia and New Zealand. A record is not kept of the countries of origin and the quantities originating therefrom, and the previous data is based simply on observations of the notation on the bales. Similarly, the greater proportion (>70%) of the wool that the Bradford company scours comes from UK or Irish clips, the remainder from Norway and EC countries such as France, Germany and Holland. Thus, there has been a trend towards importing clean wool, a greater reliance on UK and Irish raw wool and a concomitant decline in the importation of raw wool for scouring by a few specialised companies. As a result, the waste from the woollen processing and manufacturing industry of predominantly foreign origin has become a rare commodity in the past twenty years. There has thus been a considerable reduction in the potential wool alien seed bank originating from regions outside Great Britain and Ireland.

The nature of the shoddy industry has changed considerably in the past twenty years. Few of the ten textile waste processors in the Kirklees and Wakefield Municipal Boroughs of West Yorkshire import rags from abroad and if they do, European Community regulations are such that the rags must be cleaned before

import. Most rely on UK sources for c.90% of their manufacturing base, acquired either via high street charities or from the textile waste reclamation banks of local authorities. The proportion of woollen to synthetic rags in such consignments is usually low and wool raw materials far less common, so that inevitably, a greater proportion of the processed shoddy fibre for spinning is synthetic. Whether wool or synthetic rags are used, there is little waste and this merely in the form of zips, studs, buttons and labels, which finds its way to a skip and thence a landfill site. The UK woollen manufacturing industry in general is in decline, in the face of economic market forces relative to European Community and Third World trade agreements. Take for example, the three mills at Kirkheaton, Huddersfield, the heirs of the Jarman Company, whose wool waste dump was visited by both John Dony and Ted Lousley and from where Kit Rob and David McLintock first recorded *Medicago laciniata* in 1955 (Wilmore 2000). One has changed its operation to merchandising of cloth, a second was placed in administration in late 2004 and the third changed to cotton production and closed in March 2005.

CHANGES IN AGRICULTURAL PRACTICE AND ENVIRONMENTAL FACTORS

The distribution of wool aliens, particularly in West Yorkshire, is now largely dependent upon the agricultural practices associated with the production of a particular vegetable crop, especially rhubarb, winter cauliflowers and spring cabbage. The waste is spread on the land in May–June, ploughed into the host soil in autumn and crowns of rhubarb planted, there to remain for two years, until transfer to the forcing sheds in the third autumn. In these two growing seasons, the casuals germinate and some apparently set viable seed. Once the crowns have been transferred, the land is again treated with wool waste, ploughed and set down to winter cauliflowers followed by spring cabbage or wheat for a further two or three years. The slow release of nitrogen from the wool waste allows for the production of two or three crops from one spread. The amount of wool waste required per acre is only 25% the volume compared with farmyard manure, which has to be applied annually and is much more difficult to spread. The various types of woollen waste vary in terms of their ability to retain moisture as a mulch and in their nitrogen concentration. They all are in the top group of

organic nitrogen sources, being ranked with guano and hide meal at 10%, with only hoof and horn meal of a higher concentration at 12% (see Table 2). Precise data is lacking on the relative nitrogen contents of the various types of wool waste, but the noils produced by the scouring process seem to have a particularly high concentration. This encourages the growth of a weed flora dominated by nitrophilous species such as *Chenopodium album*, *Galium aparine* and *Urtica urens*, and rather unusually, *Impatiens glandulifera*, a prominent and persistent weed of rhubarb fields. The gregarious nature of such plants tends to restrict the growth of other less competitive, annual wool casuals, many of which are denizens of drier soils typical of, for example, Mediterranean Europe. In the Rhubarb Triangle the predominant soil type is a clayey or loamy pelo-stagnogley of the Dale Association, a type of comparatively restricted distribution overlying Carboniferous shales in scattered areas from Sheffield in South Yorkshire, north to Ilkley (Soil Survey of England and Wales 1977, 1983). Typical brown earths of the Rivington 1 association also occur over Carboniferous sandstones, but both types are so modified by fertiliser addition as to restrict natural occurrences to a few narrow strips along a network of footpaths, old railway banks and narrow field boundaries. Many casuals of the Cardueae Tribe of the Asteraceae appear to have suffered due to the progressive reduction in marginal habitats on natural soils and in their inability to withstand competition from gregarious weed species. This group includes species of *Centaurea* such as *C. calcitrapa*, *C. solstitialis*, *C. melitensis*, *C. diluta*, along with *Carthamus tinctorius*, *C. lanatus*, *Silybum marianum* and *Scolymus maculatus*. An increase in a highly competitive nitrophilous weed flora thus appears to have further restricted the frequency of opportunity for annual and biennial wool aliens typical of relatively xeric soil conditions.

Rhubarb was first grown in the Wakefield region of West Yorkshire in the late-nineteenth century and by 1938, the 3818 acres accounted for 52.8% of the total acreage of the crop in England and Wales (Beaver 1941). The concentration was truly remarkable and a vital mainstay of many small farms; in the parish of West Ardsley 40% of the arable land was devoted to the crop, in Morley parish 36%, and in Outwood 34%. Beaver remarks: 'The soils are not by nature rich, and intensive cultivation

can only be sustained by frequent heavy applications of manure – which, incidentally, is now less easy to obtain than in the days when horse-drawn drays and not lorries were the chief means of transport in the towns.' The implication here is that the use of wool waste had not yet become the predominant method of fertilisation in the late-1930s. This is confirmed by local information that describes the acquisition in 1941–42 of a new rhubarb variety 'Timperley Early', from the eponymous Cheshire village, where it was grown with great success by the application of liberal amounts of sewage and night soil. The same treatment was tried in the West Riding for a few seasons, but gradually the almost exclusive use of readily available wool waste came to predominate in the late forties. In the same decade, the market gardeners of Bedfordshire began to import large quantities of wool waste, but other vegetable producing regions such as the peatlands of Lincolnshire, Cambridge and south Lancashire continued to rely upon sewage, night soil and farmyard manure. Since the maximal extent of the industry in the late 1930s, a variety of market forces and agricultural trends have led to the reduction of the acreage under rhubarb in West Yorkshire from almost 4000 acres to about 150 acres from which three main growers produce the bulk of British rhubarb. Wilmore (2000) has remarked on that there has the general trend towards cereal production and a consequent decline in the use of wool waste as a fertiliser. A decline in the areal extent of traditional rhubarb fields has thus reduced the extent of habitat treated with wool waste and consequently the opportunities for the growth of wool aliens.

CHARACTERISTICS OF THE WOOL ALIEN FLORA OF THE RHUBARB FIELDS OF WEST YORKSHIRE

From the comprehensive data presented in Wilmore (2000), it is clear that most of the recording of wool aliens in West Yorkshire in the period 1950–1980 was undertaken on the waste tips of scouring mills in the region. Significantly, all the records prior to 1980 came from localities in ten kilometre grid squares other than SE32 and it was mainly through the fieldwork of John Martin that the flora of the shoddy fields of Ardsley, Rothwell and Oulton in this latter grid square became so well known. His database and herbarium and the publication of his records by Wilmore (2000) are surely one of the major contributions to botanical

recording in the British Isles in the late-twentieth century and the data allow meaningful interpretations of the nature of the presumed wool alien flora in one of its last refuges. Fieldwork by the author since 2000 has suggested that the special ecology and environment provides a refuge for several groups of uncommon and declining alien plant species, a selection of which is discussed in the following text.

Seven species of the Pigweed genus *Amaranthus* are considered by Wilmore to be especially characteristic of the shoddy fields, whilst formerly being found as grain aliens in docklands and on local authority rubbish tips in the 1950s and 1960s. It is difficult to consider several of them to be wool aliens (*A. albus*, *A. blitoides*, *A. hybridus* and *A. retroflexus*) for they originate from North America, never a traditional source of imported wool in living memory, but a source of raw cotton, oilseed and grain, commodities that may have been a past vector. Wool imports from South Africa and South America may have resulted in the presence of *A. capensis*, *A. thunbergii* and *A. quitensis*, but the quantities imported have been so small that other vectors such as oilseed or bird seed must be considered as strong

contenders (Hanson & Mason 1985). One of the rhubarb growers recalls using oilseed waste from the mills of British Oil and Cake Mills Ltd., (BOCM) at Selby in the 1970s (BOCM Pauls 2005). From its early establishment in 1910, the port mill of Selby on the Aire-Calder Navigation, some 30 km to the east, crushed oilseeds to produce vegetable oils for the human food industries and the by-product of this process was oilseed cake, a rich source of protein for feeding to all types of animals. The cake comprised waste from vegetable oilseeds such as soya from the USA and South America, groundnuts from West Africa and cottonseed from East Africa and the Far East, mixed with waste from maize and hard red wheat from the USA. All these provenances could account for the presence of most *Amaranthus* species recorded as aliens in Britain. But this source for the shoddy field aliens would necessitate either regular replenishment with the waste, for which there is no evidence, or production of viable seed annually for twenty years by *A. hybridus* to account for many of the later records. This latter situation may be the case for there are fourteen records from 1982 to 1998 *passim* (Table 1), four from Woodhouse Lane Farm, East Ardsley (SE2924), in which locality I have

TABLE 1. COMMONNESS AND RARITY OF *AMARANTHUS* AND *ERODIUM* SPECIES IN V.C. 63, POST-1980, IN 10 KM GRID SQUARES SE22 AND SE32

Species	Origin	post 1980 Records	1 km grid squares	Other 10 km records
<i>Amaranthus hybridus</i>	Tropical & North America	14	8	—
<i>A. albus</i>	North America	5	3	SE42
<i>A. retroflexus</i>	Tropical & North America	3	2	SE13/60/72
<i>A. blitoides</i>	North America	2	2	—
<i>A. thunbergii</i>	Tropical & South Africa	2	2	—
<i>A. viridis</i>	Tropical America	2	2	—
<i>A. capensis</i>	South Africa	1	1	—
<i>A. deflexus</i>	South America	1	1	—
<i>A. quitensis</i>	South America	1	1	—
<i>Erodium cicutarium</i>	Native/Mediterranean	>20	>10	22 SE squares
<i>E. moschatum</i>	Mediterranean	>20	>10	SE11/13
<i>E. botrys</i>	Mediterranean	15	8	SE13
<i>E. crinitum</i>	Australia	8	6	SE13
<i>E. stephanianum</i>	China, SE Asia	3	3	—
<i>E. brachycarpum</i>	North Africa	2	2	—
<i>E. chium</i>	Mediterranean	2	2	—
<i>E. malachoides</i>	SW Asia	2	2	—
<i>E. ciconium</i>	Australia	1	1	—
<i>E. cynorum</i>	Australia	1	1	—
<i>E. laciniatum</i>	Mediterranean	1	1	—

[Tabulated data derived from an interpretation of cartographic details presented by Lavin & Wilmore (1994) and textual records published by Wilmore (2000)]

recorded it in 2002 and 2005. If regular seed set does occur, therefore, one must simply surmise that it is the phospho-nitrophilous nature of the habitat that encourages the growth of such a diversity of species, rather than repeated introductions; that it is ecology which is the determining factor for their ontology.

Other species from a variety of families have equally dubious origins. For example, *Sisymbrium irio*, according to Rich (1991) is "often associated with grain imports and often as a wool alien", whereas Pearman (2002) considers it to be "formerly a wool alien." Of the forty-one records cited in Wilmore (2000), twenty-nine are from wool waste dumps and shoddy fields of Yorkshire, and in two localities at East Ardsley (SE2924) and Newton Hill (SE3222), there are respectively ten and nine annual records in the period 1981–94. These data and personal observations in the period 2002–05 indicate that there can be no doubt that this species of Eurasian origin reproduces annually by seed and as such cannot be considered as a wool casual requiring reintroduction from seed in waste wool originating in the Middle East. Yet one must not dismiss a similar origin to the species of *Amaranthus*, as an oilseed alien maintaining itself in a nutrient-rich, frequently disturbed habitat. The shoddy field habitat could probably not be more contrasting than some of those of the plant's original London localities, such as the Roman walls and environs of the Tower. A similar diversity of origin is implied for various alien members of the Poaceae, Yorkshire records for approximately 30% (45 species) of which come from this locality. The species are mostly Mediterranean in origin and there is a strong probability that most may be sourced to wool imports, but the rhubarb fields are also the main habitat for *Ehrharta longiflora* from South Africa, *Ceratochloa brevis* and *C. cathartica* from South America, and from tropical regions *inter alia*, *Chloris virgata*, *Setaria verticillata* and *Pennisetum clandestinum*. Again, the oilseed cake residues from Selby are perhaps more strongly implicated as vectors than wool waste.

Certain groups of species with fruiting heads, fruit or seeds that are clearly adapted to animal dispersal by their ornamentation with hooks and spines may be considered with a far greater certainty as wool aliens. Examples of gross morphological adaptations include the species of *Centaurea* mentioned earlier, the two

species of thistle, *Carduus tenuiflorus* and *C. pycnocephalus*, and *Datura stramonium* for which the rhubarb fields are probably the main inland locality in Britain. In the Lamiaceae, *Marrubium vulgare* has hooked calyx teeth, in the Malvaceae, the two commonly encountered species *Malva pusilla* and *M. parviflora*, have reticulate and ridged nutlets, whilst most species of *Medicago* (Fabaceae) have curved or spiraled, spiny fruits. Wilmore (2000) lists eleven species in the genus, of which *M. arabica*, *M. laciniata*, *M. minima* and *M. polymorpha* are the most common and particularly characteristic of the shoddy fields where they will certainly set viable seed. There are, for example, relatively early records by Kit Rob for *M. laciniata* from a potato field at Berryhills in v.c. 65 for the period 1958–63, and it was also recorded during the present study in a single rhubarb/cauliflower field at Rothwell (v.c. 63) in the period 2000–05 by the author. Wilmore also records eleven species of *Erodium* (Geraniaceae) in the Rhubarb Triangle, only four of which were found to be relatively frequent during the past five years' research (Table 1). All these species are characterized by the beaked or hooked apices of their mericarps, a feature which is no doubt responsible for their dissemination in wool waste. Although the native *E. cicutarium* is regarded as native in sandy, coastal habitats, here in the vegetable fields it is certainly introduced and is probably of Mediterranean origin. The same is true of *E. moschatum*, often the most obvious species, capable of attaining a gregarious growth which makes it the dominant weed in several fields. Both species set good seed regularly but observations on whether *E. botrys*, of Mediterranean origin, and *E. crinitum* from Australia, do likewise proved to be inconclusive.

FLORA OF THE WASTE DUMPS OF THE UPPER COLNE VALLEY

A previously unrecorded use of wool waste in agriculture came to the notice of the author in 2000, namely, its use by several milk, suckling and beef cattle farmers in the Slaithwaite district of the upper Colne Valley (SE01), where local information indicated that the practise had been in operation for the past twenty years. The origin of the shoddy is the Dewsbury scouring company of Chadwick & Sons and it is used for bedding cattle in stall

during winter. When the cattle are turned out to grass in late-April, the bedding, comprising a mixture of shoddy, straw, manure and silage is cleared to waste dumps and left to rot. After several years rotting, usually a minimum of five, the mixture is spread on pastures previously treated with herbicide and then ploughed in as an organic nitrogen-rich fertiliser to encourage growth of an Italian ryegrass silage crop. That the environments of the dumps are short-lived is exemplified by the fact that those at Booth Hey Top (locality 2) were spread and ploughed into the surrounding pastures in the winter of 2004. In 2005, only *Chenopodium murale* and *Medicago arabica* survived in nutrient rich wall bottoms and a marginal footpath strip, the bank of which yielded a surprisingly luxurious growth of *Conopodium majus* and *Ranunculus bulbosus*. The waste heaps are augmented by a new dump of used bedding each year, so that several heaps comprise a sequence of five annual deposits on which a short-term vegetation succession is sometimes apparent. The habitat is extremely nitrogen-rich and Table 2 shows both the nitrogenous nature of wool shoddy relative to other animal by-products and the contributions of the other three components of the habitat. The habitat differs from that of the rhubarb fields of East Ardsley and Rothwell in this respect that the environment is wholly waste dump, lacking adjacent, native arable soil. The other major difference between the two habitats is that the Slaithwaite waste dumps are at least 200 m higher at 245–330 m compared to an altitudinal range of 50–125 m for the rhubarb fields. These two considerations, plus the fact that the waste dumps are simply much smaller in area, accounts for the lower species diversity; no species was present on the dumps and absent in the rhubarb fields, though some such as *Chenopodium murale* had a seemingly greater frequency of occurrence.

A study of the five waste heaps over the period 2001–2005 showed that the components of their flora may be divided into six ecosociological groups:

- a. a group of common annual weeds typical of most nutrient-rich habitats that occur in abundance over the first three years of the life of the waste dumps: *Atriplex patula*, *Chenopodium album*, *Epilobium ciliatum*, *Matricaria discoidea*, *Polygonum aviculare*, *Poa annua*, *Persicaria lapathifolia*, *Sonchus oleraceus* and *Stellaria media*;

TABLE 2. PERCENTAGE NITROGEN CONTENT OF COMPOST MATERIALS

	Source 1	Source 2
Animal Manures		
pigeon	4.2	---
fowl	1.6	1.0
dog	1.9	---
duck	1.1	1.0
pig	0.6	0.4
horse	0.4	0.6
cow	0.3	0.4
Animal By-products		
feather	15	8
blood meal	15	12
hoof & horn meal	12	12
silk waste	8.4	--
wool shoddy	8	10
fish meal	6.5	9
bone meal	4	4
Vegetable Wastes		
field bean haulms	1.70	
cotton waste	1.32	
timothy hay/silage	1.25	
brewing molasses/grain	0.70	
potato haulms	0.60	
wheat straw	0.50	
beet haulms	0.40	

Source 1: Primal Seeds (2004). Percentage composition of composts. <http://www.primalseeds.org/npk.htm>

Source 2: Moor, F (2004). The world of soil: food values of different manures and fertilisers. <http://web.ukonline.co.uk/fred.moor/soil/fertilis/f01.htm>

- b. a group of gregarious perennials that gradually come to dominate after approximately five years: *Cirsium arvense*, *Dactylis glomerata*, *Elymus repens*, *Galium aparine*, *Lolium perenne*, *Phleum pratense*, *Rumex obtusifolius*, *Trifolium repens* and *Urtica dioica*;
- c. species with helophyte tendencies, both annual and perennial, growing in the moist environment provided by the water-absorbent shoddy: *Agrostis stolonifera*, *Alopecurus geniculatus*, *Impatiens glandulifera*, *Puccinellia distans* and *Ranunculus repens*;
- d. cereal species from seed in the straw and cattle feed: *Avena fatua*, *Hordeum vulgare* and *Triticum vulgare*;
- e. pioneer species characteristic of high nitrogen environments such as *Chenopodium murale*, *Datura stramonium* and *Arctium minus*;

TABLE 3. FREQUENCY OF SELECTED ANNUAL AND BIENNIAL SPECIES OF ECOSOCIOLOGICAL GROUPS E & F ON SLAITHWAITE WASTE DUMPS, 2001–05

Species	2001	2002	2003	2004	2005	Records	%F	C/I
<i>Chenopodium murale</i>	1–3,5	1–5	1,2,4,5	1–5	1,2,4,5	21	80	-1.63
<i>Erodium cicutarium</i>	1–5	1,3–5	1,3–5	1,3–5	1,3–5	21	77	-0.11
<i>Medicago arabica</i>	1–3,5	1–3	1–3,5	1–3,5	1–5	20	77	+0.69
<i>Erodium moschatum</i>	1,2,5	1,2,5	1,2	1,2,5	1,5	13	53	+0.47
<i>Melilotus indicus</i>	1–3	1,2	1,2	1,3–5	1	12	50	-1.59
<i>Melilotus albus</i>	1,2	1,2	2,5	1,2,5	1	10	33	-0.20
<i>Geranium molle</i>	1,3	3	1	1,3	1,5	8	33	-0.46
<i>Melilotus officinalis</i>	1,4	1,4	1,5	4	1	8	33	+0.02
<i>Arctium minus</i>	4,5	4,5	-	4,5	4	7	28	-0.41
<i>Malva parviflora</i>	1,4,5	-	3,4	3,5	-	7	28	nd
<i>Malva pusilla</i>	-	1,2,4	1,2	1,2	-	7	28	nd
<i>Geranium pusillum</i>	1	1	1,3	1	1	6	24	+0.16
<i>Geranium lucidum</i>	1	1	1	1	1	5	20	+1.42
<i>Marrubium vulgare</i>	2	2	2	1,2	-	5	20	-2.02
<i>Medicago polymorpha</i>	1,2	1	-	-	4	4	16	-1.34
<i>Datura stramonium</i>	-	-	1,2	2	-	3	12	-0.71
<i>Geranium dissectum</i>	1	1	1	-	-	3	12	-0.09
<i>Trifolium arvense</i>	1	1	1	-	-	2	12	-0.01
<i>Carduus tenuiflorus</i>	1	1	-	-	-	2	8	-0.14
<i>Erodium botrys</i>	-	-	2	2	-	2	8	nd
<i>Sisymbrium irio</i>	-	-	3	-	3	2	8	+0.13

Localities	Grid Ref	Alt (m)	Area (m ²)
1. Coalgate, Slaithwaite	SE052140	330	3500
2. Booth Hey Top, Slaithwaite	SE057137	315	1500
3. Row Farm, Slaithwaite	SE063138	285	900
4. Delves Lane, Dowry Farm, Lingards	SE077128	265	1500
5. Shroggs Top, Dowry Farm, Lingards	SE076129	245	1000

Records = number of records in 2001–2005; %F = % frequency of occurrence; C/I = Change Index as derived from Preston, Pearman & Dines (2002)

- f. annual and biennial species typical of open habitats, probably introduced as seed from the cleaning of imported wool; divisible into four sub-groups:

(i) members of the Fabaceae with nitrogen-fixing root nodules – *Medicago arabica*, *M. polymorpha*, *Melilotus albus*, *M. indicus*, *M. officinalis*, *Trifolium arvense*;

(ii) members of the Geraniaceae, including *Erodium cicutarium*, *E. moschatum*, *E. botrys*, *Geranium dissectum*, *G. lucidum*, *G. molle* and *G. pusillum*;

(iii) members of the genus *Malva* – *M. parviflora* and *M. pusilla*.

(iv) members of other families – for example, *Marrubium vulgare* (Lamiaceae) and *Carduus tenuiflorus* (Asteraceae).

In terms of the sociological affinities of the six components, Group (a) constitutes a variant of OV33 *Polygonum lapathifolium*-*Poa annua* community, the Group (b) assemblage fits into OV25 *Urtica dioica*-*Cirsium arvense* community, and Group (c) finds a place in OV28 *Agrostis stolonifera*-*Ranunculus repens* community (Rodwell 2000). Groups (e) and (f) show the closest affinity to OV25 which is seen to contain four of the species in Table 3 (*Arctium minus*, *Geranium dissectum*, *G. molle* and *Malva neglecta*), plus *Amaranthus albus*. There are other less significant associations with three species. Specifically, these are OV5 *Digitaria ischaemum*-*Erodium cicutarium* community (with *Amaranthus retroflexus*, *Erodium cicutarium* and *Geranium molle*) and OV6 *Cerastium glomeratum*-*Fumaria muralis* ssp. *boraiei* community (with *Erodium*

moschatum, *Medicago arabica* and *Medicago polymorpha*). However, the apparent restriction of these two communities to the Bagshot Beds in Surrey and the Scilly Isles and southwest Cornwall respectively, precludes any meaningful insight into sociological affinities. *Chenopodium murale* is recorded only once in OV30 *Bidens tripartita*-*Polygonum amphibium* community typical of the eutrophic margins of lowland ponds and clearly not closely akin to the waste dump habitat in its physiognomy. From the frequency records in Table 3, the waste dumps are clearly a major habitat for this archaeophyte which has a change index of -1.63 (Akeroyd 2002). It is one of a group of species with a relatively high negative change index that includes *Marrubium vulgare* (-2.02), *Melilotus indicus* (-1.59) and *Medicago polymorpha* (-1.34). Finally, it is interesting to note that of the seventeen species listed in Group f above, only the three *Melilotus* species, *Erodium botrys*, *Malva parviflora* and *M. pusilla* are given full records by Wilmore (2000). Nine of the remaining species are relegated to an appendix on account of their native status in parts of Britain other than Yorkshire, whilst three – *Geranium dissectum*, *G. molle* and *G. pusillum* – are not considered as aliens. These three species of Crane's-bill are clearly to be considered as wool aliens and probably symbolise the changing face of the woollen manufacturing industry in that most of the home scoured wool, and hence the waste, comes from UK sources.

DISCUSSION AND CONCLUSIONS

From the foregoing information, it is quite clear that the nature of the UK woollen manufacturing industry has undergone major changes in the past thirty years, particularly, in a context relative to the changing flora of Britain, with respect to the change to the predominant use of imported, clean wool and the concomitant decline of British scouring companies. As a direct consequence, the quantities and sources of wool waste available to the agricultural industry have declined dramatically. Further, there is now a predominance of the use of the home clip from Britain and Ireland over imported wool in the few remaining scouring mills, and the shoddy manufacturers are legally bound under EC regulations to use only clean imported rags. All these features have contributed to a major decrease in the size and diversity of the wool

alien seed bank entering the country. In addition, the relatively small quantity of wool waste available for use as fertiliser in agriculture has declined drastically and hence, so has its geographical use. Thus, at the start of the twenty-first century, the potential replenishment and continued existence of a wool alien flora is apparently restricted to two localised areas of West Yorkshire. The future prospects for this specialised section of the British flora would thus appear to depend on the continued operation of the two scouring mills and the use of wool waste in the rhubarb growing industry and as in-stall bedding for livestock. In an era of multiple subsidies for many aspects of the processing and production industries there may be a case to be made for the conservation of this traditional industrial and agricultural linkage as a strategy for halting future loss of biodiversity.

Perhaps a more practical and immediate contribution to an understanding of the future prospects of this section of the British flora would be the inception of a programme of research into the reproductive capacities of selected species as a contribution to the conservation of biodiversity in the face of changing climate. Four main groups/types would seem worthy of investigation. First, a comparative study of the various species of well represented genera, such as *Amaranthus*, *Erodium* and *Medicago*, should yield valuable data on their relative ability for establishment as stable neophytes. Second, the investigation of plants with high negative change index values, >1.0 (Preston, Pearman & Dines 2002), such as the native *Marrubium vulgare* (-2.02) and *Medicago polymorpha* (-1.34), the archaeophyte *Chenopodium murale* (-1.63) and the neophyte *Melilotus indicus* (-1.59) should provide insights into their conservation. Third, there would seem to be some merit in acquiring information on certain neophytes for which there is a lack of change index data, including *Malva parviflora* and *M. pusilla*, *Trifolium angustifolium* and *T. hirtum*. Finally, an investigation of the reproductive capacities of native species in this habitat, in comparison with their capacities in other more typical habitats, such as *Geranium lucidum*, *G. molle* and *G. pusillum* and *Trifolium arvense*, might form a fourth avenue of research. Apart from generating an important botanical and ecological data base, such research would also aid the definition of which species might be termed established 'wool aliens' and which considered as mere 'wool casuals'.

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REFERENCES

- AKERROYD, J. R. (2002). *Chenopodium murale*, in Preston, C. D., Pearman, D. A. & Dines, T. D. (2002). *New Atlas of the British & Irish Flora*. Oxford University Press, Oxford.
- BEAVER, S. H. (1941). The West Riding of Yorkshire, in STAMP, L. D., ed. *The Land of Britain. The Report of The Land Utilisation Survey of Britain*. Part 46. London School of Economics, Geographical Publications Ltd., London.
- BOCM PAULS (2005). A history of British Oil and Cake Mills Ltd. <http://www.bocmpauls.co.uk/bocmpauls/main/page.jhtml> (accessed 3 August 2005).
- CLEMENT, E. J. & FOSTER, M. C. (1994). *Alien Plants of the British Isles*. Botanical Society of the British Isles, London.
- DONY, J. G. (1953). *The Flora of Bedfordshire*. Hitchin Museum, Hitchin Urban District Council.
- DONY, J. G. (1969). Additional notes on the flora of Bedfordshire. *Proceedings of the Botanical Society of the British Isles* **7**: 523–535.
- DONY, J. G. (1976). *Bedfordshire plant atlas*. Borough of Luton Museum and Art Gallery, Luton.
- DONY, J. G. & DONY, C. M. (1986). Further notes on the flora of Bedfordshire. *Watsonia* **16**: 163–172.
- FITCHETT, C. E. (1943). Bedfordshire, in STAMP, L. D., ed. *The Land of Britain. The Report of The Land Utilisation Survey of Britain*. Part 55. London School of Economics, Geographical Publications Ltd., London.
- HANSON, C. G. & MASON, J. L. (1985). Bird seed aliens in Britain. *Watsonia* **15**: 237–252.
- HAYWARD, I. M. AND DRUCE, G. C. (1919). *The adventive flora of Tweedside*. T. Buncle & Co., Arbroath.
- LAVIN, J. C. & WILMORE, G. T. D. (1994). *The West Yorkshire Plant Atlas*. City of Bradford Metropolitan Council, Bradford.
- LEES, F. A. (1888). *The Flora of West Yorkshire*. Lovell Reeve, London.
- LEES, F. A. (1941). *A Supplement to the Yorkshire Floras*. A. Brown, Hull.
- LOUSLEY, J. E. (1958). Alien plants introduced by the Yorkshire wool industry. *Naturalist (Hull)* **1958**: 77–81.
- LOUSLEY, J. E. (1960). How sheep influence the travel of plants. *New Scientist* **8**: 353–355.
- LOUSLEY, J. E. (1961). A census list of wool aliens found in Britain, 1946–1960. *Proceedings of the Botanical Society of the British Isles* **4**: 221–247.
- LOUSLEY, J. E. & DONY, J. G. (1952). The travels of plants. *Bedfordshire Magazine* **3**: 185–189.
- MOOR, F. (2004). The world of soil: food values of different manures and fertilisers. <http://homepages.which.net/~fred.moor/soil/fertilis/f0107.htm> (accessed 8 November 2004).
- PEARMAN, D. A. (2002). *Sisymbrium irio*, in PRESTON, C. D., PEARMAN, D. A. & DINES, T. D. (2002). *New Atlas of the British & Irish Flora*. Oxford University Press, Oxford.
- PRESTON, C. D., PEARMAN, D. A. & DINES, T. D. (2002). *New Atlas of the British & Irish Flora*. Oxford University Press, Oxford.
- PRIMAL SEEDS (2004). An alphabetical list of random compost materials. <http://www.primalseeds.org/npk.htm> (accessed 8 November 2004).
- RICH, T. C. G. (1991). *Crucifers of Great Britain and Ireland*. B.S.B.I. Handbook No.6. Botanical Society of the British Isles, London.
- RODWELL, J. S., ed. (2000). *British Plant Communities 5: Maritime communities and vegetation of open habitats*. Cambridge University Press, Cambridge.
- SOIL SURVEY OF ENGLAND AND WALES (1977). *Soils of South and West Yorkshire, 1:250,000*. Ordnance Survey, Southampton.
- SOIL SURVEY OF ENGLAND AND WALES (1983). *Soils of Northern England, Sheet 1, 1:250,000*. Ordnance Survey, Southampton.

- STACE, C. A. (1997). *New Flora of the British Isles*. Second Edition. Cambridge University Press, Cambridge.
- WILMORE, G. T. D. (2000). *Alien Plants of Yorkshire*. Yorkshire Naturalists' Union, York.
- WOOL RESEARCH ORGANISATION OF NEW ZEALAND (2005). A history of technological innovation in New Zealand. <http://www.techhistory.co.nz> (accessed 28 April 2005).

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Conservation of Britain's biodiversity: *Hieracium riddelsdellii* (Asteraceae), Riddelsdell's Hawkweed

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ABSTRACT

Hieracium riddelsdellii Pugsley, Riddelsdell's Hawkweed, is a rare Welsh endemic plant. It was first found in 1899, was described as a variety in 1907, and raised to a species in 1941. It has been reported from four sites, but is currently only known in two localities in the Brecon Beacons (v.c. 42) and one in Carmarthenshire (v.c. 44), with an estimated total population of about 870 plants. Records for Berwickshire (v.c. 81) refer to another taxon. It qualifies as 'Vulnerable' under the IUCN Threat Criteria. The main threat is the spread of *Cotoneaster integrifolius* over its Carboniferous Limestone rocky habitats, but all populations would also benefit from relaxation of grazing pressure. It is being cultivated at the National Botanic Garden of Wales and seed has been deposited in the Millennium Seed Bank.

KEYWORDS: endemic, IUCN Threat Criteria, lectotype, Wales.

INTRODUCTION

Hieracium riddelsdellii Pugsley (Asteraceae), Riddelsdell's Hawkweed, is a very rare, endemic plant, which has been reported from localities in the Brecon Beacons (v.c. 42), Carmarthenshire (v.c. 44) and Berwickshire (v.c. 81) (Sell & West 1968; Wigginton 1999). It was reported from four 10-km squares by D. McCosh in the Vascular Plant Red Data Book (Wigginton 1999): these were SN81 Craig-y-nos, SN82 Llyn y Fan Fach, SN92 Craig Cerrig-gleisiad and NT96 Burnmouth (D. McCosh, pers. comm., 2004). Recently, as the status of some of its records and the relationship between the Brecon and Berwickshire plants had been revised, further information on its distribution and population sizes was required to inform conservation work. A joint project was therefore set up between the National Museum of Wales, the National Botanic Garden of Wales and the Countryside

Council for Wales to review its current status and determine its need for conservation. In this paper the information is summarised; full details can be found in Rich (2004a, b).

TAXONOMY AND IDENTIFICATION

Hieracium riddelsdellii was first separated as a distinct taxon by A. Ley who named it as *H. ciliatum* Alm. var. *venosum* (Ley 1907). Ley had first found it abundantly on the Craig-y-nos ridge in 1899 and cultivated it thereafter. Later, whilst naming *H. repandum* Ley (now *H. repandulare* Druce), he transferred it to that species, retaining it at varietal rank (Ley 1909). Pugsley (1941) raised it to species rank and named it after H. J. Riddelsdell (one of the early collectors), as the name *H. venosum* L. was already in use for another species. It is a member of *Hieracium* Section *Stelligera* Zahn (Section *Sub-Oreadea* Pugsley).

A lectotype for *H. ciliatum* Alm. var. *venosum* Ley, for which *H. riddelsdellii* Pugsley is a *nom. nov.*, has been selected by P. D. Sell and C. West as the sheet collected on 1 August 1899 from the high limestone ridge above Craig-y-nos, Breconshire by A. Ley in **herb. Ley** (currently in **CGE**) which has Ley's original description and notes attached; it is hereby designated by P. D. Sell. Some other sheets in **BM** and **BIRM** have a different selection noted, which should now be disregarded.

SUMMARY OF SYNONYMY:

Hieracium riddelsdellii Pugsley, *Journal of Botany (London)* **79**: 181 (1941).

= *H. ciliatum* Alm. var. *venosum* Ley, *Journal of Botany (London)* **45**: 109 (1907).

= *H. repandum* Ley var. *venosum* Ley, *Journal of Botany (London)* **47**: 13 (1909).

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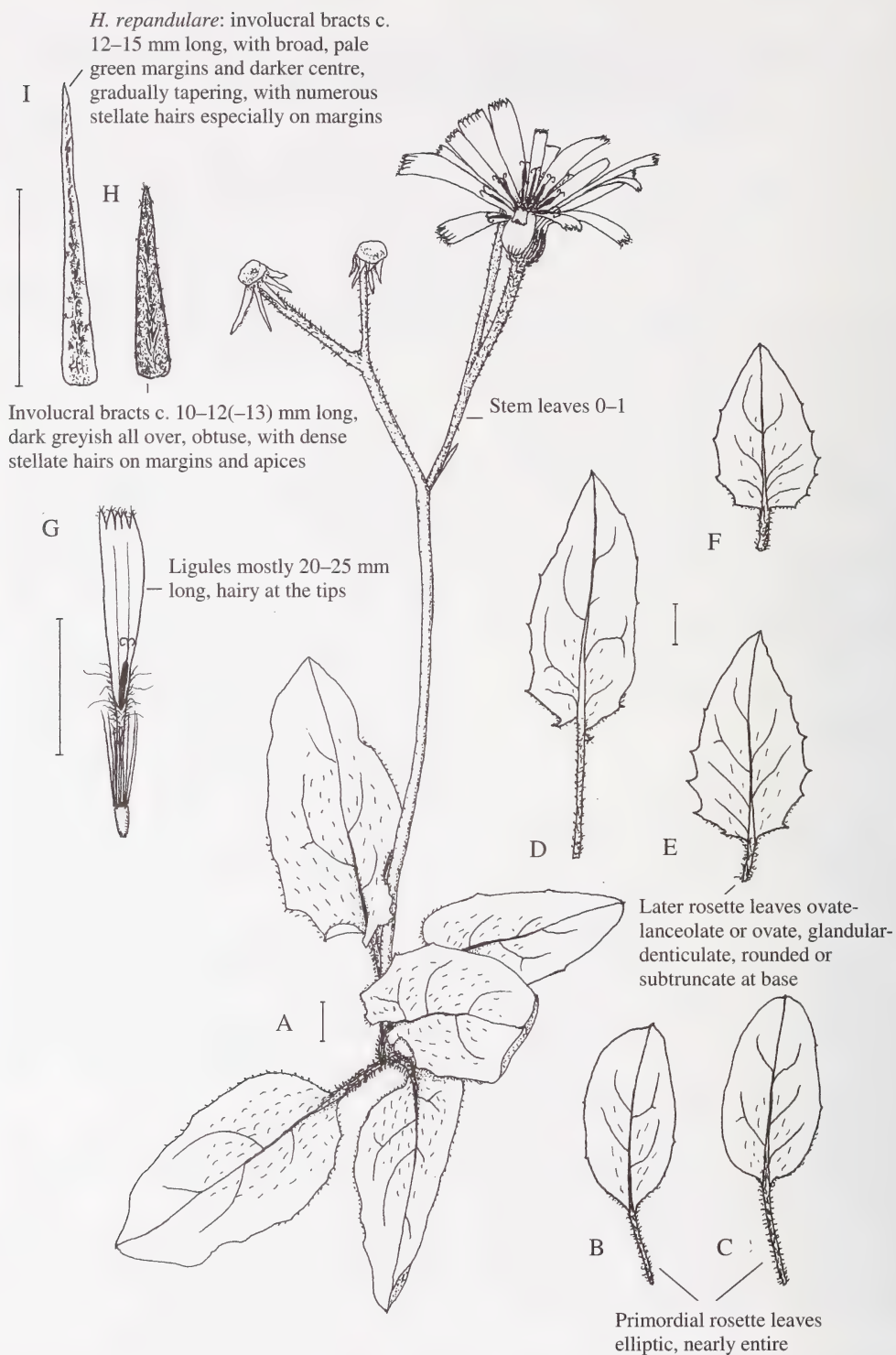


FIGURE 1. Illustration of *Hieracium riddelsdellii* showing main identification features. A. Whole plant. B–F. Basal rosette leaves. G. Flower. H. Involuclral bract. I. Involuclral bract of *H. repandulare*. Scale bars 1 cm.

TABLE 1. CHARACTERS DISTINGUISHING *HIERACIUM RIDDELSDELLII* AND *H. REPANDULARE*

Character	<i>H. riddelsdellii</i>	<i>H. repandulare</i>
Base of rosette leaves	Rounded to truncate, entire or with a few small teeth, younger rosette leaves sometimes with more pronounced teeth, usually green or partially flushed red	Rounded to truncate (rarely cordate), entire or toothed with small or pronounced teeth, often glaucous, sometimes green
Involucral bracts	c. 10–12(–13) mm long, greyish over most of involucral bract, obtuse-subacute, with dense stellate hairs on margins and apices (Figure 1, H)	c. 12–15 mm long, with broad pale green margins and darker centre, gradually tapering, with numerous stellate hairs especially on margins (Figure 1, I)
Capitula	Smaller, ligules up to 28 mm long	Larger, ligules up to 34 mm long

Key taxonomic features of *H. riddelsdellii* are the oval basal rosette leaves which are glandular-denticulate with a rounded or subtruncate base and sometimes large teeth, the rather slender usually leafless stem, the medium-sized heads which are rounded below, the dark green, mostly obtuse/subacute involucral bracts with dense stellate hairs on margins and apices (the latter like a white tuft in fresh material), the hairy tips to the ligules, and the yellow styles (Figure 1).

Sell & West (1968) noted that *H. riddelsdellii* is very similar to *H. repandulare* and could have been derived from the same parent, and that there are no very close allies of either. The differences between the two species are set out in Table 1; the best characters are the size, shape and hairiness of the involucral bracts. Pugsley (1948) suggested *H. riddelsdellii* could also be distinguished from *H. repandulare* in lacking the pronounced out-curved teeth at the base of the rosette leaves and the more compact inflorescence. However, during field work it was found that the leaf bases of both species are significantly more variable than noted by Pugsley, and toothiness of the leaves is unreliable for identifying them. The differences in compactness of the inflorescence are also more visible in cultivated plants than in the field.

Sell & West (1968) noted that plants at Burnmouth, Berwickshire (v.c. 81) matched the Brecon plants exactly morphologically and could be regarded as conspecific, though perhaps of different origin. More recently, this diagnosis has been questioned (Braithwaite & Long 1990). The original record was based on a specimen in CGE which is no longer in the *H. riddelsdellii* folder and has been re-determined, though P. D. Sell cannot currently recall to which species (pers. comm. 2005). D. McCosh has failed to refind *H. riddelsdellii*-

like plants on several visits to the Burnmouth populations; *H. britanniciforme* Pugsley is the most common plant at Burnmouth, and another nearby locality has a *Hieracium* species with noticeably pilose ligules but which is not *H. riddelsdellii*.

DISTRIBUTION

The historical records traced from the literature and herbaria (BM, BIRM, CGE, E, LIV, MANCH, OXF and NMW) are summarised in Table 2. It has been confirmed in three sites, and recorded doubtfully in another. Ley (1907, 1909) reported it only at Craig-y-nos; he had also collected it at Llyn y Fan Fach but included it under *H. repandulare*. There are also many duplicates of his cultivated specimens from Craig-y-nos 1903–1910. Records for Craig Cerrig-gleisiad are errors for *H. repandulare*.

The historic records were used to direct the field surveys. In addition, other suitable areas were searched in the Upper Tawe valley.

CRAIG-Y-NOS RIDGE, V.C. 42 BRECON (SN8314 AREA)
Craig-y-nos Ridge (also known as Cribarth) is a large Carboniferous Limestone hill on the west side the Tawe Valley, with low broken cliffs and screes along the south-east side and quarries on the top and at the east end of the hill. *Hieracium riddelsdellii* was found scattered and sometimes abundant throughout much of the site, especially on the unquarried rocks. In 2004, 388 plants in flower were counted, but there were many vegetative rosettes suggesting a total population of about double that, c. 750 plants (Rich 2004b).

CRAIG RHIWARTH V.C. 42 BRECON (SN8314 AREA)
There is a specimen from Craig Rhiwarth, 8 July 1906, A. Ley in CGE, but I am

TABLE 2. HERBARIUM RECORDS OF *HIERACIUM RIDDELSDELLII*

Locality/date	Collector	Site	Source and notes
Craig-y-nos/Cribarth (v.c. 42)			
1/8/1899	A. Ley	Craig-y-nos, high limestone ridge west of, 1250 ft., abundantly	BM, CGE (lectotype), LIV, OXF, NMW
6/7/1900	A. Ley	Craig-y-nos ridge	BM
10/6/1904	A. Ley	Craig-y-nos ridge	BM, CGE, LIV, OXF, NMW
11/6/1904	A. Ley & H. J. Riddelsdell	Craig-y-nos ridge	BM, BIRM, CGE, LIV, MANCH, NMW
3/7/1906	E. F. Linton	Craig-y-nos	BM, LIV
8/7/1906	A. Ley	Craig-y-nos	CGE
3/6/1953	J. E. Raven	Craig-y-nos, old quarry	E
23/6/1953	P. D. Sell	Craig-y-nos Castle, quarry by, SN841150	CGE
29/5/1955	C. A. E. Andrews	Craig-y-nos quarry	BIRM
22/7/1957	F. R. Browning	Craig-y-nos	BM
15/6/1958	B. A. Miles	Old quarry above Pant-y-wal Farm	CGE
1/6/1963	J. N. Mills	Craig-y-nos, limestone cliffs SN841150	MANCH
15/6/2000	T. C. G. Rich & S. O. Hand	Craig-y-nos ridge and quarry SN8314, 8414 and 8515	NMW
Penwyllt (v.c. 42)			
23/8/1965	J. N. Mills	Penallt, disused quarry near SN856161	MANCH
Llyn y Fan Fach (v.c. 44)			
4/7/1906	A. Ley	Craig y Llyn y Fan Fach, Carmarthenshire	CGE
20/7/1960	B. A. Miles	Llyn y Fan Fach, cliffs above, main gully in western corner SN800214	CGE
27/6/2002	T. C. G. Rich	Llyn y Fan Fach, 9 plants and 1 seedling, main gully, SN800215	NMW

unconvinced of its identity. Craig Rhiwarth is a very likely locality being directly up-wind and on the opposite side of the valley to the Craig-y-nos Ridge. The site has been searched three times since 2000, and no material has been found.

PENWYLLT, V.C. 42 BRECON (SN8516 AREA)

There are numerous disused Carboniferous Limestone quarries around Penwyllt, all but one of which with no access have been searched. The Twyn Disgwyfla Quarry (SN856161) has been markedly enlarged since *H. riddelsdellii* was recorded by J. N. Mills in 1965 (Table 2), and no plants could be found in 2004. *Hieracium riddelsdellii* was however found in the two adjacent disused quarries to the south, with 105 plants flowering in the larger quarry at SN856156, and four plants flowering on west-facing cliffs in the smaller quarry at SN856157.

Llyn y Fan Fach, V.C. 44 CARMARTHEN (SN800215)

The Old Red Sandstone crags above Llyn y Fan Fach form a cirque which has had at least fourteen species of *Hieracium* reported, though only about half this number have been collected in recent years. On 27 June 2002, nine plants and one seedling of *H. riddelsdellii* were refound in three close groups on the low cliffs at the bottom on the main gully above the western end of Llyn y Fan Fach, where *H. riddelsdellii* had previously been localized by B. A. Miles.

Hieracium riddelsdellii is thus currently known from three populations in two 10-km squares in two vice-counties, with a total estimated population of 870 plants. One population at Twyn Disgwyfla Quarry has been destroyed. A 10-km square distribution map is given in Figure 2.

LIFE CYCLE AND ECOLOGY

Like most British *Hieracium* species, *H. riddelsdellii* is a polycarpic perennial which reproduces by seed. The main flowering period is mid May to mid June, and seeds ripen about 3–4 weeks after flowering. It is probably an obligate apomict: the stamens and styles were excised on one of the two flowering heads in bud on the one plant available in cultivation in 2004, which did not prevent seed set (further larger scale trials are required). The mean potential pollen viability assessed using Alexander's Stain (Alexander 1969) was 57.2% $\pm$ 3.36 s.e. ($n = 25$) (H. Cleal & T. Rich,



FIGURE 2. National distribution map of *H. riddelsdellii*, plotted using DMAPW by Alan Morton. ● 2002–2004. x = error.

unpublished). The seeds have a small pappus and are wind-dispersed. DNA analysis of five *H. riddelsdellii* plants using amplified fragment length polymorphism (AFLP) during an investigation of genetic variation in *Hieracium cyathis* (Ley) W. R. Linton showed each plant was genetically different (M. D. Lledó, pers. comm. 2006).

The associated vegetation was recorded in seven representative 2 m $\times$ 2 m quadrats. The vegetation was usually open (mean percentage cover 9%, range 5–20%), short (mean height 5 cm, range 2–10 cm), and on steep slopes (mean slope 79°, range 70–90°) of all aspects. In terms of *British Plant Communities* (Rodwell *et al.* 1991–2000), the vegetation was generally the OV39 *Asplenium trichomanes* – *Asplenium ruta-muraria* community and the CG10 *Festuca ovina* – *Agrostis capillaris* – *Thymus praecox* grassland.

Soil pH was measured with a pHep2 Hanna pocket-sized pH meter in a 50:50 mixture with distilled water on soil samples collected from around the roots. Five pHs of soils measured from the limestones of Craig-y-nos area were 6.9, 6.9, 7.0, 7.1 and 7.7, and pH 6.5 was measured from soils derived from the Old Red Sandstones at Llyn y Fan Fach; these indicate *H. riddelsdellii* is a calcicole.

In 2000, 2003 and 2004, many flowering heads were infected by a small grub causing distorted growth and sterility (Pugsley 1948 noted this for *Hieracia* generally), and in 2004 many plants were heavily infested with aphids which were unusually abundant that year.

CONSERVATION

Under the IUCN (2001) Threat Criteria, *H. riddelsdellii* qualifies as 'Vulnerable' (total population less than 1000 individuals, highly restricted area of distribution). It is not protected under Schedule 8 of the Wildlife and Countryside Act 1981, but is included in the Vascular Plant Red Data Book (Wigginton 1999).

All the *H. riddelsdellii* sites are in the Brecon Beacons National Park, which gives them a limited degree of protection. The population at Llyn y Fan Fach is within the Mynydd Du (Black Mountain) S.S.S.I. The Penwyllt population is within the boundary of the Ogof Ffynnon Ddu S.S.S.I. which is designated for its cave system but not for its surface biological interest. The main population at Craig-y-nos is not within an S.S.S.I., and is clearly a priority for designation to conserve *H. riddelsdellii* as it contains 86% of the population.

All sites except for the northern of the two quarries at Penwyllt are heavily sheep-grazed, and *H. riddelsdellii* is largely confined to rocks out of the reach of sheep (most *Hieracia* are sensitive to grazing, and *H. riddelsdellii* is no exception). As a plant of open rocks and cliffs, generally no management is required provided these habitats stay free from scrub and are ungrazed. If grazing is relaxed significantly, it could spread onto adjacent rocky grasslands (all *Hieracia* present would probably benefit from this).

The only immediate threat to the populations is the continued spread of the alien *Cotoneaster integrifolius* in the quarries at Penwyllt which already requires control. There are no immediate threats to survival of *H. riddelsdellii* at either Craig-y-nos or Llyn y Fan Fach, though longer term intensive grazing will limit the ability of the population to spread.

Two collections of plants grown from seeds are currently being cultivated at the National Botanic Garden of Wales, and seed from 39 plants has been deposited in the Millennium Seed Bank.

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REFERENCES

- ALEXANDER, M. P. (1969). Differential staining of aborted and non-aborted pollen. *Stain Technology* **44**: 117–122.
- BRAITHWAITE, M. E. & LONG, D. G. (1990). *The botanist in Berwickshire*. The Berwickshire Naturalists Club, Berwick.
- IUCN (2001). *IUCN Red list categories and criteria. Version 3.1*. IUCN, Gland.
- LEY, A. (1907). *Hieracium* notes. *Journal of Botany* **45**: 108–112.
- LEY, A. (1909). Brecon and West Yorkshire hawkweeds. *Journal of Botany* **47**: 8–16 and 47–55.
- PUGSLEY, H. W. (1941). New species of *Hieracium* in Britain. *Journal of Botany* **79**: 177–183 and 193–197.
- PUGSLEY, H. W. (1948). A prodromus of the British *Hieracia*. *Journal of the Linnean Society of London (Botany)* **54**: 1–356.
- RICH, T. C. G. (2004a). *Distribution and conservation of Hieracium riddelsdellii, Riddelsdell's Hawkweed*. Unpublished interim report to Countryside Council for Wales.
- RICH, T. C. G. (2004b). *Distribution and conservation of Hieracium riddelsdellii, Riddelsdell's Hawkweed*: additional information 2004. Unpublished report to Countryside Council for Wales.
- RODWELL, J. S. *et al.*, eds. (1991–2000). *British plant communities*. Volumes 1–5. Cambridge University Press, Cambridge.
- SELL, P. D. & WEST, C. (1968). *Hieracium* L., in PERRING, F. H. ed., *Critical Supplement to the Atlas of the British flora*. B.S.B.I., London.
- WIGGINTON, M. J., ed. (1999). *British Red Data Books. 1. Vascular Plants*. 3rd ed. Joint Nature Conservation Committee, Peterborough.

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The status and conservation of stoneworts (Characeae) in West Gloucestershire (v.c. 34) and North Somerset (v.c. 6)

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ABSTRACT

West Gloucestershire and North Somerset are nationally important for stoneworts and although there are diverse assemblages at some sites, the area is particularly important for the strong populations of several rare species. The most important areas are flooded gravel pits in the River Severn floodplain at Frampton-on-Severn, a complex of dew-ponds and pits created through extraction of strontium in the Wickwar – Yate area and ditches in grazing marshes in the Gordano Valley.

KEYWORDS: *Chara*, *Nitella*, *Nitellopsis*, *Tolypella*, distribution, conservation.

INTRODUCTION

North Somerset (v.c. 6) and West Gloucestershire (v.c. 34) (referred to hereafter as the region) include a number of sites supporting diverse or large populations of stoneworts (charophytes). These sites are mainly very small and discrete and, as discussed further below, the remainder of the region has little in the way of suitable stonewort habitat. Survey and literature reviews by J. A. Moore and R. H. Bailey in the mid-1970s (Moore & Bailey 1986) and by N. F. Stewart (N.F.S.) and R. V. Lansdown (R.V.L.) since the early 1990s have shown that, although some important sites and species appear to have been lost, many of the more important sites and the most vulnerable species still occur and the region can be considered to be of national importance for stoneworts (Stewart 2004).

This article presents an account of the status and distribution of charophytes in the region, supported by a comprehensive list of records. The information presented here is based on compilation of data from the literature, herbarium specimens, the database of the Biological Records Centre, material submitted to N.F.S. for determination, the databases of the Bristol Naturalists Society and Gloucestershire Naturalists Society records held by the M.A.R. and C.K. as well as personal records of all the authors.

CHAROPHYTE HABITAT

The region comprises the Forest of Dean, the lower, tidal part of the River Severn and its historic floodplain, the southern Cotswolds and the coastal plains south through the Mendips and the Somerset Levels to Bridgwater Bay. It overlaps with all or part of the current administrative counties of Somerset, North Somerset, Bath and North-east Somerset, Bristol, South Gloucestershire and Gloucestershire. The landscape is dominated by the hills of the Cotswolds, the Mendips and the Poldens to the east of the River Severn, the Severn Estuary and the Forest of Dean to the west. Much of the region involves the low-lying areas of the Severn Vale and the coastal plain, characterised by pasture and complex field systems with small copses. The hills are broken by a small number of larger rivers, such as the Parrett, the Brue and the Axe in the south and the Little Avon in the north. The former floodplains of the larger rivers have created

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much of the suitable wetland habitat for charophytes, particularly in the Somerset Levels.

Geologically, the region is one of the most varied districts of Britain, for with the exception of the Ordovician, Cretaceous and possibly the Permian, there are surface exposures of every geological formation from the Cambrian to the Jurassic (Kellaway & Welch 1948). The underlying geology has a very strong influence on the distribution of charophytes. One of the reasons for its importance for charophytes is that most of the region is predominantly calcareous, characterised by the inferior oolite of the Cotswolds to the carboniferous limestone of the Mendips, with calcareous clays in the vale of the River Severn (Green *et al.* 1997; Green *et al.* 2000). However, there are also important outcrops of acid strata, in particular the coal measures of the Forest of Dean, with an outlier forming the Bristol Coalfields. Overlying the hard geology, most of the coastal plains are dominated by deep alluvial clays, with occasional surface peat deposits in areas such as the Gordano Valley and parts of the Somerset Levels.

Within the region, areas with wetland habitats suitable for charophytes tend to be fairly discrete and mainly restricted to the lowlands of the Severn Vale and the coastal plains. There are only a few records from the Forest of Dean, the Cotswolds, the Mendips and Poldens, most of which are from anthropogenic habitats, i.e. habitats that have developed as a result of human influence.

The main habitats supporting charophytes in the region are:

- Pools remaining from coal and metal ore extraction in the Forest of Dean.
- Gravel pits and some ditch systems in the Severn Vale north of Sharpness, particularly in the area from Over to Walham and around Frampton-on-Severn.
- Canals, artificial lakes and a few farm ponds on the plateau of the Cotswolds.
- Farm ponds and strontium pits in the Wickwar – Yate area.
- Predominantly artificial water bodies, such as canals and ornamental lakes, in and around urban areas associated with Bristol and Bath.
- The wet pasture and ditches (rhynes or rhines) in the Gordano Valley.
- Large artificial lakes such as Chew Valley Lake and Blagdon Lake.
- Ditches serving as “wet fences”, scattered standing water bodies and canals in the Somerset Levels, particularly in areas such as Southlake, Butt, Kenn and Nailsea Moors.
- Dune slacks on the coast between Weston-Super-Mare and Bridgwater.

The more important sites are described in detail below.

IMPORTANT STONEWORT AREAS

NORTH SOMERSET (V.C. 6)

The Somerset Levels

The Somerset levels were formed in a large inlet as the sea receded, allowing development of peat and fen woodland (Green *et al.* 1997). Originally, they would have comprised a vast complex of wetland habitats with smaller dry areas on higher ground. With drainage and cultivation, the wetland habitats have been reduced and are now mainly represented by ditches serving as “wet fences”, with isolated wet grassland, pools and fen. Whilst the ditch systems generally do support some important charophyte populations, the most important sites are those where the ditches are associated with wet pasture. In most recent surveys of the aquatic plants of the ditches in the levels, charophytes have not been identified to species level (often being recorded simply as “*Chara* sp.”) and there is a need for more informed survey. There are scattered records for *C. contraria*, *C. globularis*, *C. hispida*, *C. virgata*, *C. vulgaris*, *Nitella mucronata* and *N. opaca* as well as old records for *N. translucens*, *Tolypella glomerata* and *T. intricata*. Records are generally rather scattered, with concentrations in the King’s Sedgemoor area, Kenn Moor and the Nailsea and Tickenham Moor complex. Two sites currently support important populations of *T. prolifera*: Southlake Moor is an area of wet grassland and grazing marsh on alluvial clays with some peat, where *T. prolifera* has been recorded from around 14 ditch sections. Butt Moor is another clay moor with areas grazing marsh and wet grassland with *T. prolifera* in a number of ditch sections.

The Gordano Valley

The Gordano Valley extends from Avonmouth, south west to just north of Clevedon. It is mainly an area of grazing marsh defined to the north-west and south-east by steep limestone

hills which feed strongly calcareous water into the system. There are charophyte records from four main areas within the valley; ditches in the Portbury area (near Portishead) and three of the moors within what was one continuous wetland complex; Clapton Moor, Weston Moor and Walton Moor. The northern half of the valley has mainly been converted to agriculture and much of Weston Moor has been lost under a refuse tip. However, part of the valley floor is a National Nature Reserve and includes three Avon Wildlife Trust Reserves as well as much being designated as SSSI (Green *et al.* 2000). The arterial drains are nutrient enriched but many lesser ditches have a good aquatic flora, particularly Walton Moor and the remnants of Weston Moor (Stewart 2004). The charophyte flora is still the richest in the region. *Chara hispida*, *C. vulgaris* var. *papillata* and *Tolypella glomerata* were recorded from Portbury between 1887 and 1922 but there are no recent records of charophytes from this area; Both Walton and Weston Moors still support *Chara aculeolata*, *C. globularis*, *C. hispida*, *C. virgata*, *C. vulgaris* and *N. flexilis* agg. but there has been no record of *T. intricata* since 1989. Clapton Moor still supports *C. virgata* and *C. vulgaris* var. *papillata* but appears to have lost *C. contraria*, *C. globularis*, *C. hispida* and *Tolypella glomerata*. In the species accounts, records for all sites within the Gordano Valley have been included under one heading, subdivided only where specific site details are given.

WEST GLOUCESTERSHIRE (V.C. 34)

The Wickwar – Yate Area

This area is situated on the edge of the Severn Floodplain, toward the south of v.c. 34. It contains a much higher than average (Williams *et al.* 1998) number of ponds (over 450 in the 10 km square ST78) and consequently has provided a high proportion of the records of charophytes for v.c. 34. The ponds derive from strontium sulphate extraction, cattle watering and a small amount of quarrying and mining. The area from which the records come can best be defined by a line running from Rangeworthy in the west, through Wickwar to the base of the Cotswold escarpment below Hillesley, then following the base of the escarpment south through Horton to Old Sodbury, west through Chipping Sodbury to Yate and back to Rangeworthy. In the species accounts a number of named sites shown on the Ordnance Survey 1:25,000 Explorer map (No. 167) have been included within this broad area; these include

farms such as Cherryrock Farm, Goose Green (although the farm has been lost to development), Hall End Farm and Leech Pool Farm, as well as other features such as the village of Little Sodbury End, Vinney's Lane (running north-westward from Horton), Yate Court and Yate Rocks. The core of the area is characterised by a complex of commons, including; Assley, Hawkesbury, Inglestone, Kingrove and Sodbury Commons. The commons border Lower Woods SSSI/NR which includes the following named sites referred to in charophyte records: Green Trench, Horton Great Trench, Lance Coppice, Lower Woods Lodge, Spoil Coppice and Stonybridge Wood. Lower Woods NR lies mainly on the Lower Lias clays, with exposures of Keuper and Tea Green Marls. It has a long history of human use, including a roman villa nearby just south of Vinney's Lane, as well as historic active management. This historical use has resulted in frequent flooded relict features, such as saw-pits, whilst Horton Great Trench may have been a roman road, was probably a drove road and was still a major highway until at least the 1700s (Gloucester Wildlife Trust 1997).

Celestine (strontium sulphate) occurred in irregular masses in the Keuper Marl; it was largely worked by hand and formerly sent to Germany for use in refining sugar from sugar-beet (Kellaway & Welch 1948). It was also used to give red colours to pyrotechnics, but is now mainly used in ferrite for radios and in glass for TV tubes (A. R. Lansdown pers. comm.). The pits resulting from this work were generally small and fairly deep (often over 2 m deep). Consequently, those which have not been actively infilled for agriculture or development have not been particularly affected by succession and most still hold water. They extend from Little Sodbury, Horton, Wickwar and Yate, to the Inglestone Common area. In addition to these ponds, there are a very large number of dew-ponds mainly located at the junctions of two to three fields, particularly on the margins of the commons. A survey of 368 ponds in ST78 between 1996 and 1999 showed that 127 (35%) had been infilled and 36 (10%) had succeeded to terrestrial habitats. Of the remainder, 84 (23%) were under more than 50% shade and only 17 (5%) were sufficiently poached to provide suitable habitat for charophytes such as *Tolypella intricata* (Stewart & Lansdown 1999b).

During the early 1900s, many of the pits were surveyed by people such as J. W. White,

I. M. Roper and C. I. and N. Y. Sandwith and most of the pre-1994 records derive from this period. However, few records give sufficiently detailed site descriptions for the individual pit to be matched to current water bodies and so it is difficult to assess whether individual populations still occur. The available data would suggest that *Chara vulgaris* (including all three common varieties) and *C. virgata* are as abundant now as they ever have been. Detailed surveys for *T. intricata* mean that although populations vary between years, it appears to be as abundant now as it ever has been. The type locality for the var. *gracillima* of *Nitella mucronata* is in this area, in a strontium pit near Yate Court. The pit appears to have been infilled for development and the plant has not been recorded in the area since the early 1900s. Two other taxa appear to have been lost from the area; both *C. globularis* and *N. opaca* were recorded from a number of sites around Yate in the early part of the twentieth century. The area around Yate extends over part of the Bristol coalfield and formerly supported taxa more typical of acid habitats, such as *Apium inundatum* and *Baldellia ranunculoides* (Green *et al.* 2000). Unfortunately most of the common land and associated wetlands in this area, such as Yate (or Westerleigh) Common, were lost to agriculture during the second World War (Green *et al.* 2000), or to the increasing sprawl of development around Yate and Chipping Sodbury.

Frampton Pools SO7407–7507

Frampton Pools SSSI is a complex of three large and a number of smaller shallow lakes created by gravel extraction, located approximately 1 km from the flood bank of the Severn Estuary. The lake complex was designated an SSSI in 1974 to protect wintering wildfowl and the developing flora. Many of the lakes are fringed by young woodland, which shades the margins, however in places gravel beaches occur leading down from short, sheep-grazed pasture. *Nitellopsis obtusa* occurs in a broad band running parallel to a long gravel beach on the north-western side of a lake with a surface area of approximately 21 ha, which is at least 2 m deep in parts. Associated species included *Ceratophyllum demersum*, *Elodea canadensis*, and *E. nuttallii*. Other aquatic plants in the lake included *Chara globularis*, *C. vulgaris*, *Potamogeton pectinatus*, *P. pusillus* and *Ranunculus circinatus*.

Mendip Reservoirs

The importance of the Mendip Reservoirs has only recently come to light as a result of surveys by University College, London in 2003. Of particular note was the discovery of strong populations of *Nitellopsis obtusa* in both Blagdon Lake and Chew Valley Lake. Undoubtedly there is a need for further exploration of these and other reservoirs in the Mendips. The underlying Carboniferous Limestone results in strongly calcareous water which favours the stoneworts and helps to reduce the effects of nutrient enrichment washed in from the surrounding farmland, although this is still a concern. Stoneworts so far recorded are *N. obtusa*, *Chara contraria*, *C. globularis* and *C. vulgaris* in both Blagdon Lake and Chew Valley Lake, with *C. contraria* and *C. globularis* in Cheddar Reservoir.

CHAROPHYTE CONSERVATION

Stewart (2004) lists six sites within the region as being important for stoneworts. Of these, the Somerset Levels are considered to be of European importance, Frampton Pools, the Gordano Valley, the Wickwar – Yate area (as Inglestone Common area) and Richard's Wood at Over are considered to be of national importance and the Thames and Severn Canal is of local importance. The Mendip reservoirs would also have qualified for inclusion but information was not available at the time of publication. Parts of all these sites, except the Thames and Severn Canal are under some level of protection for various reasons and stoneworts are taken into account in their management.

The Thames and Severn Canal has been out of use since the middle of the twentieth century and is currently succeeding to terrestrial vegetation. However, there are plans to restore parts of the canal and eventually to restore the entire length to navigation. This would comprise the Stroudwater and Thames and Severn Canals, linking the Gloucester and Sharpness Canal at Saul Junction to the Thames at Lechlade. Currently, the future for charophytes in the canal is bleak; but restoration and low-intensity, or no boat use would be extremely beneficial and could restore good populations of all known taxa. Experience from other canal systems, such as the Kennet and Avon Canal, suggests that

restoration to anything more than light boat traffic is likely to lead to a more or less total loss of submerged aquatic vegetation, including charophytes.

The only conservation action taken specifically for charophytes in the region has involved survey and low level monitoring of *Tolypella intricata* and *T. prolifera*. This has led to the development of a reasonable understanding of the ecology of the species and proposals for management, although few of these actions have been implemented to-date (Stewart & Lansdown 1999a and b, Williams & Stewart 2002, Williams *et al.* 2003). Unfortunately, the management plan for Lower Woods (Gloucestershire Wildlife Trust 1997) was produced shortly before detailed information on *T. intricata* became widely available and this species is not mentioned. Subsequently, the Gloucestershire Wildlife Trust has been involved in the development of conservation management plans for the species.

Charophyte taxa such as *C. virgata*, *C. vulgaris* and probably *C. contraria* have the ability to colonise new habitat as it becomes available, whilst at the same time forming a less important part of the flora of established wetland systems. Although some populations of these species in the region have been lost, they are still frequent and in some areas are probably increasing. By contrast, taxa such as *C. aculeolata*, *C. globularis* and *C. hispida* tend only to occur in permanent water bodies. These species are now very local within the region and are vulnerable because of the limited number of small populations. *Nitella translucens* appears to be extinct in the region, as does *Tolypella glomerata* although there are some areas, such as the ditches near Portbury and water bodies on the New Grounds at Slimbridge which could hold populations of the latter and merit survey. *Nitella opaca* is now restricted to a few small populations, however it is likely that this species has been under-recorded in places such as the Forest of Dean and the Somerset Levels.

The impression gained is that some species have undergone significant declines since the early part of the twentieth century. However, this impression must be put in the context of the limited number of surveys carried out by botanists capable of identifying charophytes in the field. Only the Wickwar – Yate area, Southlake Moor, Butt Moor and the Gordano Valley have been subject to intensive survey involving field identification. Records of

“*Chara* sp.” from a variety of sites throughout the region would suggest that more thorough survey could re-discover a number of populations of stoneworts, while recent finds of species such as *Tolypella prolifera* and *Nitellopsis obtusa* would suggest that some of the re-discoveries are likely to involve species that are of conservation concern.

As a minimum, the steps needed to ensure the conservation of existing populations of charophytes in the region involve regular monitoring surveys of suitable habitat in all sites of European and national importance (*sensu* Stewart 2004). The results of these surveys should be employed to inform decisions on whether or not to intervene with active management for charophytes. In addition, the information gained from surveys should be published and compiled to contribute to the information base on the ecology of these species. Any further development in the Wickwar – Yate area should be subject to environmental impact assessment, giving particular consideration to reducing the loss of waterbodies and remnant common land. The restoration of the Thames and Severn Canal and works undertaken on the Hereford and Gloucester Canal (referred to in the older literature as the Newent Canal) need to be monitored, if nothing else, to record the response of aquatic plants.

SPECIES ACCOUNTS

Apart from the obvious benefits that derive from compilation of botanical data such as enabling assessment of changes in the distribution or status of species and informing conservation action, this article has been prepared to serve two main aims: to enable an assessment of the current status of stoneworts in the two vice counties and to enable the monitoring of trends in individual populations. To some extent, these two aims dictate the format of data presentation. Rather than simple lists of sites with the date and source(s) of the records, we have reproduced as much detail as was available in each original record to increase the chance of relocating individual populations. Thus, for example, although there is doubt about their validity, we have decided to make it clear where material has been identified to varietal level. In the case of *C. vulgaris* to list the named variety against each record was impractical and risked doubling the length of this article we have therefore

separated out all records identified to variety consistently throughout the article.

Records are presented under the species or varietal name following the taxonomy of Bryant *et al.* (2002). To facilitate assessment of the current status of each taxon, sites for which there are records during the last ten years (i.e. since 1994) are listed separately. Where there are post-1994 records for sites where the taxon was recorded before 1994, all records are listed as post 1994. For the same reason, records from the same named site or grid reference are grouped. All material was determined by the recorder unless otherwise stated.

The records are arranged as follows:

- The ten-kilometre square.
- The 6-figure National Grid Reference, where known.
- The location as given by the recorder.
- The date of the record (where available) and any other useful details.
- The initials of the finder e.g. C.I.S. A full list of initials and the names to which they refer is provided in the appendix.
- [det.] indicates that a specimen was identified by someone other than the finder.
- ! indicates that a specimen has been seen by N. F. Stewart and the identification confirmed according to current taxonomy.
- Location of any herbarium specimens (in bold), where relevant.
- Published sources of the record.

Records are listed in chronological order within sites and by the grid reference where more than one record was made in a single year. Any notes added by the authors and in particular, where the site is known but the grid reference was not given by the original recorder, these are given in square bracket []. (BRC) indicates that the only source that we have found for the record is on the Biological Records Centre database at the Centre for Ecology and Hydrology, Monk's Wood.

Synonyms have been included only when they have been used in the two vice counties covered here and do not represent a comprehensive list, for which see Bryant *et al.* (2002).

CHARA L.

Chara aculeolata Kütz. Hedgehog stonewort
Synonyms: *C. pedunculata* Kütz.; *C. hispida* L. forma *polyacantha* (A. Braun) R. D. Wood.

In Britain, *C. aculeolata* is nationally scarce and restricted to a few highly calcareous sites, mainly in England. Within the region it has only been confirmed from Walton and Weston Moors, in the Gordano Valley. Material from Nailsea Moor (only a few kilometres south of Walton Moor) in 1880 was recorded as *C. hispida* var. *polyacantha*, which probably refers to this species; unfortunately it has not been possible to confirm this record. Populations in the Gordano Valley are restricted but appear to be fairly healthy. It may be dependent upon regular ditch or pool maintenance and must be considered vulnerable.

V.C. 6

BEFORE 1994

ST47 [-Nailsea Moor (as *C. hispida* var. *polyacantha*), 1880, A.Le., E.H.R. [det. J.W.W.] (White 1912; Marshall 1914)].

1994 ONWARDS

ST47 - Gordano Valley:

- Walton Moor: 10 September 1903, J.W.W. [det. J.G.] (**BM!**, **MANCH!**, **NMW!**, **RNG!**, **SLBI!**) (Willis & Jefferies 1959); peat ditch, 10 September 1904, J.W.W. [conf. A.B.] [conf. H. & J.G.] (**BM!**, **MANCH!**, **NMW!**, **SLBI!**) (Groves 1905; Willis 1989); ST435727 ditch No. 54, 20 October 2002, N.F.S. *et al.*

- Weston Moor: Weston-in-Gordano, 28 September 1903, J.W.W. [det. J.G.] (**BM!**); rhine, 4 June 1915, C.I.S., [det. J.v.R.]; June 1917, [det. G.O.A.] (**BM!**); ST443731 ditch No. 199, 6 April 1989, N.F.S., S.W., E.J.M. (**SLBI!**); ST442733 ditch No. 195, c.1993 (S. Wilson *in litt.*); ST442733 ditch No. 195; ST443731 ditch No. 199; ST442733 ditch No. 195, 20 September 1999, N.F.S. *et al.*; ST444732 ditch No. 198, c.1990 (S. Wilson *in litt.*); ST444732 ditch No. 198, c.1993 (S. Wilson *in litt.*); ST444732 ditch No. 198; ST443731 ditch No. 199, 24 July 1995, S.W. [det. N.F.S.]; ST443731 ditch No. 199; ST445734 Bass Pond, 3 October 2001, N.F.S. *et al.*; 11 June 2002, N.F.S.

Chara aspera Deth. ex Willd. Rough Stonewort

White (1887) originally assigned several records to this species, but he subsequently corrected this, saying "I now know that the plants named *C. aspera* in my earlier book [refers to White 1887] should have been placed

[in *C. hispida*]” (White 1912). The only record from v.c. 6 which may represent this species is recorded as “probably this” from the [Bridgewater and Taunton] canal near Bridgewater, again it has not been possible to confirm this record and this species can not be confidently recorded for v.c. 6.

V.C. 6

BEFORE 1994

[ST23 - “Probably this” canal, near Bridgewater (Marshall 1914)].

Chara contraria Kütz. Opposite Stonewort

Synonyms: *C. vulgaris* var. *contraria* (A. Braun ex Kütz.) J. A. Moore, *C. vulgaris* var. *hispidula* (A. Braun) J. A. Moore

C. contraria is probably under-recorded in the region; all records from v.c. 34 were made since 1994 by R.V.L. and determined by N.F.S. It is likely that before 1994 this species was overlooked for *C. vulgaris*. *C. contraria* appears to be widespread but local with populations in calcareous lakes, flooded gravel pits and ditches. It often grows in relatively shallow water at the edge of the waterbodies, typically dying back as water levels fall in summer, to reappear as a dense sward following the first rains of the autumn. Until recently, it was considered nationally scarce (Stewart & Church 1992), but has recently been shown to be more widespread than previously thought (Stewart 2004) and locally frequent in the Thames catchment and East Anglia.

V.C. 6

BEFORE 1994

ST33 - (As *C. vulgaris* var. *contraria*) ST385301 North Moor, Othery, 1986, D.R. [conf. J.A.M.] (BM!).

ST47 - Rhine below Clapton-in-Gordano, 1922, C.I.S. [det. G.R.B.-W.] (White 1923; Willis & Jefferies 1959).

1994 ONWARDS

ST45 - ST436540 rather rare, NW corner of Cheddar Reservoir, 3 October 2001, N.F.S.; ST441537, 18 September 2004, B.G. *et al.* [det. N.F.S.] (BM!).

ST55 - ST515596 Blagdon Lake, 19 September 2003, B.G. *et al.* [det. N.F.S.] (BM!).

- ST569597 Chew Valley Lake, 20 September 2003, B.G. *et al.* [det. N.F.S.] (BM!).

V.C. 34

1994 ONWARDS

SO70 - SO753076 flooded, disused gravel pit,

Frampton on Severn, 2 September 1995, R.V.L! [det. N.F.S.].

- SO750090 flooded, disused gravel pit, Saul, 2 September 1995, R.V.L. [det. N.F.S.] (RVL!).

- SO752092, small pond northeast of main gravel pit, Saul, 2 September 1995, R.V.L! [det. N.F.S.].

ST78 - ST717887 deep quarry pool north of Wickwar, 1995, R.V.L! [det. N.F.S.].

ST80 - ST813015 upper (western), large artificial lake, Woodchester Park, 26 June 1995, R.V.L. [det. N.F.S.] (RVL!).

ST89 - ST899986 Cherington Park Lake, 1995 R.V.L! [det. N.F.S.].

Chara globularis Thuill. Fragile Stonewort

Synonyms: *C. globularis* Thuill. var. *capillacea* (Thuill.) Zaneveld.; *C. globularis* Thuill. var. *hedwigii* (Agardh. ex Bruzelius) J. A. Moore.

C. globularis is widespread and fairly frequent in Britain. Within the region it was recorded from a wide variety of waterbodies. Some records prior to Groves and Bullock-Webster (1924) probably refer to *C. virgata* which had previously been separated only at varietal level. This particularly applies to records given as var. *capillacea* which H. and J. Groves usually applied to specimens now included in *C. virgata*. Some of the apparent decline may be due to a lack of survey or a lack of identification of charophytes to species level during surveys of the Somerset Levels combined with changes in our understanding of the taxonomy of this and *C. virgata*. However, it does appear to have been genuinely lost from a number of sites and if this loss can be confirmed, measures should be identified which could restore populations.

V.C. 6

BEFORE 1994

ST25 - ST295517 pool, Berrow sand dunes, 26 June 1980, M.V.M. [det. J.A.M.] (BM).

ST33 - Bridgewater and Taunton Canal, H.S.T. (Murray 1896).

ST34 - In deep water of excavated scrape, Tealham Moor, 1992, R.S.C. (Willis 1992).

ST44 - Turf pits near Ashcott railway station, c. 1902, C.B., D.F., J.W.W. (Bucknall *et al.* 1903); pits on the peat between Ashcott and Shapwick Stations (as var. *capillacea*) (White 1912; Marshall 1914).

ST46 - Kenn Moor (White 1912; Marshall 1914).

ST47 - Near Clevedon, 1883, W.J. (Groves & Groves 1886; Murray 1896; White 1912).

- Ditches, Clapton Moor, c. 1902, C.B., D.F., J.W.W. (Bucknall *et al.* 1903).

- ST76 - In canal basins [Bath] (as *C. hedwigii*) (Murray 1896; White 1912).
- 1994 ONWARDS
- ST33 - Southlake Moor: ST36723054, northern end of ditch No. 78, 20 July 2000, N.F.S., K.P.; 4 October 2001, N.F.S.; ST36813052, ditch No. 79, 1 October 2002, N.F.S.; ST37043045, ditch No. 99N, 4 October 2001, N.F.S.; ST36903034, ditch No. 137E, 23 October 2001, N.F.S.
- ST44 - ST414426 ditch north-west of Westhay Level Peat Works, July 1995, S.G.!
- ST45 - ST441537 Cheddar Reservoir, 18 September 2004, B.G. *et al.* (BM!).
- ST47 - ST442736, 1997, R.V.L. (RVL!).
- Gordano Valley:
 - Walton Moor: 1902 (as var. *capillacea*) (White 1912; Marshall 1914; Willis & Jefferies 1959); ST432727 ditch (No. 46), 5 m altitude, 4 March 1989, N.F.S., E.J.M. (SLBI); ST425725 ditch No. 8; ST426725 ditch No. 11; ST430726 ditch No. 20; ST430726 ditch No. 29, 6 April 1989, N.F.S., S.W., E.J.M.; ST431727 ditch No. 46, 4 March 1989, N.F.S., E.J.M. (Willis 1989); ST428724 ditch No. 19, 20 September 1999, N.F.S. *et al.*; ST433730 S end of ditch No. 97, 20 October 2002, N.F.S. *et al.*; ST434733 ditch No. 101, 11 June 2002, N.F.S.
 - Weston Moor: ST442735 ditch No. 179; ST443736 ditch No. 180; ST443735 ditch No. 186, 6 April 1989, N.F.S., S.W., E.J.M. [conf. J.A.M. 1989] (SLBI) (Willis 1989); ST442735 ditch No. 179, 20 September 1999, N.F.S. *et al.*; ST442737 ditch No. 148, 3 October 2001, N.F.S. *et al.*; ST435731 ditch, 11 June 2002, N.F.S.; ST441737 ditch No. 160–162, 24 February 2004, N.F.S.
- ST55 - ST515596 Blagdon Lake, 19 September 2003, B. Goldsmith *et al.* [det. N.F.S.] (BM!).
- ST569597 Chew Valley Lake, 20 September 2003, B. Goldsmith *et al.* [det. N.F.S.] (BM!).
- SO90 - Canal, Chalford (Riddelsdell *et al.* 1948).
- Pond, Rudgeway, Alveston, 1925 C.T. (White 1926).
- ST68 - Froglane Pit, Coalpit Heath, 1955, G.W.G. [det. G.O.A.] (Sandwith & Sandwith 1956; Moore & Bailey 1986).
- ST78 - Wickwar – Yate Area:
- [ST776848] field pond near southwest corner of Bodkin Hazel Wood, nr. Horton, 1952, G.W.G. [det. G.O.A.] (Sandwith & Sandwith 1953; Moore & Bailey 1986 as var. *capillacea*).
 - Yate Lower Common in a strontium pit, H.J.R. (Riddelsdell *et al.* 1948).
 - Wickwar area, 1920, J.W.W. (BM); 1917, J.W.W. (LSR) (White 1919; Riddelsdell *et al.* 1948; Moore & Bailey 1986).
 - ST108857 strontia pit between Yate Court and Leech Pool Farm, Yate, 15 December 1984, A.J.B. [det. J.A.M.] (Bailey & Moore 1985; Moore & Bailey 1986).
 - Barbours Court Farm, Wickwar, 10 December 1990, N.F.S., M.A.R.K., C.K.
- ST89 - near White Horse, Avening, 3 July 1926, H.J.T. (BM!).

1994 ONWARDS

- SO70 - SO753076 flooded gravel pit, Frampton-on-Severn, 2 September 1995, R.V.L. [det. N.F.S.] (RVL!).
- SO748076 pond, Frampton on Severn, 1977, A.K. [det. J.A.M.] (Moore & Bailey 1986); SO753076 flooded gravel pit, 2 September 1995, R.V.L. (RVL!); SO754077 flooded gravel pit, 1995 R.V.L. (RVL!).
 - SO733056 ditch, New Grounds, Slimbridge, 29 August 1977, A.K. [det. J.A.M.] (Moore & Bailey 1986); SO720048, 1996 R.V.L.

Chara hispida L. Bristly stonewort

C. hispida is sparsely distributed in Britain, becoming rarer northwards and westwards. It has been recorded from a variety of calcareous habitats in the region, most frequently in the Gordano Valley and Somerset Levels, with other scattered records from ponds and larger waterbodies. In 1996, an unidentified stonewort, probably this species, was recorded from ponds in the National Trust Property at Westbury-on-Severn, but subsequent visits in 1997, 2000 and 2002 have failed to find any stoneworts.

V.C. 34

BEFORE 1994

- SO60 - SO620089 neglected lake, dredged c. 10 years ago, Brock Lane, Parkend, 20 June 1984, M.V.M. [det. J.A.M.] (Bailey & Moore 1985; Moore & Bailey 1986).
- SO61 - SO662110 pond, Soudley Brook, Forest of Dean, June 1975, D.N.A., M.J.A., S.C.H. [det. J.A.M.] (Moore & Bailey 1986).

This species appears to have declined throughout the region. In v.c. 6, it has only been recorded since 1994 from the Gordano Valley although before 1994 it was apparently widespread in the Somerset Levels. In v.c. 34, it has never been abundant and has only been recorded from scattered pools in the Forest of Dean. Few of these have been surveyed for charophytes in recent years and it is possible that a reasonably healthy population remains in the area.

V.C. 6

BEFORE 1994

ST33 - Ditch, near Weston Zoyland, Kings Sedge Moor, 23 August 1907, E.S.M. (**BM!**, **CGE!**) (Marshall 1914; 1908).

- Nr. Middlezoy, W.W. (Marshall 1914).

- Nr. Othery, G.R.B.-W. (Marshall 1909; 1914).

- Drain near Sedgemoor Cut, May 1899, G.R.B.-W. (Bullock-Webster 1901).

ST45 - Ditches, Clevedon (White 1887 as *C. aspera*, Murray 1896; White 1912, Marshall 1914).

ST46 - Marsh ditch Kenn Moor, 28 September 1903, J.W.W. (**CGE!**); peaty ditch Kenn Moor 17 September 1904, J.W.W. [det. A.B.] (**BEL!**, **BM!**, **CGE** [det. J.G.]!, **E!**, **NMW!**, **OXF!**, **SLBI!**), 17 September 1904, J.W.W. [det. A.B.] (**CGE** [det. J.G.]!, **NMW!**) (Groves 1905; White 1912, Marshall 1914).

- Ditches Yatton (White 1887 as *C. aspera*; Murray 1896; White 1912; Marshall 1914).

ST47 - Ditches, Portbury (White 1887 as *C. aspera*; Murray 1896; White 1912; Marshall 1914 gives recorder as E.G.).

- Nailsea Moor, 4 September 1902, J.W.W. (**CGE!**).

- Gordano Valley:

- peaty ditch Clapton Moor, 28 September 1903, J.W.W. (**CGE!**, **NMW!**, **OXF!**) (White 1920); ditch, peaty meadow, 28 September 1903, J.W.W. [conf. G.R.B.-W.] (**E!**) (White 1912).

ST73 - ST705322 Park Wood, south of Redlynch, August 1984, J.G.K. [det. J.A.M.] (**BRC**).

ST76 - "In the canal" [Bath] (Babington 1834; White 1887; 1912); canal between Bath and Bathampton, 4 July 1956, J.P.M.B. (**BM**).

1994 ONWARDS

ST47 - Gordano Valley:

- Walton Moor: 1867, J.D.H. (**BM**) (White 1887; Murray 1896; White 1912; Marshall 1914); 25 June 1849, C.C.B. (**CGE!**); 13 August 1922 F.G. (**LSR**) (Willis & Jefferies 1959); ST444735 ditches, 7 May 1984, A.L. [det. J.A.M.] (**BM!**); ST430730 ditch (No. 137), 5 m altitude, 4 March 1989, N.F.S., E.J.M. (**SLBI**); ST426725 ditch No. 11; ST428724 ditch No. 19; ST430726 ditch No. 20; ST429725 ditch No. 22; ST430726 ditch No. 29, 6 April 1989, N.F.S., S.W., E.J.M.; ST427725 ditch No. 18/18.1; ST429725 ditch No. 22; ST430726 ditch No. 29, 20 September 1999, N.F.S. *et al.*; ST434733 ditch No. 101, 11 June 2002, N.F.S.; ST434727 ditch No. 53, 20 October 2002, N.F.S. *et al.*

- Weston Moor: 1903 G.C.D. (**OXF!**); ST443735 ditch No. 186; ST443731 ditch No. 199, 6 April 1989, N.F.S., S.W., E.J.M.; ST443736 ditch No. 180, 30 June 1989, S.W., O.M., [det. J.A.B.]; ST442735, 1997, R.V.L. (**RVL!**); ST442734 ditch No. 193, 6 June 1999, N.F.S., R.V.L.; ST442735 ditch No. 179; ST442733 ditch No. 195; ST443731 ditch No. 199, 20 September 1999, N.F.S. *et al.*; ST442739 ditch No. 169 [det. N.F.S.]; ST443731–ST444732, ditch No. 199, 3 November 1999 A.W.; ST440738 ditch No. 159, 24 February 2004, N.F.S.; ST438736 ditch No. 154/155; ST442738 ditch No. 166–168, 11 June 2002, N.F.S.; ST441734 ditch No. 176; ST441735 ditch No. 176A; ST442735 ditch No. 179, 6 June 1999, N.F.S., R.V.L.; ST441734 ditch No. 184; ST443731 ditch No. 199; ST444732 ditch No. 206; ST445734 Bass Pond, 3 October 2001, N.F.S. *et al.*; ST445734 Bass Pond, 11 June 2002, N.F.S.; ST442734 ditch No. 193, 20 October 2002, N.F.S. *et al.*

V.C. 34

BEFORE 1994

SO61 - SO644124 pond near Lightmoor Pond, Ruspidge, 31 August 1977 A.K. [det. J.A.M.] (**BRC**); Lightmoor Colliery, Ruspidge, 1980, A.O. (Moore & Bailey 1986); SP642122 Lightmoor Pond, October 1980 S.C.H. [det. J.A.M.] (**BM**); 1994 C.W., D.H. (English Nature 1994).

SO71 - [probably this] Water garden ponds, Westbury Court, Westbury-on-Severn,

1973, S.C.H., K.E.L. [det. R.H.B.] (Holland 1974, Moore & Bailey 1986).

1994 ONWARDS

SO61 - Crabtree Colliery, Cinderford, 2 October 1980 A.O. (Bailey & Moore 1985, Moore & Bailey 1986); SP639134, December 1997, R.V.L!

Chara virgata Kütz. Delicate stonewort
Synonym: *C. delicatula* Agardh; *C. globularis* var. *virgata* (Kütz.) R.D. Wood

C. virgata is widespread and frequent throughout Britain, particularly in the west. In the region, it appears to be mainly an early colonizer of new waterbodies, particularly worked strontium pits and farm pools in the Wickwar area and it is possible that it tends to decline after a few years as a result of competition from other charophytes and vascular plants. It is still frequent in ditches in the Gordano Valley where it prefers the more peaty substrates. Whilst many of the pools from which it has been reported have been lost to development or in filled for agriculture in recent years, this is still one of the most frequently recorded charophytes in the region and there is no real evidence of a decline.

Forms with well developed stipulodes and more prominent spine cells have been recorded from Shapwick and the Gordano Valley as *C. delicatula* Desv. var. *barbata* (Ganterer) J. Groves and Bull.-Webst.

V.C. 6

BEFORE 1994

ST43 - Moor ditch below Compton Dundon, 14 July 1891, R.P.M. (as *C. fragilis*) (BM!, MANCH!) (Murray 1896).

ST44 - Shapwick Moor, 10 May 1899, G.R.B.-W. (CGE); Shapwick, 1953, A.J.D. (as *C. delicatula* var. *barbata*), [det. G.O.A.] (Sandwith & Sandwith 1954, Wallace 1954).

- Pond near Shapwick Station, 8 August 1937, J.P.M.B., C.I.S. (BM).

ST47 - Nailsea Moor (White 1912 as *C. globularis*, Marshall 1914); 10 September 1921 (as *C. fragilis*) H.S.T., C.I.S. *et al.* (BM!).

1994 ONWARDS

ST47 - Gordano Valley: rhines, 1925, [det. J.G.] (White 1926, Willis & Jefferies 1959)
- Walton Moor: ST431731 ditch No. 138, Walton Moor, 5 m altitude, 4 March 1989, N.F.S., E.J.M. (SLBI) (Willis 1989); ST425725 ditch No. 8; ST426725 ditch No.

11 (Willis 1989); ST428724-ST427724, ditch No. 19 (Willis 1989); ST427724-S427725 ditch No. 18/18-1 (Willis 1989); ST429725 ditch No. 22, 6 April 1989, N.F.S., S.W., E.J.M.; ST427725 ditch No. 18/18.1 [det. J.A.B.]; ST428724 ditch No. 19, 29 June 1989, S.W., O.M., [det. J.A.B.]; ST436734 ditch near 107, 30 June 1989, S.W., O.M., [det. J.A.B.]; ST425726 ditch No. 6, 11 March 1992, S.W. [det. J.A.B.] (in J. A. Bryant correspondence file); ST427725 ditch No. 18/18.1, 20 September 1999, N.F.S. *et al.*; ST434727 ditch No. 53; ST435727 ditch No. 54, 20 October 2002, N.F.S. *et al.*

- Weston Moor: Weston-in-Gordano (as *C. delicatula* var. *barbata*), 1903, G.C.D. (OXF!) (Groves & Bullock-Webster 1924); ST444735, 7 May 1984, A.L. [det. J.A.M.] (BM); ST438734 peaty ditch No. 171, Weston Moor, 5 m altitude, 5 March 1989, N.F.S. (SLBI) (Willis 1989); ST443737 ditch No., 147 (Willis 1989); ST442738 ditch No. 167 (Willis 1989); ST443737-ST443738, ditch No. 168 (Willis 1989); ST439734 ditch No. 171N; ST442735 ditch No. 177 (Willis 1989); ST442735, ditch No. 179, 6 April 1989, N.F.S., S.W., E.J.M. (Willis 1989); ST443736 ditch No. 180, 30 June 1989, S.W., O.M., [det. J.A.B.]; ST442734, ditch No. 193, 11 March 1992, S.W. [det. J.A.B.] (in J. A. Bryant correspondence file); ST442736 Weston Moor, 15 May 1997 R.V.L. (RVL!); ST441734 ditch No. 176; ST441736 ditch No. 177; ST442735 ditch No. 179; ST443731 ditch No. 199, 6 June 1999, N.F.S., R.V.L.; ST442734 ditch No. 185; ST442733 ditch No. 195; ST444732 ditch No. 206, 20 September 1999, N.F.S. *et al.*; ST441734 ditch No. 184; ST442734 ditch No. 193; ST444732 ditch No. 206; ST445734 Bass Pond, 3 October 2001, N.F.S. *et al.*; ST441737 ditch No. 160-162; ST446733 W of ditch No. 212.1; ST445734 Bass Pond; ST445733 Pool S of Bass Pond, 11 June 2002, N.F.S.; ST442734 ditch No. 193, 20 October 2002, N.F.S. *et al.*; ST438738 ditch No. 121-124; ST441737 ditch No. 160-162, 24 February 2004, N.F.S.

- Ditch, Clapton Moor ST454735, 3 November 1999, A.W!; rare, ditch, Clapton Moor ST460734, 3 October 2001, N.F.S. *et al.*

- ST52503611 Butt Moor, ditch No. 1, 23 July 2003, N.F.S., E.J.M. *et al.*

V.C. 34

BEFORE 1994

- SO68 - Wickwar – Yate area: – Pond, Coal Pit Heath, Froglane, 21 September 1910, J.W.W. (CGE) (Riddelsdell *et al.* 1948 – as Coalpit Heath is probably this record).
- SO6878 - Kingsgate Park, by Stanshawe's Court, Yate, 1978, G.W.G. (Willis 1978, Moore & Bailey 1986).
- SO80 - SO8902 Thames and Severn Canal (Riddelsdell *et al.* 1948).
- SO90 - SO9002 Thames and Severn Canal (Riddelsdell *et al.* 1948).
- ST78 - Wickwar – Yate area: – various times in at least seven ponds, including Goosegreen Farm, nr. Yate [det. H. & J.G.] (White 1912; Riddelsdell *et al.* 1948).
 - pond, north east of Lance Coppice, Inglestone Common, 1953, G.W.G. (Moore & Bailey 1986)
 - strontia pits, Goose Green, Yate, 1953, G.W.G. (Moore & Bailey 1986)
 - standing water on old mineral railway, Froglane, Mayshall, 1954, G.W.G. (Moore & Bailey 1986)
 - mill pond, Whitwell Bottom, Lower Kilcot, 1955, G.W.G. (Moore & Bailey 1986)
 - pond on the skirt of Yate Lower Common, south of Hall End, 4 June 1917, J.W.W. (as *C. fragilis*) (RNG!).
 - Yate - ST718825, 7 May 1955 H.J.M.B! (RNG!).
 - pool in an old clay pit between Rangeworthy and Hall End, 16 July 1910 J.W.W. [det. H. & J.G.] (Moss 1911).
- ST96 - Gall Pond, Tortworth, A.J.B.

1994 ONWARDS

- SO70 - SO750091 flooded gravel pit, Saul, 2 September 1995, R.V.L!
- SO80 - SO816015 old pond, Woodchester Park, 28 August 1995 R.V.L.
- ST78 - Wickwar – Yate area:
 - Yate Court, 1954, (Moore & Bailey 1986); ST710860 Yate Court, 1995, R.V.L!
 - ST702884 [Newland's Farm], 14 June 1978 R.H.B., J.A.M. (BM) (Willis 1978, Moore & Bailey 1986); ST703883, 10 February 1990 N.F.S., M.A.R.K., C.K.; ST702883, 19 August 1995 R.V.L!; ST702884, 19 August 1995, R.V.L!; ST703883, 19 August 1995 R.V.L.
 - ST710859, 19 August 1995, R.V.L!
- ST89 - ST870992 Lake, Longford's Mill, near Nailsworth, 9 June 1997, R.V.L.

Chara vulgaris L. Common Stonewort

C. vulgaris is frequent in Britain, particularly in the lowlands. It is the most widespread and frequently recorded stonewort in the region. It occurs in most types of waterbody, even in shallow, still backwaters of flowing rivers. It appears very capable of colonising newly created ponds, particularly in lime-rich areas, tolerating some competition from other charophytes and vascular plants such as *Lemna minor* (Common Duckweed), *Zannichellia palustris* (Horned Pondweed) and *Elodea canadensis* (Canadian Waterweed). Within the region, it probably has the most stable population size of all the stoneworts, colonising new waterbodies as other populations decline and disappear. Although there are fewer records in the region since 1994 than before, this is likely to be mainly due to a lack of survey and, when the abundance of the three common varieties is taken into consideration, there is no evidence to suggest that it is declining.

No detail is given of the status of the varieties of *C. vulgaris*; the varieties tend only to be identified occasionally and almost never on a systematic basis. It is therefore difficult to interpret apparent changes. It is likely that many of the records listed as *C. vulgaris* s.l. refer to *C. vulgaris* var. *vulgaris* however this was not specified on information relating to the record.

V.C. 6

BEFORE 1994

- ST23 - Bridgwater, H.S.T. (Murray 1896).
- ST2535 - Pond, Brean, 3 August 1882, R.P.M. (BM) (Murray 1896); 16 September 1906, H.S.T. (BM).
- ST33 - Weston Zoyland, 1907, E.S.M. (Marshall 1908; 1914).
 - ST370305 Burrow Mount, 12 July 1987, M.A.R.K., C.K.
- ST34 - Near Edington Burtle, 8 June 1835, (possibly also var. *longibracteata* referred to as recorded by W.B.W. in White 1912) T.C. (BM) (White 1912; Marshall 1914).
 - Ditch, Edington Junction, 23 August 1915, E.S.M. (BM).
 - Mark Moor, 1915, C.I.S. [det. G.O.A.] (Sandwith & Sandwith 1958).
 - Burnham, W.B.W. (White 1912).
- ST36 - ST3868 Rhine, Kingston Seymour, 16 April 1981, P.M.W. (PMW!).
 - ST345610 ditch, north of Weston Airport, Weston-Super-Mare, 1990, J.N!

- ST383638 rhyne near West Hewish, 17 February 1990, M.A.R.K., C.K!
 - ST392604 southern side of track near Woolvershill Batch, Banwell, 17 February 1990, M.A.R.K., C.K!
 - ST43 - King's Sedge Moor, 13 August 1883, R.P.M. (BM).
 - ST44 - ST4145 Tadham Moor, 4 June 1979, M.A.P. (BRC).
 - Ditch near Catcott Burtle, 3 August 1937, J.P.M.B., C.I.S. (BM).
 - ST45 - Clevedon, D.F. (Murray 1896; White 1912).
 - ST46 - Moor ditches, Yatton (White 1912).
 - Kenn Moor, 11 October 1953, C.I.S., N.Y.S. [det. G.O.A.] (BM) (Sandwich 1962).
 - ST47 - Nailsea Moor, 1949, C.I.S. [det. G.O.A.] (Wallace 1950); ditch on Nailsea Moor, 27 July 1914, J.W.W. [det. J.G.] (Britton 1918).
 - ST53 - Kingweston (Murray 1896).
 - ST56 - Reservoir, Barrow Gurney, 6 October 1933, H.S.T. (BM).
 - Quarry pool, Hartcliff Rocks, I.M.R. (White 1912; Marshall 1914).
 - ST63 - Pond, Bruton, September 1936, F.K.M. (BM).
 - ST65 - Old coal canal, Camerton (White 1912).
 - ST73 - Roadside pond near Penselwood, 20 July 1891 R.P.M. (BM) (Murray 1896).
 - ST76 - "In the canal" Bath (Babington 1834; Murray 1896).
- 1994 ONWARDS
- ST25 - Dune slacks near Berrow (White 1912; Marshall 1914); [ST2952] pond, 20 May 1929, J.E.L. (BM); 20 September 1950, C.I.S. (BM); Pool west of church, 1992 R.S.C. (Willis 1992).
 - ST33 - Ditches Southlake Moor: ST36393048, ditch No. 53; ST374302 ditch No. 120, June 1998, R.V.L., S.J.L., K.P., L.W.; ST36243055, ditch No. 1; ST36313057, ditch No. 3; ST36733050, ditch No. 58; ST36913057, ditch No. 61; ST36723054, ditch No. 78, N end; ST37003053, ditch No. 81; ST36813037, ditch No. 95; ST36853038, ditch No. 96; ST36983045, ditch No. 98; ST37043045, ditch No. 99N, 20 July 2000, N.F.S., K.P.; ST36193025, ditch No. 64; ST36333026, ditch No. 85, 26 July 2000, N.F.S., P.W., K.P.; ST36723054, ditch No. 78, N end; ST36983045, ditch No. 98; ST37043045, ditch No. 99N, 4 October 2001, N.F.S.; ST36373030, ditch No. 88; ST36903034, ditch No. 137E; ST36783030, ditch No. 147 23, October 2001, N.F.S.; ST36313027, ditch No. 86; ST37413027, ditch No. 120; ST36903034, ditch No. 137E; ST37062984, ditch No. 194 19, September 2003, N.F.S.
 - ST308392 roadside ditch in N. edge of Bridgwater, 26 July 2004, N.F.S.
 - ST42 - ST483260 trial pit, in Appledoor Quarry, 10 May 2002, M.R.H!
 - ST44 - Tealham Moor: ST40794520 ditch No. 1, 9 May 2003, N.F.S.; ST40644540 ditch No. 3, 23 February 2004, N.F.S.; ST40504521 ditch No. 6, 23 February 2004, N.F.S.; ST40804520 ditch No. 10, 9 May 2003, N.F.S.; ST40794509 ditch No. 11, 10 June 2004, N.F.S.; ST40644524 ditch No. 12, 9 May 2003, N.F.S.; ST40924505 ditch No. 13, 9 May 2003, N.F.S.; ST41024515 ditch No. 14, 9 May 2003, N.F.S.; ST41084527 ditch No. 15, 9 May 2003, N.F.S.; ST41144520 ditch No. 16, 9 May 2003, N.F.S.
 - ST47 - Gordano Valley: 1914, C.I.S. [det. G.O.A.].
 - Walton Moor: ST430730 ditch No. 137, 4 March 1989, N.F.S., E.J.M.
 - Weston Moor: ST439734 ditch No. 171N; ST443736 ditch No. 180, 5 March 1989, N.F.S.; ST441736 ditch No. 177; ST442735 ditch No. 179; ST442737 ditch No. 148; ST442738 ditch No. 166-168; ST443735 ditch No. 186; ST443736 ditch No. 180; ST443737 ditch No. 147, 6 April 1989, N.F.S., S.W., E.J.M.; ST439734 ditch No. 171N; ST443736 ditch No. 180, 30 June 1989, S.W., O.M. [det J.A.B]; ST443731 ditch No. 199, 6 June 1999, N.F.S., R.V.L.; ST445737 ditch No. 191, 3 November 1999, [det N.F.S.]; ST443731 ditch No. 199, 20 September 1999, N.F.S. *et al.*; ST438736 ditch No. 154/155; ST438738 ditch No. 121-124; ST442738 ditch No. 166-168; ST443737 by E end of ditch No. 147; ST444736 ditch No. 192; ST444738 ditch No. 181; ST445734 Bass Pond, 11 June 2002; ST446733 ditch No. W of 212.1, 11 June 2002, N.F.S.; ST438738 ditch No. 121-124, 24 February 2004, N.F.S.
 - ST493738 Cattle trough near Downs School, 2002, P.M!
 - ST53 - Butt Moor: ST52563606 ditch No. 2, 26 July 2000, N.F.S., P.W.; ST52563606

- ditch No. 2, 23 October 2001, N.F.S.; ST52623609 ditch No. 3; ST52613600 ditch No. 4; ST52573614 ditch No. 5; ST52673614 ditch No. 6, 10 October 2002, N.F.S.; ST52503611 ditch No. 1; ST52503585 ditch No. 8; ST52563606 ditch No. 2; ST52223608 ditch No. 11; ST52173610 ditch No. 12; ST52213615 ditch No. 13, 23 July 2003, N.F.S., E.J.M. *et al.*; ST52513589 ditch No. 7; ST52463583 ditch No. 9; ST52663563 ditch No. 10, 17 September 2003, N.F.S.
- ST55 - ST515596 Blagdon Lake, 19 September 2003, B. Goldsmith *et al.* [det. N.F.S.] (BM!).
- ST58 - ST530807 New mitigation ponds, Avonmouth, 1999, V.H!
- V.C. 34**
BEFORE 1994
- SO50 - SO565065 Clearwell Quarry, 27 July 1986, S.H.B. S.C.H. [det. J.A.M.] (BRC).
- SO51 - Jugshole Pool, Coleford, 1980, S.C.H., M.J.A. [det. A.O.] (Moore & Bailey 1986).
- SO60 - SO612033 lake, Lydney Park, 1980, A.K. [det. J.A.M.] (Moore & Bailey 1986).
- pond in marshy field by River Severn, Poulton Court Farm, Awre, 1988, S.C.H. [det. J.A.M.].
- SO61 - Speech House (Riddelsdell *et al.* 1948).
- SO695067 Shallow pools on track, Lennetshill Plantation, Cinderford, 1980, A.O. (Bailey & Moore 1985).
- Shallow calcareous pool and ditch, Crabtree Plantation, Cinderford, 1980, A.O. (Bailey & Moore 1985).
- Soudley valley, H. (Riddelsdell *et al.* 1948); SP662116 Upper Soudley pool, August 1976, S.C.H. [det. J.A.M.] (BRC); 1994 C.W., D.H. (English Nature 1994); 1994, C.W., D.H. (English Nature 1994).
- SO70 - SO733056 ditch, New Grounds, Slimbridge, 29 August 1977, A.K. [det. J.A.M.] (BRC).
- Nupend (Riddelsdell *et al.* 1948).
- SO71 - Highnam (Riddelsdell *et al.* 1948).
- Arlingham (Riddelsdell *et al.* 1948).
- SO72 - Pond near Newent Canal (as *C. hispida*), G.A.O.B. (Riddelsdell *et al.* 1948).
- SO80 - Woodchester Park, H.P.R. (Riddelsdell *et al.* 1948).
- SO90 - Pool by canal above Chalford, H.P.R. (Riddelsdell *et al.* 1948).
- ST57 - Quarry pools, Eastfield, Westbury-on-Trym (White 1887; 1912).
- Ponds, Durdham Down and Shirehampton (White 1912).
- ST67 - Brickworks ponds, Shortwood, Mangotsfield, 1955, G.W.G. (Moore & Bailey 1986); 28 October 1964, D.M.-S. [det. S.P.P.] (Moore & Bailey 1985).
- Duchess Ponds, Stapleton (White 1912).
- Ditch, Siston Common, 1882, D.Ha. (White 1887; 1912); 1920 D.Ha. (White 1912).
- ST68 - Standing water on old railway, Froglane, Mayhill, 1964, G.W.G. (Moore & Bailey 1986).
- Woodlands, Patchway I.M.R. (Riddelsdell *et al.* 1948).
- ST69 - ST633977 newly dug pond north of Hill Pill, 16 November 1986, M.A.R.K., C.K!; ST628973 newly dug pond, Hill Pill, 16 November 1986, M.A.R.K., C.K!
- ST75 - [ST7159] canal near Dunkerton (as *C. contraria*), 25 June 1910, C.B., J.W.W. [det. H. & J.G.] (BM, MANCH! specimen labelled *C. fragilis* probably misprint) (Moss 1911; White 1912; Marshall 1914).
- ST78 - Wickwar - Yate area: ST791888 mill pond, Whitewell Bottom, Lower Kilcot (Riddelsdell *et al.* 1948); ST7183, 1910, J.W.W. (CGE! - probably the same record, located by C.B. and preserved by J.W.W.); 1953, (Moore & Bailey 1986); 1955, G.W.G. (Moore & Bailey 1986).
- ST79 - ST786932 sunny pond, Newark Park Estate, May 1984, M.S., W.L. (Clements *et al.* 1985); ST786932 pond, Newark Park, 16 May 1985, W.L. [det. J.A.M.] (BRC).
- ST88 - Ornamental Lake, Westonbirt School, 1984, R.H.B. (Bailey & Moore 1985, Moore & Bailey 1986).
- ST89 - Cherington Park Lake (Riddelsdell *et al.* 1948); ST898986, 7 July 1977, R.H.B., J.A.M. [det. J.A.M.] (BM) (Moore & Bailey 1986).
- Pond, Midland Fishery, Nailsworth, 2 September 1949, D.F.L. (BM) (Moore & Bailey 1986).
- Pond near White Horse, Avening, 3 July 1926, H.J.R. (as *C. fragilis*) (BM!) (Riddelsdell *et al.* 1948).
- 1994 ONWARDS
- SO61 - SO639134 Crabtree Colliery, Cinderford, December 1997, R.V.L!
- SO70 - Frampton Pools SSSI, 1993, C.W., A.H. (English Nature 1994); Frampton Sailing Lake, 1993, C.W., A.H. (English Nature 1994); SO753076 flooded gravel pit, 1995, R.V.L.
- SO750090 flooded gravel pit, Saul, 1995, R.V.L.

SO72 - SO713266 pond nr. Newent, 31 August 1998, R.V.L.

SO80 - Thames and Severn Canal: SO858042 Brimscombe, 27 July 1997, R.V.L.; SO848051 Stroud, 1997, R.V.L.; SO8104 Ebley, 7 October 2003 R.V.L.

- SO85810203 small, spring-fed pool used by cattle, Black Ditch, edge of Minchinhampton Common, 14 January 2004, D.C.

SO90 - SO967004 abundant in Severn and Thames Canal near Coates, 1997, R.V.L. (RVL!)

ST69 - ST674976 pond, Whitcliff Deer Park, near Ham, 1997, M.A.R.K., C.K., B.A.G.

ST78 - Wickwar - Yate area:
- ST710859 Yate Court, 1954, (Moore & Bailey 1986);

- ST716888 margin of deep quarry pool, 1995, R.V.L.

- ST703883 pond, Newland's Farm, 1995, R.V.L.

- ST757883 pond east of Lance Coppice, 1953, G.W.G. (Moore & Bailey 1986); 1995, R.V.L.; 1996, R.V.L.; 1997, R.V.L.; 1998, R.V.L.; 5 June 1999, N.F.S., R.V.L.

ST79 - ST771939 lake, Tyley Bottom, 1978, R.H.B., J.A.M. [det. J.A.M.] (Moore & Bailey 1986); ornamental lake, Tyley Bottom, 1984, R.H.B., J.A.M. (Bailey & Moore 1985); ST775942 recently dug farm pond, Tyley Bottom, 1996, R.V.L.

ST89 - ST803973 new pond at the top of the stream entering Owlpen Valley, 1997, R.V.L.; newly created pond on site of old dew pond on farm adjacent to Owlpen Manor, 2003, R.W. (supplied by M. Palfrey) [det. M.A.R.K].

- Marl pool, Ruskin Mill, 1 June 1996, J.J.D!

var. *crassicaulis* (Schleich. ex A. Braun) Kütz.

V.C. 6 or 34 (the vice county boundary runs through the middle of the reservoir)

BEFORE 1994

ST77 - Monks Wood Reservoir, Bath, 1928 C.I.S. [det. J.G.] (White 1928).

var. *longibracteata* (Kütz.) J. Groves and Bull.-Webst.

V.C. 6

BEFORE 1994

ST47 - Gordano Valley:

- Walton Moor: ST430730 ditch No. 137, 5 m altitude, 4 March 1989, N.F.S., E.J.M. (SLBI).

- Weston Moor: ST445737 3 November

1999, A.W!; ST442738 ditch No. 166-168, 6 April 1989, N.F.S., S.W., E.J.M.; ST442735 ditch No. 179, 6 April 1989, N.F.S., S.W., E.J.M.

ST57 - Pond between Bedminster and Whitchurch, 1882 (White 1887; Murray 1896; White 1912).

1994 onwards

ST33 - Southlake Moor: ST36933040, ditch No. 97 20 July 2000, N.F.S., K.P.

ST44 - Tealham Moor: ST40604551 ditch No. 8; ST40704545 ditch No. 9, 23 February 2004, N.F.S.; ST40794509 ditch No. 11, 9 May 2003, N.F.S.

- ditch Clapham Moor ST454735, 3 November 1999 A.W!

V.C. 34

BEFORE 1994

SO70 - Frampton on Severn (Riddelsdell *et al.* 1948); SO748071 at edge of Blue Pool, Frampton Pools, 25 June 1976, J.A.M. (Moore & Bailey 1978); SO748076 pond, 29 August 1977, A.K. [det. J.A.M.] (Moore & Bailey 1986).

ST66 - Pond, Bitton, 18 June 1914, I.M.R. [det. J.G.] (BM) (Riddelsdell *et al.* 1948).

ST67 - Wickwar - Yate area: Newly dug ditch, Siston Common, 2 October 1962, D.M.-S. [det. S.P.P.] (Bailey & Moore 1985, Moore & Bailey 1986).

ST78 - Wickwar - Yate area:
- Ponds, Little Sodbury End, Sodbury Common, 1953, G.W.G. (Sandwith & Sandwith 1954, Moore & Bailey 1986).

- Inglestone Common, 1953, G.W.G. (Sandwith & Sandwith 1954).

- Horton, 1953, G.W.G. (Sandwith & Sandwith 1954, Moore & Bailey 1986).

1994 ONWARDS

SO80 - SO816015 ornamental lake, Woodchester Park, 28 August 1995, R.V.L.

ST69 - ST638931 rhyne near Duckhole, 1996, R.V.L. (RVL).

ST78 - Wickwar - Yate area:
- ST743851, one stem, pond by Vinney's Lane, 5 June 1999, N.F.S., R.V.L.

- ST729835 newly dug ornamental ponds, Yate Golf Course, 1997, R.V.L.

ST89 - ST899986 Cherington Lake, 23 August 1995, R.V.L!

var. *papillata* Wallr. ex A. Braun.

V.C. 6

BEFORE 1994

SO60 - SO695067 [pond in marshy field by R. Severn, Poulton Court Farm, Awre] 4 June 1998, S.C.H. [de. J.A.M.] (J. A. Bryant correspondence file).

ST23 - Clay pit, near Bridgwater, August 1899, G.R.B.-W. (Bullock-Webster 1901, Marshall 1914).

ST44 - Shapwick Moor (White 1912; Marshall 1914).

ST47 - Nailsea Moor, 10 September and 17 September 1904, J.W.W. [det. H. & J.G.] (**BM**, **NMW** recorded as var. *longibracteata*!, E det. A.B!) (Roper 1918); ditch, 1914, J.W.W. [det. J.G.] (**BM**) (Britton 1918); 1948, C.I.S. [det. G.O.A.] (Wallace 1950; Sandwith & Sandwith 1950).

- Gordano Valley:

- ST458736 abundant along ditch, Clapton Moor, 3 October 2001, N.F.S. *et al.*

- Ditch between Portbury and Portishead, 1889, (White 1912; Marshall 1914).

- Tickenham Moor (White 1912; Marshall 1914).

ST55 - Blagdon Lake, 1937, H.S.T. (**BM**).

ST56 - Ponds under Dundry Hill, 1886, [probably this specimen collected by] J.W.W. [det. H. & J.G.] (Groves & Groves 1887; White 1912).

ST75 - ponds in Prior Park, nr. Bath (White 1912; Marshall 1914).

1994 onwards

ST33 - ST36863056, ditch No. 60E 26 June 1998, R.V.L., S.J.L., K.P., L.W.

- ST394327 ditch beside drove near Sowry River, 2003, E.J.M. *et al.*

ST47 - ST457737 Clapton Moor, 2003, P.M!

- Gordano Valley:

- Walton Moor, 1901, J.W.W. [det. H. & J.G.] (**CGE**) (White 1912; Marshall 1914); ditch, September 1935, G.O.A. (**BM**) (Sandwith & Sandwith 1958, Willis & Jefferies 1959); ST443736, 1989, S.W. [det. J.A.M.]; ST439734, 1989, S.W. [det. J.A.M.]; ST434733 ditch No. 101, 11 June 2002, N.F.S.

- Weston Moor: ST439735 in a recently cleared peaty ditch No. 171 with some iron ochre, Weston Moor, near Weston in Gordano, 5 m altitude, 5 March 1989, N.F.S., S.W. [conf. J.A.M. 1989] (Willis 1989); ST439734 ditch No. 171N, 6 April 1989, N.F.S., S.W., E.J.M.; ST442733 ditch No. 195, 20 September 1999, N.F.S. *et al.*

ST55 - ST569597 Chew Valley Lake, 20 September 2003, B. Goldsmith *et al.* [det. N.F.S.] (**BM**!).

V.C. 34

BEFORE 1994

SO61 - Pond, Cannop, 12 July 1976, [det. J.A.M.] (BRC).

SO70 - SO748071 at edge of Blue Pool, Frampton Pools, 25 June 1976, J.A.M., R.H.B. (Moore & Bailey 1977, Moore & Bailey 1978 as recorded by J.A.M.).

SO80 - Thames and Severn Canal, Brimscombe, 1953, J.E.L. [det. G.O.A.] (Moore & Bailey 1986).

SO90 - Lake, Misarden Park [as Miserden, however this spelling refers to the village], 1977, A.K. (Moore & Bailey 1986).

- Pool by canal above Chalford, H.P.R. (Riddelsdell *et al.* 1948).

ST58 - Water tank, Filton aerodrome, 7 October 1948, D.McC. [det. G.O.A.] (**RNG**!).

ST78 - Wickwar - Yate area:

- Ponds, Little Sodbury End, Sodbury Common, 1953, G.W.G. (Sandwith & Sandwith 1954, Moore & Bailey 1986).

- Kingrove Common, Chipping Sodbury, 1954, G.W.G. (Moore & Bailey 1986).

- Inglestone Common, 1953, G.W.G. (Sandwith & Sandwith 1954)

- Goosegreen Farm, Yate, C.B. (White 1912; Riddelsdell *et al.* 1948).

- ST716817 pool on strontium-rich marl at c. 200 ft., Yate, 1 November 1954, H.J.M.B. [det. G.O.A.,] (**RNG**!).

1994 ONWARDS

SO80 - SO816015 ornamental lake, Woodchester Park, 28 August 1995, R.V.L.; 1998 RVL!

ST78 - Wickwar - Yate area:

- Goosegreen Farm, Yate Court, 5 October 1910, J.W.W. (**CGE**); ST709858 strontium pit, 1995, R.V.L. (**RVL**!);

- ST710859 strontium pit, 19 August 1995, R.V.L.; ST708858 strontium pit near Yate Court, 1996 R.V.L. (**RVL**!).

- ST717887 margin of deep quarry pool, The Cliffs, Wickwar, 19 August 1995, R.V.L.!

- ST729835 newly dug ornamental ponds, Yate Golf Course, 1997, R.V.L.

- ST757883 pond east of Lance Coppice, 1996, R.V.L. (**RVL**!).

ST79 - ST733967 trout pond, North Nibley, 1996, R.V.L. (**RVL**!).

ST89 - ST899986 Cherington Lake, 23 August 1995, R.V.L.!

var. *vulgaris*.

V.C. 6

BEFORE 1994

ST47 - Nailsea Moor, 10 September 1904, J.W.W. [det. H. & J.G.] (as var. *crassicaulis* det. as *C. vulgaris* J.G.) (BM!, E det. A.B!) (Roper 1918); ST444704 ditches, 25 January 1975, I.F.G. [det. J.A.M.] (BRC).

ST47 - Gordano Valley: ST442735, ditch (No. 179), 6 April 1989, N.F.S., S.W., E.J.M.; ST443735 - ST442734, ditch (No. 186), 6 April 1989, N.F.S., S.W., E.J.M.

- ST431731 ditch (No. 137), Walton Moor, 5 m altitude, 4 March 1989, N.F.S., E.J.M. (SLBI).

- Weston Moor: ST442735 ditch (No. 177), 6 April 1989, N.F.S., S.W.; ST442737-ST443737, (ditch No. 148), 6 April 1989, N.F.S., S.W. (SLBI); ST442738 ditch (No. 167), 6 April 1989, N.F.S.; ST438734 peaty ditch (No. 171), 5 m altitude, 5 March 1989, N.F.S. (SLBI); ST443736 peaty ditch (No. 180), 5 m altitude, 5 March 1989, N.F.S. (SLBI); ST443737 ditch (No., 147), 6 April 1989, N.F.S., S.W.

- Portbury, 24 October 1902, C.B. [det. A.B.] (BM); ditch, Portbury Marsh, October 1907, C.B. (BM).

ST56 - pond between Bedminster and Whitchurch, 1882 (White 1887; Murray 1896; White 1912).

V.C. 34

BEFORE 1994

ST78 - Goosegreen Farm, Yate, C.B. (White 1912; Riddelsdell *et al.* 1948).

ST79 - ST774948 pond, Cotswold Edge Golf Club, Wotton-under-Edge, 21 January 1985, S.C.H. [det. J.A.M.] (BRC).

1994 ONWARDS

SO80 - SO816015 ornamental lake, Woodchester Park, 28 August 1995, R.V.L.; 1998 RVL!

ST78 - ST710859 strontium pit, 19 August 1995, R.V.L!

- ST729835 newly dug ornamental ponds, Yate Golf Course, 1997, R.V.L.

- ST757883 pond east of Lance Coppice, 1996, R.V.L. (RVL!).

ST79 - ST733967 trout pond, North Nibley, 1996, R.V.L. (RVL!).

ST89 - ST899986 Cherington Lake, 23 August 1995, R.V.L!

NITELLOPSIS HY.

Nitellopsis obtusa (Desv.) J.Groves Starry stonewort

Red List - Vulnerable.

A large and apparently healthy population of this species was located in a flooded gravel pit on the Frampton Pools SSSI (v.c. 34) in 1995. In 2003, populations were found in Chew Valley Lake and Blagdon Lake (both in v.c. 6), in 2004 a population was found just outside the region, in the Cotswold Water Park and in late 2004 another population was found in a flooded gravel pit in Lincolnshire. These comprise the only known sites in Britain apart from the Norfolk Broads. These discoveries over quite a short period suggest that this species may be a new arrival and be spreading. However, *N. obtusa* tends to be limited to fairly deep water and is therefore only found by people sampling beyond the margins who are aware of the diagnostic features. It is therefore also possible that it has been overlooked.

V.C. 6

1994 ONWARD

ST55 - ST515596 Blagdon Lake, 19 September 2003, B.G. *et al.* [det. N.F.S.] (BM!).

- ST569597 Chew Valley Lake, 20 September 2003, B.G. *et al.* [det. N.F.S.] (BM!).

V.C. 34

1994 ONWARDS

SO70 - SO753076 Frampton Pools, probably this species, recorded as *Nitella flexilis*, 1993 C.W., A.H. (English Nature 1994); SO753076, September, 1995, R.V.L. (RVL!); 9 January 1996 R.V.L. (RVL!).

NITELLA C. AGARDH.

Nitella mucronata A. Braun (Miguel) Pointed stonewort.

N. mucronata has been recorded from several sites in the region but populations have been found at only two since 1994. It is likely that all of the records refer to var. *gracillima*. The type locality for this variety was in a pool created by strontium extraction near Wickwar (variously "In a small pond nearly six feet deep of clear land water" (Moore & Bailey 1985), "Wickwar area", "pond near Wickwar" "small deep pond near Rangeworthy" by I. M. Roper). Ponds in the area which probably provided the

type specimen were destroyed for development in late 1996. This species is nationally scarce but seems to have increased in recent years, particularly in renovated canals and it is possible that the var. *gracillima* is not native (Stewart 2004).

V.C. 6

BEFORE 1994

ST43 - ST463394 ditch, Street Heath, 8 June 1975 P.M.W. [det. J.A.M.] (BRC); August 1989 C.F. and J.G.K [det. J.A.M.] (BRC).

V.C. 34

BEFORE 1994

ST78 - ST708855 [north of the Leech Pool], Wickwar area, 1984 A.J.B. [det. J.A.M.] (BM).

Nitella mucronata (A. Braun) Miq. var. *gracillima* J. Groves and Bull.-Webst.

V.C. 34

BEFORE 1994

ST69 - Tortworth Lake, Tortworth Estate, 11 February 1990 N.F.S., M.A.R.K., C.K.; ST6991, 1990 RUD! (BRC); ST6992, 1990 RUD! (BRC).

ST78 - Wickwar - Yate area: 11 July 1917, I.M.R. [det. G.O.A.] (BM!); 4 June 1917, I.M.R. [det. G.O.A.] (BM!); August 1918, I.M.R. [det. G.O.A.] (BM!).

- small deep pond near Rangeworthy, 30 April 1917, I.M.R. [det. G.O.A.] (BM!, E!) (White 1919; Allen 1950; Moore & Bailey 1985); 4 June 1917, I.M.R. [det. G.O.A.] (BM!); pond (old strontium pit) E. of Rangeworthy, 16 May 1917, J.W.W. [det. J.G.] (BM!); pool (old strontia pit) east of Rangeworthy, 22 March 1918, J.W.W. [det. J.G.] (BM!) (Riddelsdell *et al.* 1948; Moore & Bailey 1986); strontia pit between Yate Court and Leech Pool Farm, Yate, 15 December 1984, A.J.B (Bailey & Moore 1985).

1994 ONWARDS

SO70 - SO783062 (disused) Thames and Severn Canal near Eastington, 1997, R.V.L. (RVL!).

SO80 - SO786031 (disused) Thames and Severn Canal, Brimscombe, 1997, R.V.L.

Nitella opaca Dark stonewort

Over the last few decades *N. flexilis* (smooth stonewort) and *N. opaca* were united under one species. Recently *N. opaca* has been reinstated as a species in line with the accepted view elsewhere in Europe (Bryant *et al.* 2002). As

fertile material is needed to separate the two species, there are several records which cannot be attributed to either species. In this account, records for which determination to species has not been possible, have been listed here (as *N. flexilis* agg.) under *N. opaca*, because *N. flexilis* s.s. has never been confirmed from either county.

All records are from slow moving or still water in medium to small ponds or from canals. Elsewhere *N. opaca* is frequent, particularly in western Britain, while *N. flexilis* is nationally scarce and is scattered in lowland areas. *N. opaca* appears to have declined significantly in the region, with records since 1994 only from pools in the Forest of Dean, a short length of the Severn and Thames Canal, the Gordano Valley and a marl pool at Ruskin Mill near Nailsworth.

One of the reasons for the lack of recent records from sites in the Wickwar - Yate area is certainly the loss of the less basic commons overlying the coal measures, near Chipping Sodbury and Yate to urban development. The species is unlikely to be found again in this area. A small number of water bodies have been and continue to be, created in association with quarrying and with housing development and it is possible that it will reappear in one of these.

V.C. 6

BEFORE 1994

ST47 - ST453726 ditch, Walton Moor, 1989 S.W. det. J.A.B.

ST55 - Blagdon Lake, 5 September 1933 H.S.T. (BM).

ST57 - ST558731 Bristol University Botanic Gardens, 7 May 1984 A.L. [det. J.A.M.] (BM).

ST76 - In the canal at Bath, D.H.G (Babington 1834; White 1887; Murray 1896).

- 1918 C.I.S. (White 1920).

1994 ONWARDS

ST47 - Gordano Valley:

- Walton Moor: ST435726 ditch No. 55 [det J.A.B.]; ST436726 ditch No. 56 [det J.A.B.]; ST436727 ditch No. 57, 29 June 1989, S.W., O.M. [det J.A.B.]

V.C. 34

BEFORE 1994

SO61 - SO609125 *N. flexilis* agg. pond with slow stream entering and leaving, Cannop, 9 November 1983, M.V.M. [det. J.A.M.]

(Bailey & Moore 1985, Moore & Bailey 1986).

ST59 - pond, Tidenham Chase, 7 July 1898 J.H.M. (BM) (Riddelsdell *et al.* 1948).

ST69 - pond, Berkeley, 1868 J.W.W. [det. H. & J.G.] (White 1912) probably the same record listed as "pond, Berkeley Canal", 1868 (as *Chara flexilis*) G.A.O.B. by Riddelsdell *et al.* (1948).

ST78 - Wickwar - Yate area:

- Yate Common: 30 April 1910, J.W.W. (CGE!); three ponds, C.B. [det. J.W.W.] (CGE) (White 1912); south of Hall End, June 1917, I.M.R. (LSR) (White 1919); pond, 22 March 1918 J.W.W. [det. H. & J.G.] (BM!) (Barton 1919; Riddelsdell *et al.* 1948).

- pond, Little Sodbury End, 1953 G.W.G. (Sandwith & Sandwith 1954, Moore & Bailey 1986).

1994 ONWARDS

SO61 - *N. flexilis* agg. Woorgreens Lake, northeast of the Speech House, 1993, C.W., A.H. (English Nature 1994); 1997, R.V.L.; *N. flexilis* agg. SO631126 pond near Fox's Bridge, near Woorgreens, 1997, R.V.L.; *N. flexilis* agg. SO630128, 31 August 1998, R.V.L.; *N. flexilis* agg. SO631127 Woorgreens Lake, 31 August 1998, R.V.L.

- *N. flexilis* agg. SO639134 Crabtree Colliery, Cinderford, 1997, R.V.L.

SO90 - SO967008 *N. flexilis* agg., Thames and Severn Canal near Coates, 7 July 1977, R.H.B., J.A.M. [det. J.A.M.] (BM) (Moore & Bailey 1986); SO967004 abundant in (disused) Severn and Thames Canal near Coates, 1997, R.V.L. (RVL!).

ST89 - *N. flexilis* agg., Marl pool, Ruskin Mill, 1996, J.J.D!

Nitella translucens (Persoon) Agardh.
Translucent Stonewort

N. translucens has only been recorded from a single site in the region and there, apparently only twice. It tends to occur in the deeper parts of water bodies, rarely being visible from the margins. As such, it is possible that it has been overlooked and it may be under-recorded. Conversely, this species is very much in decline in southern England and has become extinct in several counties and may well be extinct in the region. There are few areas in v.c. 34 which are likely to be suitable, but any ponds or lakes in peaty parts of the Somerset Levels could be suitable.

V.C. 6

BEFORE 1994

ST43 - Ashcott Station, Glastonbury Peat Moors, 18 June 1919 H.P. and C.I.S. (BM) (Druce 1920; White 1921); Ashcott, June 1922, H.J.G. (LSR).

TOLYPELLA (A. BRAUN) A. BRAUN.

Tolypella glomerata (Desv.) Leonh. Clustered Stonewort

Synonym: *T. nidifica* var. *glomerata*.

T. glomerata is a nationally scarce and decreasing species but is widely scattered throughout Britain. The two records from the region are from disused canals before 1985. Both sites have been surveyed since 1995 and this species now appears to be extinct in both vice counties. It continues to survive in the Cotswold Water Park in Wiltshire, a few kilometres to the east of the site at Coates.

V.C. 6

BEFORE 1994

ST33 - In one of the old clay pits, near Bridgwater, 21 August, 1899 G.R.B.-W. [det. J.G.] (BM) (Bullock-Webster 1901; Marshall 1914).

- Drain near Sedgemoor Cut, May 1899, G.R.B.-W. (Bullock-Webster 1901).

ST43 - Ditch, King's Sedge Moor nr. Othery, 8 May 1899, G.R.B.-W. (BM) (Marshall 1914; 1909).

ST47 - Rhine near Portbury, 1922, O.V.D. (White 1923).

- ST4573 rhyne on Clapton Moor, February 1922, C.I.S. (BM) (White 1923; Willis & Jefferies 1959).

V.C. 34

BEFORE 1994

SO80 - Canal between Bowbridge and Chalford on N. side, 1907, G.A.O.B.; 1922 C.I.S., N.Y.S. (Riddelsdell *et al.* 1948).

SO90 - SO967006 Thames and Severn Canal near Coates, 7 July 1977, R.H.B., J.A.M., det. J.A.M. (BM).

Tolypella intricata (Trent. Ex Roth.) Leonh. Tassel Stonewort

Red List Endangered; BAP

This is a rare and declining species in Britain and in recent years, it has only been recorded from a few areas, with the main British populations apparently occurring in the Wickwar area and on Otmoor in Oxfordshire. *T. intricata* is a classic species of disturbed, ephemeral waterbodies.

It is not immediately obvious from the list of records below, but there have been three discrete periods within which *Tolypella intricata* has been recorded in the Wickwar – Yate area: 1917–1918 (5 records), 1952–1955 (11 records) and 1995–2000 (17 records). The first two periods coincide with periods of increased interest in stoneworts due to recent publication of identification guides. There are no data on issues such as grazing and land management in the area for the first two periods, but we have reasonable information for the third. The early 1990s followed the end of the period of low rainfall of the early to mid-1980s and comprised a period with good annual rainfall. Active woodland management had been carried out in Lower Woods NR resulting in poaching of many of the rides, while large numbers of cattle were grazed on the commons, to the extent that the pond to the east of Lance Coppice was usually churned to completely bare mud in the early summer. As a result of this combination of factors, from a single plant found in the pond east of Lance Coppice in 1995, eight sites had growing plants in 1997, with most supporting more than ten plants (although counts of plants have only limited meaning in relation to aquatic annual plants such as this). Since then, a decline in grazing pressure due to a combination of the foot and mouth disease outbreak and falling profits for dairy farming, combined with no significant poaching on the rides in Lower Woods NR, has led to vegetation succession in most of the ponds that previously supported *T. intricata*. Surveys in 2002 and 2004 found plants at only five sites in 2002, two of which were new for the species (Williams *et al.* 2003) and only one plant at one site in 2004.

Outside the Wickwar – Yate area, the prognosis for *T. intricata* is not good. The Hereford and Gloucester Canal was dry and largely full of earth in 1997, although parts were under restoration and the plant may re-appear. There is no sign of the pond near Pitney Wood, although no thorough survey of the area has been carried out. The ditch in which it was recorded in the Gordano Valley has been searched a number of times in recent years and no plants have been found, possibly because the ditch is becoming overgrown. In all these sites, except possibly at Pitney Wood, there is no reason to suppose that the species has disappeared. However without frequent visits we are unlikely to know if and when it does reappear. Similarly, without frequent survey of

all sites from which the species has been recorded we are unlikely to gain a better understanding of the dynamics of populations of this species and consequently decisions on the need for management will always be somewhat speculative. The dramatic decline in the number of sites supporting plants certainly appears to be worrying, but we still have insufficient data to know whether the best course is to intervene, with the risk of creating a more or less a permanent obligation to management, or whether it is better to do nothing in the expectation that it normally undergoes a “boom and bust” cycle and that populations will recover naturally.

V.C. 6

BEFORE 1994

ST42 - pond outside Pitney Wood, nr. Langport, 21 March 1907, E.S.M. [det. G.O.A.] (**BM!**, **E!**, **NMW!**) (Druce 1919); pond on northern edge of Pitney Wood, 27 April 1907, E.S.M. [det. J.G.] (**BM!**, **E!**, **NMW!**, **OXF!**) (Riddelsdell 1908, Groves and Bullock-Webster 1924, Marshall 1908 – as “pond outside Pitney Wood”).

ST47 - near Bristol 1917, C.I.S. [det. G.O.A.] (**BM**) (Druce 1919) (possibly refers to Weston Moor).

- ST441736 recently cleared peaty ditch (No. 177), Weston Moor, Gordano Valley, 6 April 1989, N.F.S. (Willis 1989) (**SLBI**); ST441736 ditch No. 177, 6 June 1989, N.F.S., S.W., E.J.M.

ST76 - canal at Bath 1918, C.I.S. (White 1920).

1994 ONWARDS

ST44 - Tealham Moor: ST40794509 ditch No. 11, 9 May 2003, N.F.S.

V.C. 34

BEFORE 1994

SO72 - ditches near Newent Canal, (as *Chara vulgaris*) G.A.O.B. (Sandwith 1917; Groves & Bullock-Webster 1920; Riddelsdell *et al.* 1948).

ST78 - Wickwar – Yate area:

- Yate area: In a small muddy pool (a strontium pit) north of Yate Church 25 May 1917 C.I.S. [det. G.O.A.] (**BM** labelled “Yate Common, below Yate Rocks”) (White 1919; Sandwith 1917; Druce 1918); Different pond near Yate 1918, C.I.S. [det. G.O.A.] (**BM**) (White 1920; Riddelsdell *et al.* 1948; Moore & Bailey 1986); Yate, 8 November 1918, C.I.S. [det. G.O.A.] (**BM**)

(White 1920; Moore & Bailey 1986); Old strontium pit below Yate Rocks 1917, (Riddelsdell *et al.* 1948 "in Hb. Sandwith"); Old disused strontium digging in the neighbourhood of Yate 25 May 1917, C.I.S. [det. J.G.] (Sandwith 1917; Druce 1918, Riddelsdell *et al.* 1948).

1994 ONWARDS

ST78 - Wickwar - Yate area:

- Little Sodbury and Horton: Pond, Little Sodbury End, Sodbury Common 1954, G.W.G. (Sandwith & Sandwith 1955; Moore & Bailey 1986); Sodbury Common 1954, G.W.G. (Moore & Bailey 1986); Horton 1953 G.W.G. [det. G.O.A.] (Sandwith & Sandwith 1954, Moore & Bailey 1986); Pond nr. Vinney's Lane, Horton 1952 (Sandwith & Sandwith 1953): 1953 G.W.G. [det. G.O.A.] (Sandwith & Sandwith 1954); 1954 G.W.G. [det. G.O.A.] (Sandwith & Sandwith 1954; Wallace 1955; Moore & Bailey 1986). ST743851 pond nr. Vinney's Lane, Horton, 22 February 1999, R.V.L. (Stewart & Lansdown 1999b); 5 June 1999, R.V.L., N.F.S.; 2000 R.V.L.; ST 761871 Poached, grazed and partly shaded pond on eastern edge of Hawkesbury Common, 2002, R.V.L. (Williams *et al.* 2003); pond, Hawkesbury Common, 24 February 2004, N.F.S., R.V.L.

- Inglestone Common: Ponds, 1953, G.W.G. [det. G.O.A.] (Sandwith & Sandwith 1954, Moore & Bailey 1986); two ponds 1954, G.W.G. [det. G.O.A.] (Sandwith & Sandwith 1954, Wallace 1955, Moore & Bailey 1986); 6 May 1955, H.J.M.B. (RNG!); ST758884 pond east of Lance Coppice, 21 December 1996, R.V.L. (Stewart & Lansdown 1999); 4 March 1997, R.V.L.; 29 March 1997, R.V.L. (Stewart & Lansdown 1999b) (RVL!); 14 December 1997, R.V.L. (Stewart & Lansdown 1999); 1998 R.V.L.; 5 June 1999 N.F.S., R.V.L.; 24 February 2004, N.F.S., R.V.L.; ST751884 pond north of Spoil Coppice, Inglestone Common, 21 December 1996, R.V.L. (Stewart & Lansdown 1999b).

- Lower Woods NR: ST748883 Pond, track to Lower Woods Lodge, April 1985, A.J.B. [det J.A.M.] (BM); ST748883 pond, track to Lower Woods Lodge, Lower Woods NR, Upper Wetmore, 29 March 1997, R.V.L. (Stewart & Lansdown

1999b); ST743864 track, Stonybridge Wood, Lower Woods NR, Upper Wetmore, 19 May 1997, R.V.L. (Stewart & Lansdown 1999b); ST748881 poached pool in Green Trench, south of Spoil Coppice 1999 R.V.L.; Horse's hoof print, Horton Great Trench, Upper Wetmore 1954 G.W.G. [det. G.W.G.] (Moore & Bailey 1986); ST743873-ST741872 series of hollows in Horton Great Trench, Lower Woods NR, Upper Wetmore, 21 December 1997, R.V.L. (Stewart & Lansdown 1999b); 27 February 1999, R.V.L. (Stewart & Lansdown 1999b).

- Assley Common: ST759894 pond east of Withymore Wood, nr. Inglestone, 10 April 1997, R.V.L. (Stewart & Lansdown 1999b).

- ST736895 pond east of Cherryrock Farm, nr. Inglestone, 9 April 1997, R.V.L. (Stewart & Lansdown 1999b) (RVL!).

- ST718888 margin of deep quarry pool north of Wickwar, 19 May 1997, R.V.L. (Stewart & Lansdown 1999b) (RVL!).

Tolypella nidifica (O. Müll.) Leonh. Bird's-nest stonewort

This species was "Alleged to have been detected in old river bed at Sharpness (C.N.F.C. III, 1863, 145 [presumably indicates that it was published in the Proceedings of the Cotteswold Naturalists Field Club]), but doubtless in error" (Riddelsdell *et al.* 1948). The original record was probably given as *Chara nidifica* (although even this is a little late for use of this name). *C. nidifica auct brit.* has tended to be equated with *Tolypella glomerata*, but could also have referred to *Nitella opaca* or *N. flexilis*. Thus, whilst Riddelsdell *et al.* (1948) robustly dismisses this record and it is very unlikely to have been this species, it could have been a *Tolypella* species, particularly *T. glomerata* or *T. intricata* and it may be worth searching this area for suitable habitat for both taxa.

Tolypella prolifera (Ziz. ex A. Braun) Leonh. Great Tassel Stonewort
Red List - Endangered; BAP

Before 1994, *T. prolifera* had been reported from two sites in the region. Survey by the Somerset Rare Plants Group at Southlake Moor resulted in the discovery of an apparently new, healthy population of *T. prolifera*. In contrast to all other British sites for this species, where

populations are normally restricted to one or two ditches, at both sites in the Somerset Levels it has been record from ten ditches. There have apparently been no recent surveys of the gravel pits in the Walham area by botanists familiar with this species. Not only do some of these pits support uncommon aquatic plants, such as *Ceratophyllum submersum*, but there are abundant ditches and small ponds in the area that may be suitable for this species and which merit survey.

V.C. 6

1994 ONWARDS.

ST33 - ST36393048, ditch No. 53; ST36863056, ditch No. 60E, 26 June 1998, R.V.L., S.J.L., K.P., L.W. (Leach *et al.* 1999); 18 July 2000, N.F.S., K.P. (Williams & Stewart 2002); ST36243055, ditch No. 1; ST36313057, ditch No. 3; ST36773056, ditch No. 30; ST36843057, ditch No. 31; ST36903058, ditch No. 32; ST36863056, ditch No. 60E; ST36913057, ditch No. 61; ST36933040, ditch No. 97; ST36983045, ditch No. 98; ST37043045, ditch No. 99N, 20 July 2000, N.F.S., K.P.; 26 July 2000, N.F.S., K.P., P.W. (Williams & Stewart 2002); 15 August 2000, P.W., J.Bi. (Williams & Stewart 2002); ST36843057, ditch No. 31; ST36333026, ditch No. 85; ST36373030, ditch No. 88; ST36933040, ditch No. 97; ST36983045, ditch No. 98, 26 July 2000, N.F.S., P.W., K.P.; 4 October 2001, N.F.S. (Williams & Stewart 2002); ST36723054, ditch No. 78 N end; ST36813052, ditch No. 79; ST36933040, ditch No. 97; ST36783030, ditch No. 147, 23 October 2001, N.F.S. (Williams & Stewart 2002); ST37413027, ditch No. 120; ST36903034, ditch No. 137E, 19 September 2003, N.F.S.

ST53 - ST5236 in a small ditch surrounded by frogbit, September 1986, J.G.K. Butt Moor (Leach *et al.* 1999); ST52563606 ditch No. 2, 26 July 2000, N.F.S., P.W. (Williams & Stewart 2002); ST52563606 ditch No. 2, 15 August 2000, P.W., J.Bi. (Williams & Stewart 2002); 23 October 2001, N.F.S. (Williams & Stewart 2002); ST52623609 ditch No. 3; ST52613600 ditch No. 4, 10 October 2002, N.F.S.; ST52503611 ditch No. 1; ST52563606 ditch No. 2; ST52503585 ditch No. 8; ST52223608 ditch No. 11; ST52173610 ditch No. 12; ST52213615 ditch No. 13, 23 July 2003, N.F.S., E.J.M. *et al.*; ST52463583 ditch No. 9; ST52663563 ditch No. 10; ST52223608 ditch No. 11; ST52263640 ditch No. 14, Butt Moor 17 September 2003, N.F.S.

V.C. 34

BEFORE 1994

SO82 - Walham, 4 July 1939, J.F.G.C., N.D.S [det. G.O.A.] (BM).

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REFERENCES

- ALLEN, G. O. (1950). *Nitella mucronata* Miq. var. *gracillima* Groves and Bull.-Webst. in Warwickshire. *Watsonia* **1**: 364–365.
- BABINGTON, C. C. (1834). *Flora Bathonensis*. London.
- BAILEY, R. H. & MOORE, J. A. (1985). Gloucestershire charophyte records 3. *Gloucestershire Naturalists Society Journal* **36**: 80–83.
- BARTON, W. C. (1919). Report of the Distributor for 1918. *The Botanical Society and Exchange Club of the British Isles, Report for 1918* **5**: 483–534.
- BRITTON, C. E. (1918). Report of the distributor for 1917. *The Botanical Society and Exchange Club of the British Isles, Report for 1917* **5**: 205–262.
- BRYANT, J. A., STEWART, N. F. & STACE, C. A. 2002. A checklist of Characeae of the British Isles. *Watsonia* **24**: 203–208.
- BUCKNALL, C., FRY, D. & WHITE, J. W. (1903). Notes on Bristol plants. *Journal of Botany, British and Foreign* **41**: 55–56.

- BULLOCK-WEBSTER, G. R. (1901). New Characeae records. *Journal of Botany, British and Foreign* **39**: 101–102.
- CLEMENTS, D. K., SCRUBY, M. & LUTLEY, W. (1985). *Newark Park, Glos.* Unpublished Report to National Trust, Cirencester.
- DANDY, J. E. (1969). *Watsonian Vice-counties of Great Britain*. The Ray Society, London.
- DRUCE, G. C. (1918). New county and other records. *The Botanical Society and Exchange Club of the British Isles, report for 1917* **5**: 93–137.
- DRUCE, G. C. (1919). New County and other records. *The Botanical Society and Exchange Club of the British Isles, Report for 1918* **5**: 363–412.
- DRUCE, G. C. (1920). New County and other records. *The Botanical Society and Exchange Club of the British Isles, Report for 1919* **5**: 635–412.
- ENGLISH NATURE (1994). *Open water sites in Gloucestershire September 1993/August 1994*. Unpublished Report for English Nature, Three Counties Team, Malvern.
- GLOUCESTERSHIRE WILDLIFE TRUST 1997. Lower Woods S.S.S.I. Nature Reserve: Site management plan 1997–2006. Gloucestershire Wildlife Trust, Gloucester.
- GREEN, P. R., GREEN, I. P. & CROUCH, G. A. (1997). *The atlas flora of Somerset*. Published by the authors, Somerset.
- GREEN, I. P., HIGGINS, R. J., KITCHEN, C. & KITCHEN, M. A. R. (2000). Wildlife of the Bristol Region: 1. The flora of the Bristol region. Pisces Publications/The Nature Bureau, Newbury, Berkshire.
- GROVES, J. (1905). Report for the distributor for 1904. *The Botanical Society and Exchange Club of the British Isles, Report for 1904* **2**: 109–140.
- GROVES, J. & BULLOCK-WEBSTER, G. R. (1917). *Nitella mucronata* in Gloucestershire. *Journal of Botany, British and Foreign* **55**: 323–324.
- GROVES, J. & BULLOCK-WEBSTER, G. R. (1924). *The British charophyta*. Vol. I. Ray Society, London.
- GROVES, J. & GROVES, J. (1886). Notes on the British characeae for 1885. *Journal of Botany, British and Foreign* **24**: 1–4.
- GROVES, J. & GROVES, J. (1887). Notes on the British characeae for 1886. *Journal of Botany, British and Foreign* **25**: 146.
- GROVES, H. & GROVES, J. (1895). Notes on the British Characeae, 1890–1894. *Journal of Botany, British and Foreign* **33**: 289–292.
- HOLLAND, S. C. (1974). Botanical notes and records. *North Gloucestershire Naturalists Society Journal* **25**: 301.
- HOLLAND, S. C., CADDICK, H. M. & DUDLEY-SMITH, D. S. (1986). *Supplement to the Flora of Gloucestershire*. Grenfell Publ., Bristol.
- KELLAWAY, G. A. & WELCH, F. B. A. (1948). *British Regional Geology: Bristol and Gloucester District*. 2nd Ed. HMSO, London.
- KENT, D. H. & ALLEN, D. E. (1984). *British and Irish Herbaria*. B.S.B.I., London.
- LEACH, S. J., POLLOCK, K. & LANSDOWN, R. V. (1999). *Tolypella prolifera* discovered in N. Somerset (v.c. 6). *B.S.B.I. News* **80**: 28–29.
- MARSHALL, E. S. (1908). Somerset plant notes for 1908. *Journal of Botany, British and Foreign* **46**: 252–264.
- MARSHALL, E. S. (1909). Somerset plant notes for 1908. *Journal of Botany, British and Foreign* **47**: 255–261.
- MARSHALL, E. S. (1914). *A supplement to the flora of Somerset*. Somerset Archaeological and Natural History Society, Taunton.
- MOORE, J. A. & BAILEY, R. H. (1977). Gloucestershire charophyte records – 1. Botanical notes and records. *Gloucestershire Naturalists Society Journal* **28**: 343–344.
- MOORE, J. A. & BAILEY, R. H. (1986). Charophyta: Characeae, in HOLLAND, S. C., CADDICK, H. M. & DUDLEY-SMITH, D. S. *Supplement to the Flora of Gloucestershire*. Grenfell Publ., Bristol.
- MOSS, C. E. (1911). Report for the distributor for 1910. *The Botanical Society and Exchange Club of the British Isles, Report for 1910* **2**: 537–609.
- MURRAY, R. P. (1896). *The flora of Somerset*. Barnicott & Pearce, Taunton.
- RIDDELSDELL, H. J. (1908). Report for the distributor for 1907. *The Botanical Society and Exchange Club of the British Isles, Report for 1907* **2**: 266–326.
- RIDDELSDELL, H. J., HEDLEY, G. W. & PRICE, W. R. (1948). *Flora of Gloucestershire*. T. Buncle, Arbroath.
- ROPER, I. M. (Ed) (1918). *Annual Report of the Watsonian Botanical Exchange Club 1917–1918* **3**: 82–83.
- SANDWITH, C. I. (1962). Bristol botany in 1961. *Proceedings of the Bristol Naturalists' Society* **30**: 239–244.
- SANDWITH, C. I. (1917). *Tolypella intricata* Leonh. *Journal of Botany, British and foreign*. **55**: 195.
- SANDWITH, C. I. & SANDWITH, N. Y. (1950). Bristol botany in 1949. *Proceedings of the Bristol Naturalists' Society* **28**: 17–23.
- SANDWITH, C. I. & SANDWITH, N. Y. (1953). Bristol botany in 1952. *Proceedings of the Bristol Naturalists' Society* **28**: 305–314.
- SANDWITH, C. I. & SANDWITH, N. Y. (1954). Bristol botany in 1953. *Proceedings of the Bristol Naturalists' Society* **28**: 379–386.

- SANDWITH, C. I. & SANDWITH, N. Y. (1955). Bristol botany in 1954. *Proceedings of the Bristol Naturalists' Society* **29**: 17–24.
- SANDWITH, C. I. & SANDWITH, N. Y. (1956). Bristol botany in 1955. *Proceedings of the Bristol Naturalists' Society* **29**: 101–108.
- SANDWITH, C. I. & SANDWITH, N. Y. (1958). Bristol botany in 1957. *Proceedings of the Bristol Naturalists' Society* **29**: 343–352.
- STEWART, N. F. (1996). Stoneworts – connoisseurs of fresh water. *British Wildlife* **8**: 93–99.
- STEWART, N. F. (2004). *Important stonewort areas: An assessment of the best areas for stoneworts in the United Kingdom*. Plantlife International, Salisbury, UK.
- STEWART, N. F. & CHURCH, J. M. (1992). *Red data Books of Britain and Ireland: Stoneworts*. J.N.C.C./O.P.W. Peterborough.
- STEWART, N. F. & LANSDOWN, R. V. (1999a). *The conservation status of Great Tassel Stonewort (Tolypella prolifera) in Britain*. Interim report No. 1. Plantlife Report No. 121. Plantlife, London.
- STEWART, N. F. & LANSDOWN, R. V. (1999b). *The conservation status of Tassel Stonewort (Tolypella intricata) in Britain*. Interim report No. 1. Plantlife Report No. 122. Plantlife, London.
- WALLACE, E. C. (1950). Plant records. *Watsonia* **1**: 124–263.
- WALLACE, E. C. (1954). Plant records. *Proceedings of the Botanical Exchange Club and Society for Britain and Ireland*. Report for 1919 **5**: 801–849.
- WALLACE, E. C. (1955). Plant records. *Proceedings of the Botanical Society of the British Isles*. **1**: 337.
- WHITE, J. W. (1887). *The flora of the Bristol coalfield*. James Fawn & Son, Bristol.
- WHITE, J. W. (1912). *The flora of Bristol: Being an account of all the flowering plants, ferns and their allies that have at any time been found in the district of the Bristol Coalfields*. T. Buncle, Arbroath.
- WHITE, J. W. (1919). Bristol botany in 1917. *Annual report and proceedings of the Bristol Naturalists' Society*. Series IV. **5**: 39–45.
- WHITE, J. W. (1920). Bristol botany in 1918. *Annual report and proceedings of the Bristol Naturalists' Society*. Series IV. **5**: 88–91.
- WHITE, J. W. (1921). Bristol botany in 1919. *Annual report and proceedings of the Bristol Naturalists' Society*. Series IV. **5**: 133–137.
- WHITE, J. W. (1923). Bristol botany in 1921. *Annual report and proceedings of the Bristol Naturalists' Society*. Series IV. **5**: 173–178.
- WHITE, J. W. (1926). Bristol botany in 1925. *Annual report and proceedings of the Bristol Naturalists' Society*. Series IV. **6**: 232–236.
- WHITE, J. W. (1928). Bristol botany in 1928. *Annual report and proceedings of the Bristol Naturalists' Society*. Series IV. **7**: 51–55.
- WILLIAMS, P., BIGGS, J., BARR, C. J., CUMMINS, C. P., GILLESPIE, M. K., RICH, T. C. G., BAKER, A., BAKER, J., BEESLEY, J., CORFIELD, A., DOBSON, D., CULLING, A. S., FOX, G., HOWARD, D. C., LUURSMA, K., RICH, M., SAMSON, D., SCOTT, W. A., WHITE, R. & WHITFIELD, M. (1996). Lowland pond survey 1996. Pond Action, Unpublished Report to DETR (Contract No. CR0192), London.
- WILLIAMS, P., LANSDOWN, R. V., PANKHURST, T. J. & STEWART, N. F. (2003). *The status of tassel stonewort (Tolypella intricata) in 2002*. Plantlife Report No. 224. Plantlife, London.
- WILLIAMS, P. & STEWART, N. F. (2002). *The conservation status of Great Tassel Stonewort (Tolypella prolifera) in Britain 2000–2001*. Plantlife Report No. 215. Plantlife, London.
- WILLIS, A. J. (1989). Bristol botany in 1989. *Proceedings of the Bristol Naturalists' Society* **49**: 31–42.
- WILLIS, A. J. (1992). Bristol botany in 1992. *Proceedings of the Bristol Naturalists' Society* **52**: 25–35.
- WILLIS, A. J. & JEFFERIES, R. L. (1959). The plant ecology of the Gordano Valley. *Proceedings of the Bristol Naturalists' Society* **29**: 469–490.

(Accepted February 2006)

THE NUMBER OF 10 KILOMETRE SQUARES WITH RECORDS OF EACH TAXON

Taxon	IUCN	No. 10 km squares v.c. 6		No. 10 km squares v.c. 34	
		pre-1994	post-1994	pre-1994	post-1994
<i>Chara aculeolata</i>	NS	[1]	1		
<i>Chara aspera</i>		[1]			
<i>Chara contraria</i>		2	2		4
<i>Chara globularis</i>		7	4	6	1
<i>Chara hispida</i>		6	1	2	1
<i>Chara virgata</i>		3	1	5	4
<i>Chara vulgaris</i>		16	8	18	9
var. <i>crassicaulis</i>		1			
var. <i>longibracteata</i>		2	2	4	4
var. <i>papillata</i>		7	3	6	4
var. <i>vulgaris</i>		3		2	4
<i>Nitellopsis obtusa</i>	VU, BAP		2		1
<i>Nitella mucronata</i>	NS	1		1	
var. <i>gracillima</i>				2	2
<i>Nitella opaca</i>		4	1	5	3
<i>Nitella translucens</i>		1			
<i>Tolypella glomerata</i>	NS	3		2	
<i>Tolypella intricata</i>	EN, BAP	3	1	2	1
<i>Tolypella nidifica</i>	EN, BAP			[1]	
<i>Tolypella prolifera</i>	EN, BAP		2	1	
Total		59[2]	28	56[1]	38

The numbers given represent the total number of 10 kilometre squares from which each taxon has been recorded in each period. Square brackets indicate doubtful records

KEY:

- EN - Endangered
VU - Vulnerable
NS - Nationally Scarce
BAP - listed as a Priority Species in the UK Government Biodiversity Action Plan

APPENDIX: INDIVIDUALS REFERRED TO IN THE TEXT

- | | | |
|--------------------------|---------------------------------------|-----------------------------------|
| A.B. - A. Bennet | D.F.L. - D. F. Leney | H. - Hanson |
| A.H. - A. Harrison | D.H. - D. Heaver | H.G. - H. Groves |
| A.J.B. - A. J. Byfield | D.Ha. - Dr. Hassé | H.J.M.B. - H. J. M. Bowen |
| A.J.D. - A. J. Dodd | D.H.G. - Dr. H. Gibbes | H.J.R. - H. J. Riddelsdell |
| A.K. - A. Kelham | D.McC. - D. McClintock | H.K.A.S. - H. K. Airy Shaw |
| A.L. - A. Leitch | D.M.-S. - D. Munro-Smith | H.P. - H. Perrycote |
| A.Le. - A. Leipner | D.N.A. - D. A. Allen | H.P.R. - H. P. Reader |
| A.O. - A. Orange | D.R. - D. Reid | H.S.T. - H. S. Thompson |
| A.W. - A. Washbrook | E.G. - E. Green | I.F.G. - I. F. Gravestock |
| B.A.G. - B. A. Grindey | E.H.R. - E. H. Read | I.M.R. - I. M. Roper |
| B.G. - B. Goldsmith | E.J.M. - E. J. McDonnell | J.A.B. - J. A. Bryant (née Moore) |
| C.B. - C. Bucknall | E.S.M. - E. S. Marshall | J.A.M. - J. A. Moore (now Bryant) |
| C.C.B. - C. C. Babington | F.G. - F. Gibbons | J.Bi. - J. Biggs |
| C.F. - C. Furness | F.K.M. - F. K. Makins | J.D.H. - J. D. Hooker |
| C.I.S. - C. I. Sandwith | G.A.O.B. - G. A. O. St. Brody | J.E.L. - J. E. Lousley |
| C.K. - C. Kitchen | G.C.D. - G. C. Druce | J.G. - J. Groves |
| C.T. - C. Trapnell | G.O.A. - G. O. Allen | J.G.K. - J. G. Keylock |
| C.W. - C. Walker | G.R.B.-W. - G. R. Bullock-
Webster | J.H.M. - J. H. Morgan |
| D.C. - D. Callaghan | G.W.G. - G. W. Garlick | J.J.D. - J. J. Day |
| D.F. - D. Fry | | J.N. - J. Norton |

J.P.M.B. – J. P. M. Brenan
J.v.R. – J. van Raam
J.W.W. – J. W. White
K.E.L. – K. E. Ludbrook
K.P. – K. Pollock
L.B. – Rev. L. Bloomfield
L.W. – L. White
M.A.P. – M. A. Palmer
M.A.R.K. – M. A. R. Kitchen
M.D.C. – M. D. Chitty
M.J.A. – M. J. Allen
M.R.H. – M. R. Hughes
M.S. – M. Scruby

M.V.M. – M. V. Marsden
N.F.S. – N. F. Stewart
N.Y.S. – N. Y. Sandwith
O.M. – O. Mountfield
O.V.D. – O. V. Darbshire
P.M. – P. Millman
P.M.W. – P. M. Wade
P.W. – P. Williams
R.H.B. – R. H. Bailey
R.P.M. – Rev. R. P. Murray
R.S.C. – R. S. Cropper
R.U.D. – Mrs. Ruddle
R.V.L. – R. V. Lansdown

R.W. – R. Wilder
S.C.H. – S. C. Holland
S.H.B. – S. H. Bishop
S.J.L. – S. J. Leach
S.P.P. – S. P. Phillips
S.W. – S. Wilson
T.C. – T. Clarke
V.H. – V. Hack
W.B.W. – W. B. Waterfall
W.J. – W. Joshua
W.L. – W. Lutley
W.R.M. – W. R. McNab
W.W. – W. Watson

J. H. Penson: mystery man and mystery record

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ABSTRACT

J. H. Penson was a little-known British botanist who made several important contributions to plant recording. A biographical note, together with information relating mainly to his activities in Britain but also on the North American continent, is given.

KEYWORDS: *Carex capitata*, Newfoundland, plant records, Scotland, World War I.

INTRODUCTION

In late 2004, the chanced sight of an undated, unaddressed letter written by the late Scottish botanist Robert Mackechnie (1902–1978) led me to a fascinating series of enquiries. In this letter (*in litt.* to A. C. Jermy), when discussing J. W. Heslop Harrison's finds on the Isle of Rhum in the 1940s, Mackechnie stated "My recollection of *Carex capitata* is by now rather vague, but I have the impression that it resembled J. H. Penson's Ben Hope [Scotland] plant more closely than it did material which I saw in Lapland.....". J. H. Penson's Ben Hope plant indeed!

Carex capitata (other than Heslop Harrison's dubious 1940s records from the islands of Rhum and South Uist) has never been confirmed from the British Isles although, as an Arctic-montane plant, it is quite frequent in Scandinavia and Iceland and, conceivably, could also occur here, especially in northern Scotland. So Penson's record for Ben Hope could be of particular significance. To follow this up, therefore, one needed to locate the published source (if any) of such an important record and, if a specimen had been collected, to locate and examine the voucher. This, however, was where the difficulties began. Who was J. H. Penson?

Wide-ranging enquiries amongst botanists, especially Scottish, who might have known, or heard of him, led virtually nowhere. A few people vaguely recalled the name but knew little about him and only one person remembered once meeting someone referred to as

"old Penson". A request for information in current botanical publications also met with a similar minimal response, whilst a search through past British botanical literature for any records he might have provided mostly drew a blank. His name is mentioned in the introductory section of *The Changing Flora of Glasgow* (Dickson *et al.* 2000) along with a record for *Cirsium heterophyllum* and there are other occasional records in a few issues of the *The Glasgow Naturalist* but, in neither, is biographical information forthcoming. In addition, and most surprisingly, there appears to have been no published obituary of Penson (assuming him to be no longer alive). An Internet search, however, revealed the existence within the first half of the twentieth century of someone with that surname and initials apparently residing in the U.S.A. and Newfoundland but without any definite British connection stated.

The breakthrough came by chance and in rather unfortunate circumstances. During house clearance following the death of Allan McG. Stirling in 2004, a series of botanical notebooks dating from 1958 onwards, together with a few miscellaneous letters and ephemera, were located; these were clearly the former possessions of J. H. Penson. From such early clues and a firmer establishment of Penson's past connection with the North American continent, it has been possible to provide what is still a rather incomplete summary of some important and interesting facts about this almost unknown, elusive British botanist.

A BRIEF BIOGRAPHY

Hubert Penson was born on January 21, 1893, at Hornsey, London and died on June 1, 1979, in the Southern General Hospital, Glasgow. He was the son of Arthur A. Penson, a dairy manager of Cirencester. In 1929 he married Marjorie Doreen Crawford (deceased 1971) with whom he had one son and two daughters. In 1974 he married again, this time Ellen Mary Cumming (deceased 1991).

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To date, details of his early life and education are lacking and it is not until his involvement in World War 1, where he served from 1916–1919, that information becomes available. In this conflict he was twice decorated for bravery. As Lt. Hubert Penson (promoted to that rank in 1918) of the 5th Division Signal Company of the Royal Engineers and attached to the 15th Infantry Brigade, he was awarded the Military Cross (MC) in 1918. For this, the citation recognised his “conspicuous gallantry and devotion to duty in maintaining communications which had to be constantly repaired under heavy shell fire. In addition to carrying out his signal duties he sent important information when the situation was obscure”. About a year later, serving in northern Russia, he was awarded a bar to his Military Cross. This recognised his “conspicuous gallantry and devotion to duty on August 10, 1919, having guided the Sludka-Lipovets Column for three days, and brought it to within 400 yards of the enemy’s position unobserved”. On the same day, “the column, having to withdraw from Lipovets owing to shortage of ammunition, he [Penson] guided it out under heavy fire”. He was also mentioned in military despatches.

After that the trail goes cold until 1923 at which time he wrote an article entitled ‘Translations And the Need of Guidance’ (Penson 1923). In this, he stated: “Outwardly men differ widely – in language, in appearance. Inwardly it is the similarity that is remarkable.....Translators of the Russian writers – those of Tolstoy, for example – have to give the world this world-wide appeal”. About the same time he moved into Government finance and was still living in the London area as evidenced by recently-discovered letters addressed to him, one of which indicated his residence to be in Well Walk, Hampstead. In November 1928, he was appointed Assistant Secretary to the Commission on Museums and Galleries and two years later wrote an article in the *Journal of Royal Institute of International Affairs* under the title “The Financing of Russian industry”.

His rise in Government circles must now have been rapid for in 1931 he became a member of the Newfoundland Royal Commission and subsequently was appointed there as Commissioner for Finance. Around this time he appears to have spent periods on both sides of the Atlantic and the inference gained from a letter to him dated March 1941 suggests that he

retained his house in Hampstead, London, until almost 1940. Despite this, from the mid-1930s, his career was apparently spent mainly on the North American continent. In 1937, he lectured on topics of contemporary interest at Memorial University College (St John’s, Newfoundland) and in July 1938 issued a report stating Newfoundland’s revenues to be the greatest in the country’s history. This, no doubt, was a reflection on his astute management! In the following year he advised on slum clearance in St John’s but found the project to be financially impractical. In July 1940, as Commissioner of Finance, he stated that, for the remainder of the war, Newfoundland would no longer ask Britain for financial assistance and a year later announced a \$700,000 budgetary surplus. In 1940 he was sent to St Pierre-et-Miquelon (the French enclave in Newfoundland) to meet with the Administrator in order to assess the attitude to the Nazi axis powers. He found this to be distinctly anti-Axis and, in addition, discovered that St Pierre would offer few useful facilities as an enemy military base. Shortly afterwards, his work in Newfoundland was complete and in February 1941 he was replaced as a member of the Commission of Government in Newfoundland. In 1942, for his past services he was awarded the Cross of St Michael and St George (CMG).

There is then a three-year gap until 1944 when he became Secretary-General to the British Supply Mission in Washington. Whether he remained on the western side of the Atlantic all this time is unclear, but bearing in mind the hostilities of World War 2, it is likely. Following the war, he was appointed Attaché to the British Embassy in Washington and remained in that post until his retirement, meanwhile co-authoring a book on the history of Poland for the years 1697–1935 (Reddaway *et al.* 1951). In the New Year Honours List for 1953, he received a further award, the Order of the Bath (CB), for his services at the Washington Embassy.

From then he appears he to have been in semi-retirement, moving back to Britain and living in Nithsdale Road, Glasgow. From this base he botanised over much of the north of Britain and, especially, Scotland. Surprisingly, on his second marriage in 1974 at the age of 81, his occupation was described as “Sales Representative” so he was perhaps still partly employed, even at that age. His rather flimsy, but well-kept botanical note-books conclude abruptly with an entry for a visit to Upper

Dallochy, Moray, on July 21, 1978. Possibly this was the result of the onset of a sudden illness, as he died ten months later.

BOTANICAL EXPLOITS

To date, the first indication of Penson's interest in botany is a pressed fragment of *Linnaea borealis*. This, now in **E**, is marked "N[orth] Russia, 1919", and was presumably collected at the time of his military exploits there with the Sludka-Lipovets Column. Other than this, his known botanical work falls into three phases: (a) early activities in Britain up to the mid-1930s for which there is now only scant evidence; (b) investigations of the Newfoundland (now Canada) and later Washington floras from that date until the mid-1950s. Information on this period is currently unprocessed and held at the Université de Montréal, herbar Marie-Victorin (**MT**); (c) his semi- or post-retirement period in the British Isles, mostly Scotland, from 1958 when he made several new or first post-1930 "Atlas" (Perring & Walters 1962) records for several vice-counties.

A. THE PERIOD PRIOR TO THE MID-1930S:

It was only following the discovery of a file containing letters sent to Penson, that anything at all could be said about this time, and even this information is very sparse. The letters only date back to 1933 but, other than the *Linnaea* specimen mentioned above, are the first indication of Penson's botanical interest. In them are discussions (with Clarice Vurian) regarding *Potentilla fruticosa* in the Welsh Borders and *Spiranthes* and *Calamagrostis* in Ireland, and an offer from Francis Druce to propose Penson for membership of the Linnean Society (which he apparently never took up). Around this time he was in discussion with A. H. G. Alston regarding *Cystopteris* in Teesdale and also showed an interest in the sugar limestone formations of the area. He also corresponded with F. Godwin regarding various orchids and *Pulsatilla vulgaris*.

B. NEWFOUNDLAND AND WASHINGTON c.1935 TO THE MID-1950S:

The small amount of information so far located on Penson's records and collections from the North American continent date from the last few years of this period. He was however, active over much of the full period and, prior to his return to Britain, donated his collection of

Newfoundland plants to the Université de Montréal, herbar Marie-Victorin (**MT**). There are extant letters (both in **MT** and now in **E**) in which this gift is discussed with Ernest Rouleau, the curator at that time. In one, dated December 10, 1951 (now in **E**) and addressed to Penson at the British Embassy, Washington, Rouleau states that "especially appreciated would be Graminae, Cyperaceae, Salicaceae, Caryophyllaceae, *Draba*, *Antennaria*, *Senecio*, *Epilobium*. Also, *Dryas drummondii*, *Myosotis arvensis* and *Gnaphthaleium supinum*" and that his [Penson's] "species are considered to be historically important and should be in a Canadian herbarium". At present, in **MT**, there are two copies of a 72 page unpublished manuscript by Penson under the title '*List of Newfoundland Plants*', one copy of which is subsequently annotated by him. There are also additional documents, including a plant list dealing with questions which he had put to Rouleau together with the latter's answers. In addition, his collecting expeditions and explorations are mentioned in the *Atlas of the vascular plants of the island of Newfoundland and of the islands of Saint-Pierre-et-Miquelon* (Rouleau & Lamoureux 1992). As far as the specimens are concerned, these are still being incorporated at **MT**, but within the database produced to date, there are already over 250 collections with many more to be added (pers. comm. S. Hay). In addition, other specimens are held at the U.S. National Herbarium at the Smithsonian Institution, Washington (**US**) and at the New York Botanical Garden (**NY**). A note in the journal *Rhodora* (Smith 1953) refers to a Penson record for *Borrichia frutescens*, this confirming the presence of the plant in the District of Columbia whilst in a letter (now in **E**) the Curator of Ferns (**US**) acknowledges his gift of material of *Ophioglossum engelmanni*. So, it is to the specimens and data held at the above institutions, especially that at **MT**, that further investigations of his time over there should be addressed.

C. THE BRITISH ISLES (MAINLY SCOTLAND) 1955-1978:

Apart from a recently discovered herbarium specimen of *Bartsia alpina* collected on Ben Lawers in August 1955 (**E**), the earliest of his records (and notebooks) so far traced date from 1958; this was some time after he moved to Glasgow on his return from the U.S.A. For the first few years of this period he botanised mainly in the central Scottish belt. As his interest and experience of Scottish plants

widened he ventured further afield, especially to the north and north-west, to Perthshire, to the Clova hills, the Cairngorms and the far north, as well as occasionally into southern Scotland, northern England and even to Ireland. In much of this time he botanised almost the whole year round. To West Sutherland (v.c. 108) alone he made over thirty separate visits, and to Ben Hope, apparently a favourite of his, at least ten. During the 1960s, like many before him, he sought out British rarities which involved visits to the Cuillin for *Arabis alpina*, the Storr, Skye (v.c. 104) for *Koenigia islandica*, Cul Mhor, W. Ross (v.c. 105) for *Artemisia norvegica* and to Meikle Kilrannoch (v.c. 90) and Hobcarton Crag, Cumbria (v.c. 70) for *Lychnis alpina*. He must have been a person with a strong physical constitution since many of his trips involved walks over long distances in rough mountain terrain. Several remarkable excursions were made when he was in his mid-seventies. One, at the age of seventy-seven, was to the distant corries of Beinn a'Bhuird and the northern Slochd Mhor side of Ben Avon (v.c. 94) to search for *Saxifraga cespitosa*. Although failing to find it in earlier visits, he eventually recorded about 20 "cushions" there on September 24, 1970. Even when over eighty he was tackling Ben Heasgarnich, Ben Hope and Ben Lomond.

Although a few of his plant identifications are rather fanciful, the majority seem reliable and he was never reluctant to attempt to identify hybrids or taxa down to subspecific and (occasionally) to varietal level. He showed a particular interest in critical genera, such as alpine and sub-alpine *Hieracium* and *Salix* and, from Ben Hope alone, recorded 21 taxa of the former and several hybrids within the latter.

As a botanist, Penson appears to have been a 'loner', only rarely in contact with a colleague, although Robert (Bob) Mackechnie (1902–1978) was someone to whom he is known to have written and who also examined some of his rarer specimens. Penson's find of *Carex elongata* at Loch Lomond (see Appendix 1) was probably the start of their association. The only other persons with whom he seems to have kept in touch were Allan McG. Stirling and Basil W. Ribbons.

During his years in Scotland, Penson made several significant finds including first vice-county and first post-1930 "Atlas" records. Some of the more interesting of these are listed in Appendix 1.

As an example of his botanical ability and his willingness to thoroughly explore individual localities, Appendix 2 lists over 160 taxa which he recorded between the years 1969 and 1975 on his favourite mountain, Ben Hope. It is hoped that these records might be of value as a basis for further recording work there.

On his death, Penson's British herbarium passed to the Nature Conservancy Council (N.C.C.), South-West Scotland Office, at Balloch around about 1980 (see letters by his widow and A. McG. Stirling (now in E)). When this organisation (N.C.C.) underwent reorganisation, the material was transferred to Scottish Natural Heritage (S.N.H.) Regional Headquarters at Clydebank (pers. comm. J. Mitchell, 2005). Unfortunately, it has not been possible so far to locate its current whereabouts. However, not all of his collections appear to have been included in the N.C.C. bequest since some of them were retained by A. McG. Stirling. These should come to light when his personal collection is fully processed and incorporated into the Edinburgh herbarium (E).

An interesting sequence of records relating to a population of *Hierochloa odorata* date from his early time in Scotland and run through to the mid-1970s. This was at the (apparently) threatened Blythswood (v.c. 76) site by the River Cart which was first discovered in 1931 (Dickson *et al.* 2000). Under its earlier name (*Savastana odorata* L.), Penson recorded 20–25 flowering plants there in April, 1959 followed by 12 and 64, respectively, in the following two years. In 1962 there were 18, the site having been partly damaged by refuse dumping, whilst in the following year it was entirely covered with water-borne debris and no plants were seen. In 1964 and 1965 there were also none, Penson describing the area as "obliterated by oil and rubbish". However, following the effects of a violent storm in January 1968, much of the rubbish was washed away and 60 plants now flowered. The good news was short-lived, for the following year he described the site as "destroyed" by burnt rubbish with no sign of the plant whatsoever. However, there was another revival, and from then on, despite continued despoliation there, he continued to find the plant as two separate populations right up to his last visit there in 1976. In the early 1970s the number of flowering plants roughly fluctuated between a total of 40 and 80 with a peak of 132 in 1971.

Records for his last two seasons showed only 11 and 5 respectively, Penson again expressing concern regarding the deteriorating conditions nearby and the threat of development. However, despite all his apprehension, *Hierochloa* is still present at the site with two patches on the east side of the river and one on a small island to the west (pers. comm. K. Watson 2006) and these populations have been recently studied by Tait (2000).

SUMMARY

John Hubert Penson, hitherto virtually unknown and unremembered (at least in botanical circles), appears to have been a person of no mean talent. His exploits in World War 1 and his professional career in British Government circles, mark him as someone out of the ordinary. There is still much more to learn about Penson and especially of his botanical work on the North American continent. A summary of this may be provided later when data held at the Université de Montréal, herbier Marie-Victorin (MT) becomes available.

The series of letters written to Penson, his extant field note-books, and most of the peripheral information on which this account is based, is now deposited at the herbarium/library of the Royal Botanic Garden, Edinburgh. There, additional herbarium material is currently being incorporated which

will, no doubt, contain additional examples of his collections. In consequence, more information should then be forthcoming.

Finally, the point where all this started: *Carex capitata*: In one of the Penson note-books, the entry for July 30, 1973, states: "Ben Hope, W. Sutherland, W side to 1500 ft, *Carex capitata*". Unfortunately, the epithet *capitata* has been struck out and the comment "re-identified as *C. dioica*" inserted in Penson's hand. That is probably the last word on the record unless his actual specimen comes to light and, after all, confirms his original determination. Nevertheless, the presence of *C. capitata* in northern Scotland remains a distinct possibility.

All herbarium codes quoted above are as given in Holmgren *et al.* (1990). A detailed examination of Penson's note-books might be of interest to present-day Scottish botanical recorders.

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REFERENCES

- DICKSON, J. H., MACPHERSON, P. & WATSON, K. J. (2000). *The Changing Flora of Glasgow*. Edinburgh University Press, Edinburgh.
- HOLMGREN, P. K., HOLMGREN, N. H. AND BARNETT, C. (1990). *Index Herbariorum. Part 1: The Herbaria of the World*. New York Botanic Garden, New York.
- MITCHELL, J. & STIRLING, A. MCG. (1980). *Carex elongata* in Scotland. *The Glasgow Naturalist* **20**: 65–70.
- PENSON, J. H. (1923). Translations and the Need of Guidance, *The Author* 75–76.
- PERRING, F. H. & WALTERS, S. M. (1962). *Atlas of the British Flora*. Thomas Nelson, London.
- REDDAWAY, W. F., PENSON, J. H., HALECKI, O. & DYBOSKI, R. (1951). *The Cambridge History of Poland from Augustus 11 to Pilsudski (1697–1935)*. Cambridge University Press, Cambridge.
- ROULEAU, E. & LAMOUREUX, G. (1992). *Atlas of the vascular plants of the island of Newfoundland and of the islands of Saint-Pierre-et-Miquelon*. Fleurbec, Québec.
- SMITH, L. B. (1953). *Borrichia frutescens* from Chesapeake Bay. *Rhodora* **55**: 58–59.
- STIRLING, A. MCG. (1978). Common Broomrape, in Mackechnie, R., ed. Short Notes. *The Glasgow Naturalist* **19**: 426–427.
- TAIT, T. N. (2000). The history, habitat and present status of Holy Grass (*Hierochloa odorata* (L.) P. Beauv.) at Blythswood, Renfrew District, v.c.76. *The Glasgow Naturalist* **23**(5): 17–20.

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APPENDIX 1

SOME OF PENSON'S MORE INTERESTING SCOTTISH FINDS (FOR SOME OF WHICH VOUCHERS ARE AVAILABLE)

- Allium carinatum*: waste ground by River Clyde, Bowling, Renfrewshire (v.c. 76), 29.7.1975 (E).
- Betula pubescens*: Glen Doll, Angus (v.c. 90), 25.7.1961 (a form approaching *Betula nana*) (E).
- Botrychium lunaria*: an abnormal form with three fertile branches originating from the sterile base of the frond; railway bank, near Cononish River, Tyndrum, Mid Perth (v.c. 88), 4.vi.1974 (E).
- Carex buxbaumii*: near Arisaig, Westernness (v.c. 97), 5.8.1964 (lacking an inflorescence) (E).
- Carex elongata*: first recorded by Penson north of Balloch, near Loch Lomond, Dunbarton (v.c. 99) on June 16, 1967 (E). He had twice been in the same general area in the previous year but failed to record it. Three years later on June 27, 1970, he recorded "about 75 plants" flowering freely c.1400 yards north of the northern edge of Balloch Park and confined to a small area of about one acre (notebook); also same date and apparently same place in "wet woods" (E); first post-1930 "Atlas" record for vice-county. These finds probably led to his introduction to Mackechnie and Ribbons. Further details can be found in Mitchell & Stirling (1980).
- Carex punctata*: Rocks of Garchew, Wigtownshire (v.c. 74), 5.9.1962 (E); first post-1930 "Atlas" record for vice-county.
- Cicerbita alpina*: Craig Maud, Clova, Angus (v.c. 90), 31.8.1960 (GL), notebook states "...only 4 plants left, poor state, no flowers, looked as if site robbed".
- Cirsium heterophyllum*: Pollok, Glasgow, Renfrewshire (v.c. 76), 15.6.1959 (see notebook); also Dickson et al. (2000).
- Dryopteris assimilis*: "mature spores were lacking", Meall nan Tarmachan, Killin, W. Perth (v.c. 87), 9.10.1965 (*The Glasgow Naturalist*, xviii(9): 520 (1967)).
- Geranium purpureum*: Largybaan, Mull of Kintyre (v.c. 101), 17.7.1968 (a dubious determination) (E).
- Hieracium alpinum*: Beinn a'Bhuird (v.c. 92), 3000', 8.8.1968 (E).
- Hierochloa odorata*: Banks of River Cart, Blythswood, Renfrewshire (v.c. 76), 24.5.1969 (E) (for more details see the account above).
- Lathyrus montanus* var. *tenuifolius*: Ben Hope, W. Sutherland (v.c. 108), lower slopes, 19.7.1972 (E).
- Ledum palustre*: Barochan Moss, Renfrewshire (v.c. 76), 2.9.1975 (E), a new v.c. record.
- Orobancha minor*: Bowling, Dunbarton (v.c. 99), regularly recorded here by Penson in the years 1964–1977, a small colony with a maximum of 20 plants in 1970 (see also Stirling 1978). He attributed the Bowling plants to the taxonomically obscure var. *concordata* Druce (see notebook).
- Orobancha rapum-genistae*: Locharbriggs, near Dumfries (v.c. 72), 9 plants on 24.8.1966 (see notebook).
- Potentilla argentea*: Balthayok, East Perthshire (v.c. 89), 7.6.1960 (E), first post-1930 "Atlas" record for vice-county.
- Potentilla tabernaemontani*: Ferry Hills, North Queensferry, Fife (v.c. 85), 30+ plants on 24.4.1973 (see notebook); first post-1930 "Atlas" record for vice-county.
- Poa xjemtlandica*: Ben Dorain, Argyll (v.c. 98), 1960 (GL). This is definitely an error and is possibly of *Deschampsia alpina*. However, the specimen is now very degraded and is not possible to be determined accurately. Despite this Penson did record *Poa xjemtlandica* on Lochnagar, S. Aberdeen (v.c. 92), (a known locality) on 28.8.1962.
- Polygonatum verticillatum*: Den of Reichip, near Dunkeld, East Perth (v.c. 89), 5.8.1961 (E); first post-1930 "Atlas" record for vice-county.
- Ulex gallii*: 3 miles south of Forsinard, East Sutherland (v.c. 107), 8 clumps in full flower, 17.10.1967; a new v.c. record.

n.b. "Atlas" refers to Perring & Walters (1962)

APPENDIX 2

PENSON'S PLANT RECORDS FOR BEN HOPE (V.C. 108); (OCTOBER 1969–JUNE 1975)

- Agrostis canina* subsp. *montana*
Alchemilla filicaulis
Alchemilla glomerulans
Antennaria dioica (in many forms)
Arctostaphylos uva-ursi
Arctous alpina
Athyrium alpestre
Betula nana × *B. pubescens*
Betula pubescens × *B. nana*
Botrychium lunaria
Caltha palustris subsp. *minor*
Cardamine flexuosa
Cardaminopsis petraea
Carex canescens (= *C. curta*)
Carex capitata (re-identified as *C. dioica*!)
Carex curta × *C. echinata* (= *C. ×biharica*)
Carex demissa
Carex dioica (or hybrid)
Carex elata
Carex hostiana
Carex lepidocarpa
Carex livida
Carex oederi
Carex pallescens
Carex pilulifera
Carex pilulifera var. *longibracteata*
Carex pulcaris
Carex serotina
Catapodium rigidum
Cerastium alpinum
Cherleria sedoides
Cochlearia alpina
Cochlearia officinalis subsp. *alpina*
Coeloglossum viride
Cornus suecica
Cystopteris fragilis var. *dentata*
Dactylorhiza fuchsii subsp. *hebridensis*
Dactylorhiza fuchsii subsp. *hebridensis* ×
subsp. *fuchsii*
Dactylorhiza fuchsii subsp. *o'kellyi*
Dactylorhiza occidentalis
Dactylorhiza praetermissa var. *pulchella*
Dactylorhiza purpurella
Dactylorhiza purpurella × *D. majalis*
Deschampsia alpina
Draba (query) *norvegica* (later corrected to
Cardaminopsis petraea)
Drosera anglica
Drosera intermedia
Drosera rotundifolia × *D. anglica*
Dryas octopetala
Dryopteris abbreviata
Eleocharis multicaulis
Eleocharis quinqueflora
Eleocharis uniglumis
Empetrum hermaphroditum
Epilobium alsinifolium
Epilobium anagallidifolium
Eriophorum gracile
Euphrasia borealis
Euphrasia brevipila var. *subglandulosa*
Euphrasia confusa (and query) a form of *E.*
micrantha
Euphrasia eurycarpa (confirmed)
Euphrasia frigida
Euphrasia nemorosa var. *collina*
Euphrasia occidentalis var. *calvescens*
Euphrasia rhumica
Euphrasia scottica
Festuca capillata
Festuca ovina subsp. *tenuifolia*
Festuca ovina var. *capillata*
Festuca pratensis
Festuca vivipara
Galium sternerii (a new station)
Glyceria fluitans
Glyceria ×pedicellata
Hieracium (sect. *Cerinthoides*)
Hieracium anglicum
Hieracium argenteum
Hieracium backhousei
Hieracium calanduliflorum
Hieracium callistophyllum
Hieracium cremnanthes
Hieracium euprepes
Hieracium eximium
Hieracium eximium var. *tenellum*
Hieracium gracifolium
Hieracium gracilentum
Hieracium hanburyi
Hieracium hypochaeroides
Hieracium pseudanglicum
Hieracium pseudocurvatum
Hieracium schmidtii
Hieracium senescens
Hieracium sp. (Sect. *Vulgatum*)
Hieracium submurorum
Hieracium anglicum
Holcus mollis
Hypericum pulchrum
Ilex aquifolium
Juncus alpinus
Juncus triglumis
Juniperus nana

- Lathyrus montanus* var. *angustifolius*
Lathyrus montanus var. *tenuifolius*
Leontodon autumnalis
Lobelia dortmanni
Loiseleuria procumbens
Luzula spicata
Melampyrum pratense
Melampyrum pratense subsp./var. *montana*
Montia chondrosperma
Myriophyllum alternifolium
Nymphaea occidentalis
Orchis mascula
Pedicularis palustris
Pinguicula lusitanica
Platanthera bifolia
Platanthera chlorantha
Polygala serpyllifolia
Polygala vulgaris
Polystichum lobatum var. *lonchitides*
Polystichum lonchitis
Prunella vulgaris
Pseudorchis albida
Ranunculus flammula var. *tenuifolius*
Rhinanthus borealis (and in pure form)
Rhinanthus borealis $\times$ *R. minor*
Rhinanthus minor subsp. *stenophyllus*
Rhinanthus minor subsp. *borealis*
Rhinanthus minor subsp. *minor* $\times$ subsp. *borealis* (*R. $\times$ gardinieri*)
Rhinanthus minor subsp. *monticola*
Rosa villosa
Sagina subulata
Salix aurita $\times$ *S. phylicifolia*
Salix aurita $\times$ *S. repens*?
Salix capraea subsp. *sericea*
Salix lanata
Salix lanata $\times$ *S. lapponum*
Salix lapponum
Salix lapponum $\times$ *S. repens*
Salix phylicifolia $\times$ *S. cinerea*
Salix phylicifolia $\times$ *S. repens*
Salix repens
Salix repens $\times$ *S. herbacea*
Salix repens $\times$ *S. myrsinites*?
Salix repens $\times$ *S. phylicifolia*
Saussurea alpina
Saxifraga aizoides
Saxifraga hypnoides
Saxifraga nivalis
Saxifraga oppositifolia
Schoenus ferrugineus?
Schoenus nigricans
Sedum roseum
Silene acaule?
Solidago virgaurea (+ f. *cambrica*)
Taraxacum palustre?
Thalictrum alpinum
Thymus drucei (form)
Trichophorum cespitosum subsp. *cespitosum*
Trichophorum cespitosum subsp. *germanicum*
Trientalis europaea
Trifolium repens
Trollius europaeus
Vaccinium uliginosum
Viola riviniana subsp. *minor*

Plant Records

Records for publication must be submitted to the appropriate Vice-county Recorder (see *BSBI Year Book 2005*), and not to the Editors. Following publication of the *New Atlas of the British & Irish Flora* and the *Vice-county Census Catalogue*, new criteria have been drawn up for the inclusion of records in *Plant Records*. (See *BSBI News* 95, January 2004 pp. 10 & 11). These are outlined below:

- First records of **all** taxa (species, subspecies and hybrids) included in the VCCC, designated as native, archaeophyte, neophyte or casual.
- First record since 1970 of the taxa above, except in the case of *Rubus*, *Hieracium* and *Taraxacum*.
- Records demonstrating the rediscovery of all taxa published as extinct in the VCCC or subsequently.
- Newly reported definite extinctions.
- Deletions from the VCCC (e.g. through the discovery of errors, the re-determination of specimens etc.) **NB** – only those errors affecting VCCC entry.
- New 10km square records for Rare and Scarce plants, defined as those species in the *New Atlas* mapped in the British Isles in 100 10km squares or fewer. (See *BSBI News* 95, January 2004 pp. 36–43).

Records for the subdivisions of vice-counties will not be treated separately; they must therefore be records for the vice-county as a whole. However, records will be accepted for the major islands in v.cc. 102–104, 110 and 113.

In the following list, records are arranged in the order given in the *List of Vascular Plants of the British Isles* and its supplements by D.H. Kent (1992), from which the species' numbers, taxonomy and nomenclature are taken. The Ordnance Survey national grid reference follows the habitat and locality. With the exception of collectors' initials, herbarium abbreviations are those used in *British and Irish Herbaria* by D.H. Kent & D.E. Allen (1984). Records are field records if no other source is stated. For all records 'det.' or 'conf.' appear after the herbarium if the determination was based on material already in an institutional herbarium, otherwise before the herbarium.

The following signs are used:

* before the vice-county number: to indicate a new vice-county record.

† before the species number: to indicate that the plant is an archaeophyte.

‡ before the species number: to indicate that the plant is a neophyte.

© before the species number: to indicate that the plant is a casual.

The above 3 signs may also be used before the vice-county number to indicate the status of the plant in that vice-county.

® before the vice-county number: to indicate that this is an additional hectad for a Rare or Scarce plant.

Ø at end of entry: established taxon not in Vice-County Census Catalogue.

[] enclosing a previously published record: to indicate that that record should be deleted or changed.

The following list contains records for the year 2005 and earlier. Further records for this period will be published in the next issue of *Watsonia*.

‡2/1.2 SELAGINELLA KRAUSSIANA *4, N. Devon: In garden at Watermouth, SS557480, M. Puttnam, 2005, conf. M. Pool.

4/1.1×3 EUISETUM ×TRACHYODON (EUISETUM HYEMALE × E. VARIEGATUM) *94, Banffs.: Dominant and vigorous on shingle/soil island, 8 m × max 3 m, pure stand by flowing water, less dense on higher part of island, W side of River Avon, NJ158188, A.G. Amphlett, 2005.

4/1.3 EUISETUM VARIEGATUM *63, S.W. Yorks.: Went Valley, SE649180, S. Yorks CC staff, 1980.

5/1.2 OPHIOGLOSSUM AZORICUM *3, S. Devon: 60+ fertile fronds with infertile fronds at NE end of Greenland Lake, Dawlish Warren, SX985792, N. Mugan & K. Ryland, 2005, det. A.C. Jermy, **BM**. *94, Banffs.: Growing in damp areas in clearings amongst trees, Spey Bay, NJ357648, I.P. Green, 2004.

10/1.1 HYMENOPHYLLUM TUNBRIGENSE 60, W. Lancs.: Grit rocks, Thorn Crag over Wyresdale, SD595572, E.F. Greenwood, 2000, **LIV**. Originally determined as *H. wilsonii* but re-determined in 2006. 1st record since 1881.

[10/1.2 HYMENOPHYLLUM WILSONII 37, Worcs.: Error in VCCC - no known records. Delete.]

15/2.5a ASPLENIUM TRICHOMANES subsp. TRICHOMANES *60, W. Lancs.: Grit cliffs, Cocklett Scar, Foxdale, Caton-with-Littledale, SD574609, E.F. Greenwood & J.M. Newton, 2004, conf. F.J. Rumsey. Also found in similar habitat at Hawthornthwaite Greave over Wyresdale (SD567517) conf. F.J. Rumsey.

15/2.5c ASPLENIUM TRICHOMANES subsp. PACHYRACHIS *57, Derbys.: Lathkill Dale, SK184658, P. Rushton, 2004.

‡16/2.1 ONOCLEA SENSIBILIS *94, Banffs.: Large patch in old garden, Glen Wood, Crossbrae, NJ6952, I.P. Green, 2004.

16/5.2 CYSTOPTERIS DICKIEANA *89, E. Perth: Two small colonies 7 m apart on small rock-face forming part of steep bank of burn, Den of Riechip, Dunkeld, NO061488, M.C. Robinson, 2005, conf. F.J. Rumsey, **BM**. Seen *in situ* by F.J. Rumsey on 12/8/05.

16/5.dia CYSTOPTERIS DIAPHANA *3, S. Devon: Flushed banks of old railway cutting, Tavistock, SX475743, R. Hutchins, 2004, det. R. Murphy. Previously recorded as *C. fragilis*.

17/1.1x2 POLYSTICHUM xBICKNELLII (POLYSTICHUM SETIFERUM x P. ACULEATUM) *57, Derbys.: Three plants at top of steep 2 m bank to river in light woodland and scrub, Lathkill Dale, SK200661, B. Byrne, 2004, det. K. Trewren.

17/3.8x9 DRYOPTERIS xDEWEVERI (DRYOPTERIS CARTHUSIANA x D. DILATATA) *39, Staffs.: Wet, heathy field near Wallbank Grange, west of Cauldon, SK056497, I.C. Trueman & E.V.J. Kohn, 2003.

‡20/1.nor ABIES NORDMANNIANA *H6, Co. Waterford: Several trees of various sizes self-sown on side of forest ride, Glenabbey, S188199, P.R. Green, 2005.

‡20/7.mug PINUS MUGO *©63, S.W. Yorks.: Hugset Wood, SE3006, G. Carr, 1986.

‡20/7.peu PINUS PEUCE *©63, S.W. Yorks.: Smiths Wood, Sheffield, SK3286, Sheffield City Ecology Unit, 1988.

‡21/4.squ JUNIPERUS SQUAMATA *77, Lanarks.: Well established in long abandoned industrial estate, The Gorbals, Glasgow, NS590635, P. Macpherson, 2005, det. M. Gardner, **herb. P.M.** See *BSBI Scottish Newsletter* No. 28 page 24. Ø

28/13.11 RANUNCULUS SCLELERATUS 94, Banffs.: One plant growing in a very wet area in landfill site, Nether Dallachy, NJ364641, I.P. Green, 2005. 1st record since 1970.

‡28/9.hupxvit ANEMONE xHYBRIDA (ANEMONE HUPEHENSIS x A. VITIFOLIA) *©39, Staffs.: A patch in pavement, against a wall, Philip Victor Road, east of Handsworth, SP049904, M.W. Poulton, 2005. *94, Banffs.: Several plants on waste ground, Portsoy, Institute Street, NJ590660, A.G. Amphlett, 2005. Probably cleared house site.

‡29/1.2 BERBERIS THUNBERGII *57, Derbys.: Roadside hedge, Allestree, SK331395, T. Taylor & B. Rhodes, 2004. Presumably bird-sown origin.

‡29/1.6 BERBERIS GAGNEPAINII *©57, Derbys.: In pavement under a garden bush on north side of road, Monyash, SK1566, R. Burton, 2005.

‡29/1.7 BERBERIS JULIANAE *63, S.W. Yorks.: Brecks Plantation, SE6207, G.T.D. Wilmore, 2005.

‡29/2.1 MAHONIA AQUIFOLIUM *H6, Co. Waterford: Small patch growing out of wall, Waterford, S61661149, D. McGrath, 2005, det. P.R. Green. Known on this wall by finder for 8–10 years but not named until 2005.

‡30/1.2 PAPAVER ATLANTICUM *85, Fife: Scrubby sea-bank, by shore track to Hawkcraig, Aberdour, NT196851, G.H. Ballantyne, 2005. Probably escaped from garden 250 yards away.

‡31/5.1b FUMARIA CAPREOLATA subsp. BABINGTONII *©63, S.W. Yorks.: Building site, Cliffe Road, Bradford, SE167344, B.A. Tregale, 2004.

‡35/2.1 FICUS CARICA *H6, Co. Waterford: Two large bushes self-sown on face of sea cliff, Tramore, S58060087, P.R. Green, 2005.

36/1.1gal URTICA DIOICA subsp. GALEOPSISIFOLIA *3, S. Devon: By the Gissage, Honiton, ST1500, L.J. Margetts, 2003, conf. M.F. Godfrey.

©43/1.11 CHENOPODIUM URBICUM 57, Derbys.: Weedy vegetable patch, Rodsley, SK205401, G. Hiron, 2003. 1st record since 1970.

‡43/1.bot CHENOPODIUM BOTRYS *©3, S. Devon: Garden weed, Trusham, SX853812, R.E.N. Smith, 2001, **herb. R.E.N.S.** *94, Banffs.: Two plants at landfill site, Nether Dallachy, NJ365643, I.P. Green, 2005, det. E.J. Clement. Ø

©44/1.1 AMARANTHUS RETROFLEXUS *94, Banffs.: One plant at landfill site, Nether Dallachy, NJ365643, I.P. Green, 2005.

©44/1.cau AMARANTHUS CAUDATUS *94, Banffs.: Several plants at landfill site, Nether Dallachy, NJ365643, I.P. Green, 2005.

46/3.1 HONCKENYA PELOIDES 106, E. Ross: Sandy shore, Shandwick, NH859750, B.R. & C.B. Ballinger, 2005. 1st record since 1970.

46/4.2 MINUARTIA VERNA *63, S.W. Yorks.: Levitt Hagg Quarries, SE538009, D.M. Bramley, 1992.

46/5.3 STELLARIA PALLIDA *H6, Co. Waterford: Scattered on dunes, Woodstown, S69880595, P.R. Green, 2005.

46/7.2x3 CERASTIUM xMAUERI (CERASTIUM ARVENSE x C. TOMENTOSUM) *63, S.W. Yorks.: Road verge, Rossington, SK644971, J.G. Hodgson, 1976.

46/10.3 SAGINA SUBULATA 13, W. Sussex: On and by sandy track and northwards into next tetrad, Flexham Park, TQ007219, F.L. Abraham, 2005, conf. A.G. Knapp. 1st record since c. 1931.

*‡79, Selkirks.: At 440 m on forest track, above Over Phawhope, Ettrick, NT183072, R.W.M. Corner, 2005, **herb. R.W.M.C.** Part of Southern Upland Way. Introduced on footwear?

46/10.3x5 SAGINA xMICRANTHA (SAGINA SUBULATA x S. PROCUMBENS) *4, N. Devon: Lundy, SS136456, D. Allen, 2002, det. N. Jardine.

46/17.2 SPERGULARIA MEDIA *©63, S.W. Yorks.: Wardsend Cemetery, SK340902, A. McCarthy, 2000.

46/17.3 SPERGULARIA MARINA *‡65, N.W. Yorks.: Edge of A66, Stephen Bank, Scotch Corner, NZ118110, A. Weston, 2000.

‡46/17.5 SPERGULARIA BOCCONEI 3, S. Devon: Gravel track by the sea, Beesands, SX820407, M. Catt & R.E.N. Smith, 1996, **NMW**, det. T.C.M. Rich (2005). 1st record since 1936.

‡46/23.1 VACCARIA HISPANICA *H6, Co. Waterford: Two plants on waste ground, Tramore, S58990267, P.R. Green, 2005, **herb. P.R. Green**.

46/25.5 DIANTHUS DELTOIDES ©89, E. Perth: Several places on stable shingle banks, River Tay at Delvine, NO1238, M.C. Robinson, 2004.

‡47/3.1 FAGOPYRUM ESCULENTUM *©H6, Co. Waterford: Five plants on waste ground, Tramore, S59390221, P.R. Green, 2005.

47/8.13x15 RUMEX xSAGORSKII (RUMEX CRISPUS x R. SANGUINEUS) *H6, Co. Waterford: Single plant on waste ground, Snugborough, X07119238, P.R. Green, 2005.

47/8.13x19 RUMEX xPRATENSIS (RUMEX CRISPUS x R. OBTUSIFOLIUS) 94, Banffs.: Spey Bay, NJ3664, I.P. Green & A.G. Amphlett, 2005. 1st record since 1970.

47/8.14x20 RUMEX xWIRTGENII (RUMEX CONGLOMERATUS x R. PALUSTRIS) *37, Worcs.: Wilden Marsh, SO8274, C.B. Westall & R. Maskew, 2003, det. J.A. Akeroyd.

47/8.21 RUMEX MARITIMUS 80, Roxburghs.: Muddy edge of pond, Barons Folly Loch, Ancrum, NT639264, L.W. Gaskell, 2005, det. R.W.M. Corner, **herb. R.W.M.C.** Only extant site. Extinct at previously known site.

‡49/1.mlo PAEONIA MLOKOSIEWITSHII *33, E. Gloucs.: Jurassic limestone road cutting on Fosse Way, Broadwell, SP194272, E. Norman, 1998, conf. E.J. Clement. Well established by 27th May 2005 when material collected by M.A.R. & C. Kitchen was confirmed by E.J. Clement. Source: *Wild Flower Society Magazine*, Autumn 1999 p.26. See also *BSBI News* 73 p.40. Ø Apparently 1st record for British Isles.

©53/1.8 MALVA VERTICILLATA *65, N.W. Yorks.: Woodland, Deepgill, East Witton, SE1584, A. Weston, 2000. Growing with other aliens.

©53/2.trm LAVATERA TRIMESTRIS *71, Man.: Levelled landfill sown with cornfield weeds, Ramsey, SC445948, L.S. Garrad, 2000.

‡53/4.1 ALCEA ROSEA **85**, Fife: Rocky cliff-face below gardens at Lammerlaws, Burntisland, NT238857, G.H. Ballantyne, 2005. 1st record since 1970.

‡53/5.1 SIDALCEA MALVIFLORA *©57, Derbys.: One plant in old railway sidings, Pleasley, SK493639, K. Balkow, 2003. *94, Banffs.: 4 clumps in area of waste ground (probably cleared house site), Portsoy, Institute Street, NJ590660, A.G. Amphlett, 2005.

‡54/1.fl.a SARRACENIA FLAVA *3, S. Devon: Colaton Raleigh Common, SY0487, R.E.N. & C.J. Smith, 1999, **herb. R.E.N.S.** Ø Apparently 1st record for British Isles.

57/1.9a VIOLA PALUSTRIS subsp. PALUSTRIS *94, Banffs.: Cottown Wood, NJ6852, I.P. Green, 2004.

©60/CUC.mel CUCUMIS MELO *57, Derbys.: Open disturbed ground, Heeley, E of River Sheaf, SK3484, K. Balkow, 2003. Mostly imported soil associated with building new bridge and other developments.

‡60/CUT.max CUCURBITA MAXIMA *94, Banffs.: One plant in landfill site, Nether Dallachy, NJ365643, I.P. Green, 2005.

‡61/1.bal POPULUS BALSAMIFERA *©63, S.W. Yorks.: Abbey Lane Sewage Works, SK538901, J.R. Comley, 1992.

‡61/1.bsp POPULUS 'BALSAM SPIRE' (POPULUS TRICHOCARPA × P. BALSAMIFERA) *©63, S.W. Yorks.: Edge of borrow pit, SK611945, G. Coles, 2004.

61/2.4×9 SALIX ×MOLLISSIMA (SALIX TRIANDRA × S. VIMINALIS) *4, N. Devon: Bow, SS718018, N.F. Stewart, 2004, conf. R.D. Meikle. Confirmed by R.D. Meikle as almost certainly var. *hippophaiifolia*.

61/2.9×16 SALIX ×FRIESIANA (SALIX VIMINALIS × S. REPENS) *4, N. Devon: Braunton Burrows, R.D. Meikle, 2003.

61/2.11×14 SALIX ×STREPIDA (SALIX CINEREA × S. MYRSINIFOLIA) *80, Roxburghs.: Bank above burn, Holm Hill, Newcastleton, NY474879, R.W.M. Corner, 2005, det. R.D. Meikle, **herb. R.W.M.C.**

‡61/2.ela SALIX ELAEAGNOS *©63, S.W. Yorks.: Ecclesall Wood, Sheffield, SK3181, Sheffield City Ecology Unit, 1998.

‡62/5.1 ISATIS TINCTORIA **62**, N.E. Yorks.: Dismantled railway line, Robin Hood's Bay, NZ946052, G. Young, 2003, conf. T.C.G. Rich. 1st record since 1930.

62/12.3 RORIPPA ISLANDICA *4, N. Devon: Upper Tamar Lake, SS2812, Devon Ass. Botany Section & Botanical Cornwall Group, 2003. *80, Roxburghs.: Edge of pond, Barons Folly Loch, Ancrum, NT639264, L.W. Gaskell, 2005, det. T.C.G. Rich, **herb. R.W.M.C.** 1st confirmed record.

‡62/14.5 CARDAMINE PRATENSIS *flore pleno* *94, Banffs.: Several large patches of plants on east side of railway cutting opposite Tesco's carpark, Keith & Dufftown Railway, NJ427506, A.G. Amphlett, 2004. Very striking plants in full flower.

62/14.6 CARDAMINE IMPATIENS *©63, S.W. Yorks.: Scabba Wood, SE528017, A. Lister, 1981.

‡62/14.cor CARDAMINE CORYMBOSA *94, Banffs.: Two plants in garden of 19 Bogmoor Road, Bogmoor, NJ356629, I.P. Green, 2004. Accidental introduction from Christie's garden centre, Fochabers (v.c.95), where naturalised. *H12, Co. Wexford: Nursery weed in Coolaught Garden Centre, Coolaught, S871359, P.R. Green, 2005.

‡62/20.1 LOBULARIA MARITIMA **85**, Fife: Rocky cliff-face below gardens at Lammerlaws, Burntisland, NT238857, G.H. Ballantyne, 2005. 1st record since 1970 and 1st established record (escape from gardens above).

62/23.3×5 COCHLEARIA OFFICINALIS × C. DANICA *4, N. Devon: Base of low cliffs at Buck's Mill, SS3523, M.F. Godfrey, 2003.

‡62/31.2 CORONOPUS DIDYMUS **85**, Fife: On and by sandy paths, Pettycur Cemetery, Kinghorn, NT265864, G.H. Ballantyne, 2005, **herb. G.H.B.** 1st record since 1970.

[62/34.2×3 BRASSICA ×HARMSIANA (BRASSICA NAPUS × B. RAPA) **37**, Worcs.: Error in VCCC - no known records. Delete.]

©62/34.2a BRASSICA NAPUS subsp. OLEIFERA *94, Banffs.: One plant growing on rough ground next to 19 Bogmoor Road, Bogmoor, NJ356630, I.P. Green, 2004.

‡62/34.3b BRASSICA RAPA subsp. CAMPESTRIS *©63, S.W. Yorks.: Near Brinsworth, SK4191, Rotherham Biol. Rec. Centre, 1986.

©62/NES.pan NESLIA PANICULATA **63**, S.W. Yorks.: Near Firsby Reservoir, SK4995, Rotherham Biol. Rec. Centre, 1994. 1st record since 1970.

©63/1.odo RESEDA ODORATA ***57**, Derbys.: Open disturbed ground, Heeley, E of River Sheaf, SK3484, K. Balkow, 2003. Mostly imported soil associated with building new bridge and other developments.

‡65/6.1 DABOECIA CANTABRICA ***94**, Banffs.: Good sized plant growing by path in woodland, Winding Walks, Leitch's Wood, NJ359581, I.P. Green, 2005.

65/10.1 ARCTOSTAPHYLOS UVA-URSI **63**, S.W. Yorks.: Howden Moors, SK1596, P. Ardron, 1988. 1st record since 1970.

65/13.5 VACCINIUM ULIGINOSUM ***57**, Derbys.: Two bushes in blanket bog at 513m, near Swains Head, SK131983, D.W. Yalden, 2004, det. S. Edwards.

66/1.1 PYROLA MINOR **37**, Worcs.: Woodland, edge of disused railway, Wyre Forest, SO743760, P.L. Reade, 2005, conf. J.J. Day. Last published record 1909. ***H12**, Co. Wexford: About 10 flowering spikes under birch on dunes, Raven Point, T113240, H. Northridge, 2005.

66/1.2 PYROLA MEDIA **®89**, E. Perth: Steep wooded ravine, Gleann Mhairc, N of Blair Atholl, NN 885718, P. Cramb, 2000. **®89**, E. Perth: Damp broadleaved woodland/carr adjoining loch, Monk Myre, Blairgowrie, NO2142, L. Farrell, 2004. In flower.

67/1.1a MONOTROPA HYPOPITYS subsp. HYPOPITYS ***4**, N. Devon: Waste ground at Lower Yelland, SS4832, P. Mullen, 1997.

‡69/3.1 CYCLAMEN HEDERIFOLIUM ***63**, S.W. Yorks.: Lawn, Brodsworth Hall, SE5007, C.A. Howes, 1992.

72/2.6 RIBES ALPINUM **®‡39**, Staffs.: A single bush in roadside hedge, West of Knowl Wall, SJ851392, I.J. Hopkins, 2005. Native elsewhere in vice-county.

‡73/1.3 CRASSULA HELMSII ***©80**, Roxburghs.: Margins of pond, Smailholm village, NT646362, R.W.M. Corner, 2005, **herb. R.W.M.C.** Introduced.

‡73/5.4 SEDUM SPECTABILE ***85**, Fife: One clump, Crook of Devon Moss, NO041002, G.H. Ballantyne, 2005. Has probably persisted for some time.

‡73/5.7 SEDUM SPURIUM ***94**, Banffs.: Growing on heaps of soil on old airfield, Bogmoor, NJ358631, I.P. Green & Somerset Rare Plant Group, 2004.

‡73/5.13 SEDUM SEXANGULARE **3**, S. Devon: Established on wall, Plympton, SX546551, P. Pullen, 2005. 1st record since 1970.

[73/5.19 SEDUM HISPANICUM **37**, Worcs.: Error in VCCC - no known records. Delete.]

‡73/5.hyb SEDUM HYBRIDUM ***94**, Banffs.: At least 10 plants growing on old airfield, on east side of road, just south of track to Lower Auchenreath, NJ370637, I.P. Green, 2005. Ø

‡74/1.1xrosxchi ASTILBE xARENSISII (ASTILBE JAPONICA x A. ROSEA x A. CHINENSIS) ***H6**, Co. Waterford: Two clumps on waste ground, Mapstown, X23449381, P.R. Green, 2005.

74/5.3 SAXIFRAGA NIVALIS **89**, E. Perth: Scatter of rocks at 850 m on N facing side of hill top, Meall a'Choire Bhuidhe, Glen Lochsie, NO066709, L. Tucker, 2003, conf. M.C. Robinson. Seen and photographed by MCR on 4/7/05. 1st record in this square (different locality) since 1884 and 1st in VC since 1960s.

‡74/6.1 HEUCHERA SANGUINEA ***94**, Banffs.: Growing under pine trees on east side of B9104, Bogmoor, NJ3563, I.P. Green, 2004.

‡74/8.1 TELLIMA GRANDIFLORA ***33**, E. Gloucs.: Secondary woodland on Jurassic limestone beside A436, SO9215, M.A.R. & C. Kitchen, 2002. **94**, Banffs.: Growing in woodland south of cemetery, Bellie Hill, NJ354606, I.P. Green, 2005. 1st record since 1970.

‡75/3.2 SPIRAEA ALBA ***H6**, Co. Waterford: Large patch in hedge on north side of N25, Newtown, S42630767, P.R. Green, 2005.

‡75/3.2x3 SPIRAEA xBILLARDII (SPIRAEA ALBA x S. DOUGLASII) ***H6**, Co. Waterford: Small patch in hedge on north side of N25, Newtown, S42630767, P.R. Green, 2005.

‡75/3.mulxthu SPIRAEA xARGUTA (SPIRAEA MULTIFLORA x S. THUNBERGII) ***39**, Staffs.: One small bush on side of track, Sheriffhales Common, SJ770124, I.J. Hopkins, 2005.

‡75/4.1 ARUNCUS DIOICUS ***60**, W. Lancs.: In dense shade by river in wood, Artle Dale, Caton with Littledale, SD534631, E.F. Greenwood & J.M. Newton, 2005.

‡75/7.1 KERRIA JAPONICA ***63**, S.W. Yorks.: Brecks Common, Doncaster, SE6207, G.T.D. Wilmore, 2005.

- ‡75/8.6 RUBUS PARVIFLORUS *63, S.W. Yorks.: Sunnybank Urban Nature Reserve, SK3486, Sheffield City Ecology Unit, 1995.
- 75/8.60 RUBUS LINDLEIANUS *77, Lanarks.: Wood edge, NW of Blackwood, NS7843, B. Simpson & P. Macpherson, 2004.
- 75/8.77 RUBUS QUESTIERI *10, Wight: Roadside verge outside Firestone Copse, SZ559915, D.E. Allen, 2005, det. A. Newton, **BM, HCMS**.
- 75/8.106 RUBUS INCURVATUS *12, N. Hants.: Irelands Copse, Bentley, SU7944, D.E. Allen, 2005, **HCMS**. *H6, Co. Waterford: Rocky outcrop, Ahanaglogh, S36680413, P.R. Green & A.C. Leslie, 2005, det. D.E. Allen.
- 75/8.117 RUBUS POLYANTHEMUS *77, Lanarks.: NW of Blackwood, NS7843, B. Simpson & P. Macpherson, 2004.
- 75/8.123 RUBUS SEPTENTRIONALIS *77, Lanarks.: Track side, Thinacre, SW of Larkhall, NS7349, B. Simpson & P. Macpherson, 2003.
- ‡75/8.134 RUBUS ARMENIACUS *H6, Co. Waterford: Riverside path, Ballynakill, S6311, P.R. Green & J.C. Wallace, 2005, det. D.E. Allen.
- 75/8.140 RUBUS ROSSENSIS *10, Wight: One large patch, Parkhurst Forest, SZ479910, D.E. Allen, 2005, **HCMS**.
- 75/8.142×321 RUBUS ULMIFOLIUS × R. CAESIUS *H6, Co. Waterford: Hedge on side of lane, Summerville, S62830043, P.R. Green, 2005, det. D.E. Allen.
- 75/8.144 RUBUS ADSCITUS *H6, Co. Waterford: Roadside hedge, Tallowbridge, X00049433, P.R. Green & A.C. Leslie, 2005, det. D.E. Allen.
- 75/8.154 RUBUS LANATICAULIS *11, S. Hants.: Carter's Copse, Gosport, SU584001, D.E. Allen *et al.* 2005, conf. A. Newton, **BM**.
- 75/8.163 RUBUS VESTITUS *77, Lanarks.: Near Langlands House, East Kilbride, NS6451, B. Simpson, 2005.
- 75/8.193 RUBUS MELANODERMIS *H6, Co. Waterford: Along roadside at margin of wood, Ballyheeny Bridge, X12368274, P.R. Green, 2005, det. D.E. Allen.
- 75/8.225 RUBUS BOTRYEROS *H6, Co. Waterford: Clump on hedge bank of lane, Larbarrt's Bridge, S2515, D.E. Allen, 2001, det. A.L. Newton, **BM**.
- 75/8.239 RUBUS INSECTIFOLIUS *63, S.W. Yorks.: Loxley Common, SK3090, Sheffield City Ecology Unit, 1989.
- 75/8.241 RUBUS LARGIFICUS *12, S. Hants.: Cowleigh Copse, East Green, near Bentley, SU801452, D.E. Allen, 2005, conf. A. Newton, **BM, HCMS**.
- 75/8.275 RUBUS ASPERIDENS *10, Wight: Colony above Wootton Creek, Firestone Copse, SZ5590, D.E. Allen, 2005, **BM, HCMS**.
- 75/8.305 RUBUS BRITANNICUS *10, Wight: Grammars Copse, Brighstone, SZ415841, D.E. Allen & M.J. Burnhill, 2005, **BM, HCMS**.
- 75/8.ava RUBUS AVALONIENSIS *8, S. Wilts.: Margin at crossroads, Barnridge Copse, Bentley Wood, East Grimstead, SU234288, D.E. Allen & D.A. Lewis, 2002, conf. A. Newton, **BM, HCMS**. *11, S. Hants.: Oakwood fragment, North Copse, Tye, Hayling Island, SU728022, D.E. Allen & A.O. Chater, 1985, **BM**, conf. R.D. Randall & A. Newton. *12, N. Hants.: Wood margin, Baughurst Common, SU577623, D.E. Allen, 2003, conf. A. Newton, **BM, HCMS**.
- 75/8.cae RUBUS CAESARIUS *H6, Co. Waterford: Waste ground, Cappoquin, X09869967, P.R. Green & A.C. Leslie, 2005, det. D.E. Allen.
- 75/8.int RUBUS INTENSIOR *3, S. Devon: Near Chudleigh, SX8578, R.W. Gould, 1997, det. A. Newton, **herb. R.W.G.**
- 75/8.pyd RUBUS PYDARENSIFORMIS *3, S. Devon: Abundant about Kingston and Ringmore, SX64, E.S. Marshall, 1894, **BM**, det. D.E. Allen. See *Watsonia* 25: 157–174(2004) for details of this new species. Ø
- 75/8.seg RUBUS SEGONTII *H34, E. Donegal: Common over district of middle Finn valley, west of Ballybofey, C0102 & H0397 etc. D.E. Allen, R. Fitzgerald & P. Hodson, 1992, **BM**, det. D.E. Allen, conf. A. Newton. 1st record for north half of Ireland.
- 75/8.vin RUBUS VINDOMENSIS *17, Surrey: Margin of Willey Copse, between Bentley and Farnham, SU812458, D.E. Allen, 2005, **BM**. See *Watsonia* 25: 157–174(2004) for details of this new species. Ø

75/9.11 *POTENTILLA CRANTZII* ®**89**, E. Perth: Limestone crags at 617 m, Coire a'Ghearraig, Glen Lochsie, NO076698, L. Tucker, 2004.

‡75/11.2 *FRAGARIA MOSCHATA* ©**63**, S.W. Yorks.: Todwick, SK4984, Rotherham Biol. Rec. Centre, 2005. 1st record since 1970.

‡75/12.1 *DUCHESNEA INDICA* *©**89**, E. Perth: Patch 2m × 0.5m outside garden on suburban roadside verge, Perth, NO124227, A. Rutherford, 2005. Photographed by M.C. Robinson on 20/10/2005.

75/13.1 *GEUM RIVALE* *©**71**, Man: Garden weed in newish development, Maughold, SC469928, T. Castrin, 2002.

75/13.1×2 *GEUM* ×*INTERMEDIUM* (*GEUM RIVALE* × *G. URBANUM*) **37**, Worcs.: Ancient semi-natural woodland, Twiland Wood and Brook, SO9780, R. Maskew, 2003, conf. C.A. Stace & F. Krahulec. 1st record since 1970. Several locations.

‡75/13.3 *GEUM MACROPHYLLUM* *©**39**, Staffs.: Foot of old wall, outside car park, Rugeley, SK045183, I.J. Hopkins, 2005. Not present in any nearby gardens.

‡75/18.1 *ACAENA NOVAE-ZELANDIAE* ***85**, Fife: Several cast-out plants by woodland path, St Bridget's Wood, Dalgety Bay, NT170837, J. Cook, 2005, **herb. G.H.B.**

‡75/18.2×4 *ACAENA ANSERINIFOLIA* × *A. INERMIS* *©**37**, Worcs.: Sandy grassland, West Midland Safari Park, SO802756, W.A. Thompson, 2003, det. E.J. Clement.

‡75/18.4 *ACAENA INERMIS* *©**63**, S.W. Yorks.: Pavement weed, Thurcroft, SK5088, G.T.D. Wilmore, 2005.

[75/19.10a *ALCHEMILLA FILICAULIS* subsp. *FILICAULIS* **37**, Worcs.: Error in VCCC - no known records. Delete.]

‡75/21.7 *ROSA* 'HOLLANDICA' ***94**, Banffs.: Two bushes growing on west bank of burn, on west side of the B9104, Bogmoor, NJ357628, I.P. Green, 2004.

‡75/21.8 *ROSA FERRUGINEA* ***63**, S.W. Yorks.: Wall, Thackley, Bradford, SE181383, B.A. Tregale, 2004.

75/21.13×17 *ROSA* ×*GLAUROIDES* (*ROSA CAESIA* subsp. *VOSAGIACA* × *R. MOLLIS*) ***77**, Lanarks.: Roadside verge, by hedge, Stonehouse to Udston road, NS751451, P. Macpherson, 2004, det. R. Maskew, **herb. P.M.**

‡75/22.1 *PRUNUS PERSICA* *©**63**, S.W. Yorks.: Near canal, Sheffield, SK398907, K. Balkow, 2005.

‡75/22.2 *PRUNUS DULCIS* *©**63**, S.W. Yorks.: Wadsley & Loxley Common, SK3190, Sheffield City Ecology Unit, 2002.

75/22.4×5 *PRUNUS* ×*FRUTICANS* (*PRUNUS SPINOSA* × *P. DOMESTICA*) ***94**, Banffs.: One bush growing amongst trees on bank on east side of the B9104, Bellie Hill, NJ352610, I.P. Green, 2005.

‡75/22.ser *PRUNUS SERRULATA* *©**63**, S.W. Yorks.: Burngreave, SK3689, Sheffield Wildlife Trust, 2003.

‡75/27.nie×atr *MALUS* ×*PURPUREA* (*MALUS NIEDZWETZKYANA* × *M. ATROSANGUINEA*) *©**37**, Worcs.: Single bush, considered bird sown, Harvington Island, River Avon, SP064477, A.O. Chater & R. Maskew, 2004.

75/28.1×9 *SORBUS* ×*THURINGIACA* (*SORBUS AUCUPARIA* × *S. ARIA*) ***37**, Worcs.: Scrub woodland, Malvern Hills, SO773461, P.G. Garner, 2004, det. P.J.M. Nethercott. *©**63**, S.W. Yorks.: Rokeby Road, Sheffield, SK356929, Sheffield Wildlife Trust, 2004.

‡75/28.7 *SORBUS INTERMEDIA* ***H6**, Co. Waterford: Self-sown on top of wall, Waterford, S61531126, P.R. Green, 2005.

‡75/30.1 *AMELANCHIER LAMARCKII* *©**63**, S.W. Yorks.: Disused railway embankment, Shipley, SE157381, B.A. Tregale, 2004.

‡75/32.15 *COTONEASTER CONGESTUS* ***77**, Lanarks.: Well established in long abandoned industrial estate, The Gorbals, Glasgow, NS5963, P. Macpherson, 2005, det. J. Fryer, **herb. P.M.**

‡75/32.18 *COTONEASTER CONSPICUUS* ***60**, W. Lancs.: Self seeded on wall top, car park, Preston, SD533289, M. Wilcox, 2005.

‡75/32.21 *COTONEASTER HORIZONTALIS* **94**, Banffs.: Cemetery, Fordyce, NJ555638, I.P. Green, 2005. 1st record since 1970.

‡75/32.24 *COTONEASTER ADPRESSUS* *©**63**, S.W. Yorks.: Parkin Wood, Chapelton, SK3597, K. Dulieu, 2002.

- ‡75/32.26 COTONEASTER DIVARICATUS *85, Fife: Several bushes in hedge forming part of boundary, Dunnikier Golf Course, Kirkcaldy, NT273947, G.H. Ballantyne, 2005. Originally planted, probably now self-sowing.
- ‡75/32.37 COTONEASTER DIELSIANUS *©57, Derbys.: Disused railway bed, Long Eaton, SK491344, R.D. Martin, 2005, det. A. Willmot.
- ‡75/32.40 COTONEASTER STERNIANUS *13, W. Sussex: Old railway bank, Mid Lavant, SU858084, R.C. Stern, 2005.
- ‡75/32.his COTONEASTER HSINGSHANGENSIS *63, S.W. Yorks.: Field, Reynolds Wood, Shipley, SE144361, B.A. Tregale, 2003.
- ‡75/32.ros COTONEASTER ROSEUS *29, Cambs: Several birdsown shrubs at base of railings by old car park for railway station, Newmarket, TL644626, A.C. Leslie & P.R. Green, 2005, det. J. Fryer, CGE. Ø Apparently 1st record for the British Isles.
- ‡75/33.2 PYRACANTHA ROGERSIANA *©63, S.W. Yorks.: Denholme Close, Sheffield, SK3588, Sheffield Wildlife Trust, 2004.
- ‡77/1.1 ROBINIA PSEUDOACACIA *94, Banffs.: In hedge on south side of road, Crossbrae, NJ6952, I.P. Green, 2004.
- ‡77/14.ben VICIA BENGHALENSIS ©63, S.W. Yorks.: Old Moor wetland site, Wombwell, SE4202, G.T.D. Wilmore, 2005. 1st record since 1970.
- ‡77/14.fab VICIA FABA *71, Man: Amenity site, Ramsey, SC444948, L.S. Garrad, 1999.
- ‡77/15.11 LATHYRUS HIRSUTUS ©63, S.W. Yorks.: Cannon Hall, Barnsley, SE2708, Barnsley MBC records, 1991. 1st record since 1970.
- ‡77/15.7 LATHYRUS GRANDIFLORUS *H6, Co. Waterford: Patch on edge of scrub opposite Murphy's Bar, NCR, Clohernagh, S63750244, P.R. Green, 2005, **herb. P.R. Green**.
- ©77/15.ann LATHYRUS ANNUUS *71, Man: Andreas tip, SC433987, M. Devereau, 1980. Probably from pig farm waste.
- 77/18.4 MEDICAGO POLYMORPHA ©57, Derbys.: Waste ground, Britannia Mill, Derby, SK342369, S. Jackson, 2004, **DBY**. Growing on hardcore deposited during building work from down south. 1st record since 1970.
- ‡77/19.19a TRIFOLIUM INCARNATUM subsp. INCARNATUM *H6, Co. Waterford: Four plants on waste ground, Tramore, S59150245, P.R. Green, 2005, **herb. P.R. Green**.
- 77/19.19b TRIFOLIUM INCARNATUM subsp. MOLINERII 3, S. Devon: Locally abundant on cliff edge, Bolt Tail, SX674389, P. Reay & W. Rees, 2005, **herb. R.E.N.S.** 1st record since 1900.
- ‡77/21.1x2 LUPINUS xREGALIS (LUPINUS ARBOREUS x L. POLYPHYLLUS) *94, Banffs.: Growing in clearing in trees next to rubbish dump, Nether Dallachy, NJ363645, I.P. Green, 2004.
- ‡77/22.2 LABURNUM ALPINUM 94, Banffs.: In hedge on S. side of road, Crossbrae, NJ6952, I.P. Green, 2004. 1st record since 1970.
- ©77/DOR.hir DORYCNIUM HIRSUTUM *39, Staffs.: One plant in pavement against wall by 83 Jayshaw Avenue, Great Barr, SP047938, M.W. Poulton, 2005, conf. E.J. Clement. Ø
- ‡78/2.mac ELAEAGNUS MACROPHYLLA *3, S. Devon: By coast path at St Mary's Bay, SX9355, R.E.N. & C.J. Smith, 2005, **herb. R.E.N.S.**
- ‡78/2.macxpun ELAEAGNUS xSUBMACROPHYLLA (ELAEAGNUS MACROPHYLLA x E. PUNGENS) *©63, S.W. Yorks.: Thorpe Marsh Nature Reserve, SE5909, B.K. Byrne, 2002.
- 84/1.1x8 EPILOBIUM xNOVAE-CIVITATIS (EPILOBIUM HIRSUTUM x E. CILIATUM) *60, W. Lancs.: Car park, Preston, SD536288, M. Wilcox, 2005.
- 84/1.5 EPILOBIUM TETRAGONUM *60, W. Lancs.: Waste ground, Preston, SD533292, M. Wilcox, 2005. 1st confirmed v.c record. Specimen provided by P. Jepson to be deposited at **LIV**.
- ‡84/4.5 OENOTHERA STRICTA 33, E. Gloucs.: Waste ground under development, north side of A4019, near Tewkesbury Bridge, Cheltenham, SO934238, M.A.R. & C. Kitchen, 2005. 1st record since 1970.
- 91/2.12 EUPHORBIA PORTLANDICA 13, W. Sussex: Coastal shingle, patch 2m square on top of sea wall facing Hayling Island, S. Thorney Island, SU761014, Sussex Botanical Recording Society, 2005, conf. A.G. Knapp. 1st record since 1963.
- †91/2.6 EUPHORBIA PLATYPHYLLOS *©57, Derbys.: In taller growth on disturbed ground, M1 Junction 25 south-west side, SK471354, G. Hirons, 2004.
- ‡91/2.9 EUPHORBIA LATHYRIS *94, Banffs.: One plant in landfill site, Nether Dallachy, NJ365643, I.P. Green, 2005.

‡91/2.obl EUPHORBIA OBLONGATA *©63, S.W. Yorks.: Rough ground, St. Luke's, Bradford, NE158317, B.A. Tregale, 2005.

‡93/2.3 PARTHENOCISSUS TRICUSPIDATA *63, S.W. Yorks.: Shirland Lane, Sheffield, SK3888, Sorby Natural History Society, 1988.

‡94/1.2 LINUM USITATISSIMUM *94, Banffs.: Several plants in landfill site, Nether Dallachy, NJ365643, I.P. Green, 2005. 1st record since 1970.

‡102/1.3 OXALIS CORNICULATA *94, Banffs.: Growing as a weed in the garden of a house in the village of Bogmoor, NJ3563, I.P. Green, 2004.

‡103/1.13×pla GERANIUM ×MAGNIFICUM (GERANIUM IBERICUM × G. PLATYPETALUM) *H6, Co. Waterford: Clump on road verge, Kilcana, S38881047, P.R. Green, 2005, **herb. P.R. Green**.

‡103/1.2 GERANIUM VERSICOLOR *65, N.W. Yorks.: By road south of Bland's Gill, north of Sedburgh, SD634949, C.E. Wild, 2005.

†103/2.2 ERODIUM MOSCHATUM ©39, Staffs.: Grassland, tens of plants between rear boundary fence of Sports Stadium and lake, Perry Barr Park, SP066926, J.E. Hawksford, 2005, **STOKE**. First record since 1906. Possibly accidentally introduced with sand used for field events on the other side of the fence. *©57, Derbys.: Open disturbed ground, Heeley, E of River Sheaf, SK3484, K. Balkow, 2003. Mostly imported soil associated with building new bridge and other developments.

‡103/LIM.dou LIMNANTHES DOUGLASII *94, Banffs.: Spreading along 5 metres of road verge, opposite houses, NE of Moss of Bourach, NJ255405, A.G. Amphlett, 2005.

©104/1.maj TROPAEOLUM MAJUS *94, Banffs.: Growing in trees opposite houses in Bogmoor, E side of the B9104, NJ3563, I.P. Green, 2004.

‡107/1.ran HYDROCOTYLE RANUNCULOIDES *60, W. Lancs.: Marl pit, Bispham, SD326408, M. Sutcliffe, 2005.

‡107/21.1 FOENICULUM VULGARE *94, Banffs.: Two plants growing on edge of rubbish tip, just where it joins the old airfield. Moor of Dallachy, NJ369638, I.P. Green, 2005.

107/31.1 CICUTA VIROSA ®13, W. Sussex: Bank of River Rother, well out of water, near South Grounds Farm, Stopham, TQ024175, F.L. Abraham, 2005. Also present at two other places - TQ028175 & TQ028176.

108/3.2×4 CENTAURIUM ERYTHRAEA × C. PULCHELLUM *37, Worcs.: Forestry ride, Tiddesley Wood, SO928457, A.W. Reid, 2002, conf. F. Ubsdell.

108/5.4a GENTIANELLA AMARELLA subsp. AMARELLA *94, Banffs.: 69 plants in two areas of dry calcareous grassland, grazed by rabbits with much bare ground, at a height of 450 m in Glen Builg, NJ181064 and NJ182062, A.G. Amphlett, I.P. Green, G. Roberts & R. Finch, 2005. Plants in bud, no flowers fully open.

‡110/6.1 PHYSALIS ALKEKENGII *39, Staffs.: More than 30 plants in waste ground resulting from housing demolition, Foxoak Street, Dudley Wood, SO944861, M.W. Poulton & J.E. Hawksford, 2005.

‡110/6.per PHYSALIS PERUVIANA *3, S. Devon: On compost pile, Poolmill Cross, SX807820, N.F. Stewart, 2003.

‡110/9.1 DATURA STRAMONIUM *94, Banffs.: Two plants in landfill site, Nether Dallachy, NJ365643, I.P. Green, 2005.

‡110/NIC.alaxfor NICOTIANA ×SANDERAE (NICOTIANA ALATA × N. FORGETIANA) *©39, Staffs.: 1 plant in waste ground resulting from housing demolition, St. Anne's Road, Cradley Heath, SO942859, M.W. Poulton & J.E. Hawksford, 2005. *94, Banffs.: Several plants in landfill site, Nether Dallachy, NJ365643, I.P. Green, 2005.

©110/PET.axixint PETUNIA ×HYBRIDA (PETUNIA AXILLARIS × P. INTEGRIFOLIA) *57, Derbys.: Open disturbed ground, Heeley, E of River Sheaf, SK3484, K. Balkow, 2003. Mostly imported soil associated with building new bridge and other developments.

111/3.2×4 CALYSTEGIA ×LUCANA (CALYSTEGIA SEPIUM × C. SILVATICA) 3, S. Devon: Northcote Lane, Honiton, ST1500, L.J. Margetts, 2005, conf. R.K. Brummitt, **K**. 1st record since 1970.

111/3.3×4 CALYSTEGIA ×HOWITTIIORUM (CALYSTEGIA PULCHRA × C. SYLVATICA) *63, S.W. Yorks.: Marsden, Huddersfield, SE0519, M.J. Lucas, 2002.

- ‡111/3.4dis CALYSTEGIA SILVATICA subsp. DISJUNCTA *3, S. Devon: By River Gissage, Honiton, ST1500, L.J. Margetts, 2000, det. R.K. Brummitt. Ø
- ‡114/1.pau POLEMONIUM PAUCIFLORUM *©39, Staffs.: Half a dozen plants scattered in waste ground resulting from housing demolition, Newtown Lane, Dudley Wood, SO946862, M.W. Poulton & J.E. Hawksford, 2005, **STOKE**. Ø
- ‡115/1.1 PHACELIA TANACETIFOLIA *4, N. Devon: Braunton, SS43, M. Breeds, 2005.
- 116/2.1 ECHIUM VULGARE ‡94, Banffs.: Two plants growing on the edge of grass as it meets the shingle, just east of Spey Bay Hotel, NJ355652, I.P. Green, 2005. 1st record since 1970.
- ‡116/2.2 ECHIUM PLANTAGINEUM *©57, Derbys.: Open disturbed ground, Heeley, E of River Sheaf, SK3484, K. Balkow, 2003. Mostly imported soil associated with building new bridge and other developments
- ‡116/2.4 ECHIUM PININANA *©H12, Co. Wexford: Single plant self-sown at base of wall on roadside, Millroad, S977044, P.R. Green, 2005.
- ‡116/4.6 SYMPHYTUM ORIENTALE *©80, Roxburghs.: Wooded side of picnic area by A7 at Teviothead, NT402041, R.W.M. Corner, 2005, **herb. R.W.M.C.** Presumed to have been planted.
- ‡116/5.1 BRUNNERA MACROPHYLLA *94, Banffs.: 1 plant growing on rough ground on north side of track on the east edge of Nether Dallachy, NJ3663, I.P. Green, 2004.
- ©116/6.3 ANCHUSA AZUREA *13, W. Sussex: one plant on dumped soil at 185m altitude, Summer Down, TQ265108, A. Spiers, 2005.
- 116/15.3 MYOSOTIS STOLONIFERA ®79, Selkirks.: A small population in flower in flush at 265m, N of Shorthope Sike, Deloraine Burn, Ettrick, NT338199, R.W.M. Corner, 2005, **herb. R.W.M.C.**
- ©116/CER.maj CERINTHE MAJOR *57, Derbys.: Waste ground bank, Station Road, Sandiacre, SK480363, R.D. Martin, 2005, det. A. Willmot. Ø
- ‡118/1.ann STACHYS ANNUA 17, Surrey: Disused golf course, Chessington, TQ196636, C.L. Coleman & J. O'Reilly, 2004, conf. E.J. Clement, **herb. C.O.R. & J.O.R.** 1st record since 1970. Probably 1st national record for c. 20 years.
- ‡118/2.pse BALLOTA PSEUDODICTAMUS *3, S. Devon: On bank near church at Cornworthy, SX8255, L.J. Margetts & L.M. Spalton, 1996. Ø
- ‡118/7.1 PHLOMIS RUSSELLIANA *33, E. Gloucs.: Patch 2m x 3m in small, overgrown limestone quarry, Arlington, Bibury, SP108070, M.A.R. & C. Kitchen, 2005, conf. E.J. Clement. Away from buildings. Threatened by dumping.
- ‡118/7.2 PHLOMIS FRUTICOSA *34, W. Gloucs.: Disused Jurassic limestone quarry, Breakheart Hill, North Nibley, ST756967, J.R. Doe, 2004.
- ‡118/10.1 SCUTELLARIA ALTISSIMA *‡57, Derbys.: Old railway land, Ilkeston, SK462425, B. Gough, 2005, det. B.S. Wurzell. Known here since 2002.
- 118/15.1x2 PRUNELLA xINTERMEDIA (PRUNELLA VULGARIS x P. LACINIATA) 37, Worcs.: Limestone grassland, Penny Hill, SO750612, R. Maskew, 1991, conf. W.A. Thompson. 1st record since 1970.
- ‡118/16.1 MELISSA OFFICINALIS *65, N.W. Yorks.: Woodland, Throstle Gill, Dalton, NZ1108, A. Weston, 2000. Also found shortly after beside path in an open calcareous site in Leyburn Shawl Wood (SE099) by D.J. Millward. *94, Banffs.: One plant growing in landfill site, Nether Dallachy, NJ363641, I.P. Green, 2005.
- 118/23.5 MENTHA PULEGIUM ®13, W. Sussex: Bare mud at edge of small lake (several plants around GR on N side, abundant on S side of lake), East of Bolney, TQ269227, A.G. Knapp, 2005. Appears native but may be introduction.
- ‡118/24.1 ROSMARINUS OFFICINALIS *H6, Co. Waterford: Self-sown on side and at base of wall, Ballynakill, S638109, D. McGrath, 2005.
- ‡118/25.1 SALVIA SCLAREA *©39, Staffs.: Seedlings in gaps between flagstones, Common Road, Wombourne, SO872924, C.B. Westall, 2005.
- ‡122/1.1 BUDDLEJA ALTERNIFOLIA *©63, S.W. Yorks.: Burngreave, Sheffield, SK3689, Sheffield Wildlife Trust, 2003.
- ©122/1.3 BUDDLEJA GLOBOSA *13, W. Sussex: Ifield Station, TQ251366, G. Bursnall, 2005.
- ‡124/1.10 VERBASCUM SPECIOSUM *17, Surrey: Roadside verge, Cobham, TQ118617, C.L. Coleman & J. O'Reilly, 2004, conf. V. Johnstone, **herb. C.O.R. & J.O.R.**

‡124/4.1 *MIMULUS MOSCHATUS* *H6, Co. Waterford: Plentiful in marshy area, Strancally Quay, X08539038, P.R. Green & M.J. Stribley, 2005.

[124/4.3×cup *MIMULUS* ×*MACULOSUS* (*MIMULUS LUTEUS* × *M. CUPREUS*) 37, Worcs.: Error in VCCC - no known records. Delete.]

124/5.1 *LIMOSELLA AQUATICA* ®39Staffs.: 1000s of plants in mud surround of reservoir drained for repair, Knypersley Reservoir, SJ894555, E. Oxenham, 2005.

‡124/7.1 *ANTIRRHINUM MAJUS* *94, Banffs.: Growing in bare areas amongst moss on old airfield, on south bank of track to Lower Auchenreath, NJ370638, I.P. Green, 2005.

‡124/14.2 *DIGITALIS LUTEA* *85, Fife: About ten plants in scrubby waste ground, shore, west of old harbour, Buckhaven, NT352977, G.H. Ballantyne, 2005. Possibly introduced with a seed-mix.

124/16.11×12 *VERONICA* ×*LACKSCHEWITZII* (*VERONICA ANAGALLIS-AQUATICA* × *V. CATENATA*) *H6, Co. Waterford: Single plant on edge of pool, Portnaboe, S43692070, P.R. Green, 2005.

‡124/16.25 *VERONICA LONGIFOLIA* *94, Banffs.: Growing on side of track near Nether Dallachy, NJ362638, I.P. Green, 2004.

124/16.25×26 *VERONICA LONGIFOLIA* × *V. SPICATA* *©63, S.W. Yorks.: Cowper Ave., Sheffield, SK337932, Sheffield City Ecology Unit, 1991.

‡124/16.26 *VERONICA SPICATA* *©63, S.W. Yorks.: Brightside goit side, Sheffield, SK383891, O.L. Gilbert, 1988.

‡124/17.1×ell *HEBE* ×*LEWISII* (*HEBE SALICIFOLIA* × *H. ELLIPTICA*) *H6, Co. Waterford: Self-sown on side of wall, Dunmore East, S689000, P.R. Green, 2005. Parent plant in nearby garden.

[124/20.3 *EUPHRASIA ANGLICA* 37, Worcs.: Date-class error in VCCC; last recorded in 1961.]

®39, Staffs.: Heathy, hilly pasture between Lud's Church and Back Dane, SJ979661, I.J. Hopkins, 2005. A nationally endangered species.

124/20.8 *EUPHRASIA PSEUDOKERNERI* *63, S.W. Yorks.: Calcareous grassland, Kiveton Park, SK5082, W.A. Ely, 2004, conf. J.R. Comley.

‡129/1.5 *CAMPANULA MEDIUM* *©H6, Co. Waterford: Single plant on waste ground, Ballynacourty, X27378963, P.R. Green, 2005.

‡129/1.8 *CAMPANULA PYRAMIDALIS* *71, Man: Relic in derelict garden, Peel, SC247839, L.S. Garrad, 2000.

‡129/1.9 *CAMPANULA PORTENSCHLAGIANA* *63, S.W. Yorks.: Wall, Lynton Road, Sheffield, SK3385, K. Balkow, 2005.

‡129/7.2 *LOBELIA ERINUS* *94, Banffs.: One plant growing by track in pinewood, Spey Bay, NJ358646, I.P. Green, 2004.

‡131/5.1 *LEYCESTERIA FORMOSA* *79, Selkirks.: A strong colony on rubble dumped to stabilise river bank, River Ettrick upstream from Selkirk Bridge, NT460282, D. Methven, 2005, det. D. McKean, E.

‡131/6.1 *LONICERA PILEATA* *3, S. Devon: Self-seeded by main carpark, Honiton, ST1600, L.J. Margetts, 2005, **herb. R.E.N.S.** *60, W. Lancs.: Waste ground, Preston, SD533292, M. Wilcox, 2005.

*94, Banffs.: One small bush growing on west side of path by entrance to Fife Keith Wood, NJ416507, I.P. Green, 2005. Might have been planted.

‡131/6.2 *LONICERA NITIDA* *94, Banffs.: One bush on north side of track, just south of the A98, Red Slack, NJ363588, I.P. Green, 2005.

‡131/6.6 *LONICERA JAPONICA* *4, N. Devon: Garden weed, Torrington, SS5018, W.H. Tucker, 2005. *60, W. Lancs.: Bank overlooking brackish pool, Fleetwood Nature Park, SD335465, E.F. Greenwood, 2005.

‡131/WEI.flo *WEIGELA FLORIDA* *©63, S.W. Yorks.: Nottingham Street, Sheffield, SK3588, R. Butterfield, 2003.

‡133/3.1 *CENTRANTHUS RUBER* *94, Banffs.: Two plants growing on old airfield, Moor of Dallachy, NJ369638, I.P. Green, 2005.

‡134/1.2 *DIPSACUS SATIVUS* *71, Man: Waste ground, Ramsey, SC445946, L.S. Garrad & P. Davey, 2000.

‡134/2.1 *CEPHALARIA GIGANTEA* 3, S. Devon: Three plants established on roadside at Arnold's Point, Plymouth, SX503553, P. Pullen, 2005. *94, Banffs.: Growing on heaps of soil on the old airfield. Bogmoor, NJ358631, I.P. Green & Somerset Rare Plant Group, 2004, det. P.R. Green.

- ‡134/3.mac KNAUTIA MACEDONICA *71, Man: Gravelled access, Ramsey, SC446954, L.S. Garrad, 2000. Ø Apparently 1st record for the British Isles.
- ‡135/1.3 ECHINOPS BANNATICUS *33, E. Gloucs.: Road verge, Ford, SP086292, J.P. Martin, 2005.
- 135/11.3 CENTAUREA CYANUS ‡94, Banffs.: Several plants in landfill site, Nether Dallachy, NJ365643, I.P. Green, 2005. 1st record since 1970.
- ©135/11.6 CENTAUREA SOLSTITIALIS *57, Derbys.: Disturbed ground on bank of newly-excavated pond, Barlow, SK347753, K. Balkow, 2003, **DBY**. Farmer had deliberately spread aviary sweepings.
- †135/12.1 CICHORIUM INTYBUS 93, N. Aberdeen: Old grassland in small field, Balhalgardy, Inverurie, NJ757242, A. Watson, 2002, **herb. D. Welch**. 1st record since 1930.
- 135/16.3 LEONTODON SAXATILIS *‡94, Banffs.: At least 40 plants growing on old airfield, on east side of road, just north of track to Lower Auchenreath, Moor of Dallachy, NJ369638, I.P. Green, 2005.
- 135/24.1 MYCELIS MURALIS *‡94, Banffs.: One plant on side of path in pine wood opposite Cunninghamhaugh, NJ356646, I.P. Green, 2004.
- 135/25.22 TARAXACUM RUBICUNDUM 33, E. Gloucs.: Bredon Hill, Kemerton, SO959402, A.W. Reid, 2005. 1st record since 1970.
- 135/25.31 TARAXACUM ANGLICUM *37, Worcs.: Unimproved mesic grassland, Chaceley Meadows SSSI, SO855305, M.V. Marsden, 1987, det. C.C. Haworth.
- 135/25.66 TARAXACUM HESPERIUM *37, Worcs.: Disturbed ground, Droitwich Railway Station, SO893633, J.J. Day, 2005, det. A.J. Richards & A.W. Reid, **herb. A.W. Reid**.
- 135/25.68 TARAXACUM INANE *37, Worcs.: Damp grassland, Kingswood Common, SO745603, A.W. Reid & R. Maskew, 2003, det. A.J. Richards, **herb. A.W. Reid**.
- 135/25.73 TARAXACUM OELLGAARDII *37, Worcs.: Unimproved mesic grassland, Chaceley Meadows SSSI, SO856305, A.W. Reid & K. Barnett, 2005, det. A.J. Richards & A.W. Reid, **herb. A.W. Reid**.
- 135/25.78 TARAXACUM PORTERI *37, Worcs.: Laneside bank, Battenton Green, SO828659, J.J. Day, 2004, det. A.J. Richards, **herb. A.W. Reid**.
- 135/25.81 TARAXACUM TAMESENSE *37, Worcs.: Unimproved mesic grassland, Chaceley Meadows SSSI, SO855305, M.V. Marsden, 1988, det. C.C. Haworth.
- 135/25.91 TARAXACUM KERNIANUM *37, Worcs.: Grass verge, Lower Shepley Lane, Burcot, SO980724, J.J. Day, 2003, det. A.J. Richards, **herb. A.W. Reid**.
- ‡135/25.96 TARAXACUM PRIONUM *37, Worcs.: Laneside bank, Cur Lane, Bentley, SP010699, J.J. Day, 2003, det. A.J. Richards, **herb. A.W. Reid**.
- 135/25.99 TARAXACUM QUADRANS *37, Worcs.: Laneside bank, Elmley Lovett to Podmoor, SO865711, J.J. Day, 2003, det. A.J. Richards, **herb. A.W. Reid**.
- ‡135/25.101 TARAXACUM SUBHAMATUM *63, S.W. Yorks.: Ashbourne Drive, Bradford, SE169352, B.A. Tregale, 2005, conf. A.J. Richards.
- ‡135/25.112 TARAXACUM ANGULARE *37, Worcs.: Laneside bank, Broomhall, Kemspey, SO866508, A.W. Reid, 2005, det. A.J. Richards & A.W. Reid, **herb. A.W. Reid**.
- ‡135/25.127 TARAXACUM DENSIOBUM *33, E. Gloucs.: Road verge, Grafton, Beckford, SO988372, A.W. Reid, 2005, conf. A.J. Richards.
- ‡135/25.134 TARAXACUM EXSERTIFORME *37, Worcs.: Grass verge, bridleway, Cames Coomb, Bredon Hill, SO970415, A.W. Reid, 2005, det. A.J. Richards & A.W. Reid, **herb. A.W. Reid**.
- ‡135/25.135 TARAXACUM EXSERTUM *37, Worcs.: Grass verge, Hulls Lane, Oddingley, SO904599, J.J. Day, 2003, det. A.J. Richards, **herb. A.W. Reid**.
- 135/25.139 TARAXACUM HEXHAMENSE *37, Worcs.: Grass verge, Kingsford Lane, Wolverley, SO823799, J.J. Day, 2005, det. A.J. Richards, **herb. A.W. Reid**.
- ‡135/25.141 TARAXACUM HUELPHERSIANUM *37, Worcs.: Grass verge, Beacon Lane, Lickey, SO979752, A.W. Reid, 2005, det. A.J. Richards & A.W. Reid, **herb. A.W. Reid**.
- ‡135/25.146 TARAXACUM LACERIFOLIUM *63, S.W. Yorks.: Footpath, Shipley, SE157381, B.A. Tregale, 2005, conf. A.J. Richards.
- 135/25.148 TARAXACUM LACINIOSUM *3, S. Devon: Grass verge near Strete Raleigh, SY0695, L.J. Margetts, 2003, det. A.J. Richards, **herb. L.J.M.**

- ‡135/25.155 *TARAXACUM LEUCOPODUM* *33, E. Gloucs.: Road verge, Pebworth, SP127467, A.W. Reid, 2005, conf. A.J. Richards.
- ‡135/25.162 *TARAXACUM MACROLOBUM* *37, Worcs.: Grass verge, Lane by Eldersfield Church, SO799311, A.W. Reid, 2005, det. A.J. Richards, **herb. A.W. Reid.**
- 135/25.163, *TARAXACUM MACULATUM* *3, S. Devon: Garden weed, Honiton, ST1500, L.J. Margetts, 2003, conf. A.J. Richards, **herb. L.J.M.**
- ‡135/25.175 *TARAXACUM OCHROCHLORUM* *63, S.W. Yorks.: Ashbourne Drive, Bradford, SE169352, B.A. Tregale, 2005, conf. A.J. Richards.
- ‡135/25.187 *TARAXACUM PORRIGENS* *37, Worcs.: Grass verge, Broadwas Church, SO754550, A.W. Reid, 2005, det. A.J. Richards & A.W. Reid, **herb. A.W. Reid.**
- ‡135/25.208 *TARAXACUM SUBLONGISQUAMEUM* *37, Worcs.: Kerb top, Park Gate, SO935715, J.J. Day, 2005, det. A.J. Richards, **herb. A.W. Reid.**
- ‡135/25.211 *TARAXACUM SUBXANTHOSTIGMA* *©37, Worcs.: Grass verge, Market Street, Bromsgrove, SO959709, J.J. Day, 2004, det. A.J. Richards, **herb. A.W. Reid.**
- 135/25.217 *TARAXACUM UNDULATUM* *3, S. Devon: Roadside near Strete Raleigh, SY0695, L.J. Margetts, 2003, det. A.J. Richards, **herb. L.J.M.**
- ‡135/27.3a *PILOSELLA FLAGELLARIS* subsp. *FLAGELLARIS* *63, S.W. Yorks.: Lindrick Dale, SK540821, J.G. Hodgson, 1976.
- ‡135/28.138 *HIERACIUM GRANDIDENS* *63, S.W. Yorks.: Chellow Dene, Bradford, SE122347, B.A. Tregale, 2004, conf. V. Jones.
- ‡135/28.140 *HIERACIUM EXOTERICUM* *agg.* *63, S.W. Yorks.: Broom Vale, Sheffield, SK270901, Sheffield City Ecology Unit, 1986.
- 135/28.arg *HIERACIUM ARGILLACEUM* *77, Lanarks.: Track side, Uddingston, NS7060, P. Macpherson, 2004, det. D.J. Mcosh, **herb. P.M. Ø**
- ‡135/28.med *HIERACIUM MEDIUM* *3, S. Devon: On wall near old railway, Tavistock, SX4774, C. West, 1952, **CGE**, det. P.D. Sell. Ø Apparently 1st published record for the British Isles.
- ‡135/28.mon *HIERACIUM MONSTROSUM* *3, S. Devon: On wall near old railway, Tavistock, SX4774, C. West, 1952, **CGE**, det. P.D. Sell. Ø Apparently 1st published record for the British Isles.
- ‡135/29.1 *GAZANIA RIGENS* *H6, Co. Waterford: Single plant on edge of dunes, Dungarvan, X277937, P.R. Green, 2005.
- 135/30.2 *FILAGO LUTESCENS* ®13, W. Sussex: Several plants in sandy arable field, South Ambersham, SU913205, F.L. Abraham, 2005.
- ‡135/33.6 *GNAPHALUM LUTEOALBUM* *©37, Worcs.: Bare ground between path and lawn, Homer Hill, Cradley, SO940849, M.W. Poulton, 2003, conf. F. Rose. Still present in 2004.
- ‡135/35.1 *INULA HELENIUM* *94, Banffs.: Growing on the east bank of the railway line, Keith, NJ428507, I.P. Green, 2005. First seen in 2004.
- ‡135/38.1 *TELEKIA SPECIOSA* *94, Banffs.: Large clump in flushed grassland above footpath, Drumin Tower, NJ1830, A.G. Amphlett, 2005, conf. I.P. Green. First seen in 2004 but not identified at the time.
- ‡135/40.3 *SOLIDAGO CANADENSIS* *80, Roxburghs.: S bank of River Teviot, at Ashybank W of Denholm, NT551180, R.W.M. Corner, 1997, **herb. R.W.M.C.** Scabrid plants with few disc florets per flower.
- 135/41.pun *ASTER PUNICEUS* *‡94, Banffs.: Patch growing on the waste ground between 19 & 15 Bogmoor Road, Bogmoor, NJ357629, I.P. Green, 2005. Ø
- ‡135/44.1 *CONYZA CANADENSIS* *87, W. Perth: Landscaped colliery waste, old pit bing, Blairhall, NS999885, G.H. Ballantyne, 2005, **herb. G.H.B.** Provisionally identified near here in 1979 so may have been present since then. Although in Fife, the locality is in v.c. 87
- ‡135/44.2 *CONYZA SUMATRENSIS* *H6, Co. Waterford: Single plant on waste ground, Waterford, S602111, P.R. Green, 2005, **herb. P.R. Green.**
- ‡135/44.bil *CONYZA BILBAOANA* *94, Banffs.: One plant in flower bed in the garden of 19 Bogmoor Road, Bogmoor, NJ356629, I.P. Green, 2005, det. E.J. Clement. Unknown origin.
- ©135/44.dav *CONYZA DAVEAUANA* *13, W. Sussex: Two plants at base of wall in private car park, Hove, TQ290059, A. Spiers, 2002, det. P.D. Sell, **CGE**. Ø Apparently 1st record for the British Isles.

- ‡135/48.coc TANACETUM COCCINEUM *71, Man: Garden dump on development site, Ballagarey, SC341789, L.S. Garrad, 1998.
- [‡135/50.2 ARTEMISIA VERLOTIORUM 63, S.W. Yorks.: Now extinct at all its known sites.]
- ©135/50.dra ARTEMISIA DRACUNCULUS *39, Staffs.: Many plants in pavement, between 43 New Street, Worsley and the Chapel, SO891869, C.B. Westall, 2005.
- ‡135/55.4 ANTHEMIS TINCTORIA *94, Banffs.: Three plants growing on a heap of soil on north side of road, Nether Dallachy, NJ362637, I.P. Green, 2005. Several more plants found on 10.9.2005, in same area, some of which were flowering.
- ©135/56.cor CHRYSANTHEMUM CORONARIUM *71, Man: On a levelled and capped tip at Pooldooie, Ramsey, SC444949, M.M. Davidson & L.S. Garrad, 2000.
- ©135/61.1 COTULA CORONOPIFOLIA *57, Derbys.: Bed of dried up pond between Ilkeston and West Hallam, SK452415, A. Willmot, 2004.
- ‡135/62.1 SENECIO CINERARIA *94, Banffs.: 1 clump in area of waste ground (probably cleared house site), Portsoy, Institute Street, NJ590660, A.G. Amphlett, 2005.
- 135/62.1x10 SENECIO xALBESCENS (SENECIO CINERARIA x S. JACOBAEA) *71, Man: Ramsey, SC449942, L.S. Garrad, 1997. *H12, Co. Wexford: Three plants amongst rocks on quay, Kilmore Quay, S96-03-, P.R. Green, 2005.
- 135/62.13x15 SENECIO xBAXTERI (SENECIO SQUALIDUS x S. VULGARIS) *99, Dunbarton: Waste ground, Craigendoran, NS310816, A. McG. Stirling, 1978. The plant subsequently disappeared but was also found on waste ground, Kilbowie Road, Glasgow (NS4972) by A. McG. Stirling in 1982.
- ©135/74.1 AMBROSIA ARTEMISIIFOLIA *94, Banffs.: Two plants in flower bed in the garden of 19 Bogmoor Road, Bogmoor, NJ356629, I.P. Green, 2004. *H6, Co. Waterford: Single plant on waste ground, Tramore, S59390219, P.R. Green, 2005, **herb. P.R. Green.**
- ©135/79.1 HELIANTHUS ANNUUS *H6, Co. Waterford: Single plant on waste ground, Tramore, S59250235, P.R. Green, 2005.
- ‡135/80.1 GALINSOGA PARVIFLORA *77, Lanarks.: By lamp posts and base of wall, Maryhill, Glasgow, NS5668, S.J. Longrigg, 2003, **herb. P.M.** Reappeared in 2004 and still present 2005.
- ‡135/83.1 COSMOS BIPINNATUS *94, Banffs.: One plant in landfill site, Nether Dallachy, NJ365643, I.P. Green, 2005.
- ‡135/AGE.hou AGERATUM HOUSTONIANUM *©63, S.W. Yorks.: Waste ground, Abbeyfield Park, Sheffield, SK3589, Sheffield Wildlife Trust, 2003.
- ‡135/CAT.cae CATANANCHE CAERULEA *71, Man: Gravel driveway entrance in Bride Road, Ramsey, SC446954, L.S. Garrad, 2000.
- ©135/GULaby GUIZOTIA ABYSSINICA *85, Fife: Garden, Southerton, Kirkcaldy, NT265911, G. Walker, 2004. Bird seed alien. *94, Banffs.: Several plants in landfill site, Nether Dallachy, NJ365643, I.P. Green, 2004.
- ‡135/SIL.per SILPHIUM PERFOLIATUM *71, Man, Bird seed casual in garden, Snugborough, SC355777, M.M. Davidson, 1996. Ø
- 137/4.1 ALISMA PLANTAGO-AQUATICA 94, Banffs.: Several plants in pond, Nether Dallachy Landfill Site, NJ364641, I.P. Green, 2005. 1st record since 1970.
- ‡138/4.2 ELODEA NUTTALLII *94, Banffs.: Growing in Pottie Burn just south of track, Bogmoor, NJ354632, I.P. Green, 2004.
- 151/1.13x14 JUNCUS xSURREJANUS (JUNCUS ARTICULATUS x J. ACUTIFLORUS) 37, Worcs.: Castlemorton Common, SO778398, C.A. Stace & R. Maskew, 2004. 1st record since 1909.
- ‡151/1.28 JUNCUS PALLIDUS 37, Worcs.: Lake margin, Lower Moor Gravel Pit, SO981467, J.J. Day, 1978, det. C.A. Stace. 1st record since 1970. Still present in 1989, A.W.Reid.
- 151/2.6c LUZULA MULTIFLORA subsp. HIBERNICA *H12, Co. Wexford: Forest ride, Corrageen, S802415, P.R. Green, 2005, det. T.C.G. Rich.
- 152/13.1 RHYNCHOSPORA ALBA *H6, Co. Waterford: Very plentiful over bog, Bohadoon, S24390265, P.R. Green, 2005, **herb. P.R. Green.**
- 152/16.1x15 CAREX xBOENNINGHAUSIANA (CAREX PANICULATA x C. REMOTA) *H6, Co. Waterford: Two clumps in damp woodland with both parents, Tournore, X27599587, P.R. Green, 2005.
- 152/16.44x46 CAREX xFULVA (CAREX HOSTIANA x C. VIRIDULA) *63, S.W. Yorks.: Upland flush, Agden Bog, SK251932, J.G. Hodgson, 1977.

152/16.46c *CAREX VIRIDULA* subsp. *VIRIDULA* **37**, Worcs.: Margin of seasonal pond, Burbury Brickworks, SP100834, I.C. Trueman, 1995, conf. A.C. Jermy. 1st record since 1970. Still present 2004, J.J.Day.

‡153/10.1 *ORYZOPSIS MILIACEA* ©**63**, S.W. Yorks.: Wrose, Shipley, SE157372, B.A. Tregale, 2004. 1st record since 1970.

153/12.4 *FESTUCA ALTISSIMA* ©**96**, Easterness: Vegetated bouldery slope above stream, Inverfarigaig, NH537228, G. Jones, 2004. Found in course of SNH survey.

153/13.1x2 *LOLIUM* x *BOUCHEANUM* (*LOLIUM PERENNE* x *L. MULTIFLORUM*) ***94**, Banffs.: Growing in field on old airfield, Nether Dallachy, NJ358634, I.P. Green, 2004.

‡153/17.3 *BRIZA MAXIMA* *©**H6**, Co. Waterford: Scattered along roadside, Knockboy, S63070962, P.R. Green, 2005, **herb. P.R. Green**.

153/18.9 *POA COMPRESSA* **94**, Banffs.: Growing on the north verge of the road, near the entrance to Nether Dallachy Landfill Site, NJ367640, I.P. Green, 2005. 1st record since 1970. On 23/10/05 found at two locations on disused airfield NJ3663. ***H6**, Co. Waterford: Top of churchyard wall, Fewes, S37420784, P.R. Green, 2005.

‡153/29.1 *GAUDINIA FRAGILIS* ***34**, W. Gloucs.: Semi-improved grassland cut for hay, south of Bishop's Hill Wood, Wickway, ST733872, J.P. Martin, 2005. *©**37**, Worcs.: Single large clump in set aside, Lower Howsell, Malvern, SO791488, J.J. Day, 2005, conf. S.J. Leach.

‡153/30.1b *TRisetum FLAVESCENS* subsp. *PURPURASCENS* ***37**, Worcs.: Grass verge, Hawcross, SO761302, K. Barnett, 2000, conf. R. Maskew & W.A. Thompson.

‡153/38.5 *PHALARIS PARADOXA* *©**57**, Derbys.: Disturbed ground at entrance to West Park Cemetery, SK487337, R.D. Martin, 2005, det. T.B. Ryves.

153/40.2 *CALAMAGROSTIS CANESCENS* **13**, W. Sussex: Wet woodland, The Moor, Burton Pond, SU974173, N. Sanderson & B. Middleton, 2003, conf. F.L. Abraham. 1st record since 1970.

‡153/46.2 *POLYPOGON VIRIDIS* ©**63**, S.W. Yorks.: Leeds Road, Bradford, SE181350, B.A. Tregale, 2005. 1st record since 1970.

153/47.4 *ALOPECURUS AEQUALIS* *‡**94**, Banffs.: One plant in flower bed in the garden of 19 Bogmoor Road, Bogmoor, NJ356629, I.P. Green, 2004. Accidental introduction from Christie's garden centre, Fochabers (v.c.95) where naturalised.

†153/47.6 *ALOPECURUS MYOSUROIDES* *©**H6**, Co. Waterford: Single plant on road verge next to newly sown lawn, Knockanpower, S214018, P.R. Green, 2005.

†153/50.7 *BROMUS SECALINUS* **85**, Fife: Waste ground near a grain store, Kirkcaldy Harbour, NT286921, G.H. Ballantyne, 2005, **herb. G.H.B.** 1st record since 1919. Imported with grain.

153/51.2 *BROMOPSIS BENEKENII* ***63**, S.W. Yorks.: Loversall Delph, SE591004, D. Bailey, 2002.

‡153/53.1 *CERATOCHLOA CARINATA* *©**63**, S.W. Yorks.: Fartown, Huddersfield, SE1418, M.J. Lucas, 2005.

‡153/59.3 *HORDEUM JUBATUM* ***94**, Banffs.: Growing on the verge of the A96, Newtack, NJ440467, I.P. Green, 2004.

©153/60.1 *TRITICUM AESTIVUM* ***94**, Banffs.: Several plants in landfill site, Nether Dallachy, NJ367642, I.P. Green, 2005.

‡153/67.pat *SPARTINA PATENS* ***13**, W. Sussex: Single patch c. 10m x 1m at top of saltmarsh, S of West Thorney, SU769017, A. Spiers, 2005, det. E.J. Clement. Ø Apparently 1st record for the British Isles.

‡153/ANE.les *ANEMANTHELE LESSONIANA* ***3**, S. Devon: Self-seeding and established, Crediton churchyard, SS8300, L.J. Margetts & L.M. Spalton, 1996, conf. R. Payne & T.B. Ryves. Ø

‡153/FAR.spa *FARGESIA SPATHACEA* ***80**, Roxburghs.: Woodland by burn, Harden House, Borthwick Water, NT447149, R.W.M. Corner, 2005, det. C. Stapleton, **herb. R.W.M.C.** First noted here in 1978. Long established from planting.

©153/PAN.cap *PANICUM CAPILLARE* ***57**, Derbys.: Open disturbed ground, Heeley, E of River Sheaf, SK3484, K. Balkow, 2003. Mostly imported soil associated with building new bridge and other developments

158/7.1 *COLCHICUM AUTUMNALE* *‡**94**, Banffs.: Woodland, Fife Keith Wood, NJ4150, I.P. Green, 2004.

- ‡158/10.sax *TULIPA SAXATILIS* *71, Man: Garden discard, Ballagarey, SC341789, L.S. Garrad, 1998. Ø
- ‡158/12.2 *LILIUM PYRENAICUM* *H12, Co. Wexford: Two flowering plants on verge, Rathphaudin, S83953544, P.R. Green, 2005.
- ‡158/19.1 *SCILLA BIFOLIA* *94, Banffs.: Single patch in flower in grassy area between minor road and R. Avon, west side of river, more or less opposite house, NJ154264, A.G. Amphlett, 2004, det. I.P. Green.
- ‡158/19.3 *SCILLA SIBERICA* *94, Banffs.: Three plants, only two flowering, growing on bank on north side of path, just west of bridge, Buckie, NJ419654, I.P. Green, 2004.
- ‡158/19.5 *SCILLA LILIO-HYACINTHUS* *94, Banffs.: Patch at bottom of road bank, north side, Boat o' Brig, NJ319518, I.P. Green, 2000.
- ‡158/21.1 *HYACINTHUS ORIENTALIS* *94, Banffs.: Growing on heaps of soil by Buckpool tip, NJ409643, I.P. Green, 2005.
- ‡158/22.1 *CHIONODOXA FORBESII* *94, Banffs.: Garden refuse by disused railway line and several small patches on bank below houses, Speyside Way, Aberlour, NJ269432, A.G. Amphlett, 2004.
- ‡158/22.luc *CHIONODOXA LUCILIAE* *94, Banffs.: Growing on two heaps of dumped soil on old airfield, Bogmoor, NJ358631, I.P. Green, 2004. Flowering nicely. First seen 9/4/04.
- ‡158/23.lat *MUSCARI LATIFOLIUM* *‡94, Banffs.: A single plant in woodland, by path, at top of flight of steps, close to minor road from village to train station, at junction on SE side of R. Isla, Drummuir, NJ377441, A.G. Amphlett, 2004, det. I.P. Green. Ø Apparently 1st record for the British Isles.
- ‡158/24.6 *ALLIUM MOLY* *©57, Derbys.: One plant amongst rubbish dumped in old gravel pit in open disturbed ground, Derby, SK362359, A. Mylward, 2004, det. A. Willmot.
- ©158/24.por *ALLIUM PORRUM* *H6, Co. Waterford: Clump on road verge, Boheravaghera, X125980, P.R. Green, 2005.
- ‡158/24.sat *ALLIUM SATIVUM* *©63, S.W. Yorks.: Nailers Rough, Bradford, SE121358, B.A. Tregale, 2005.
- ‡158/27.1a *AGAPANTHUS PRAECOX* subsp. *ORIENTALIS* *©H6, Co. Waterford: Single plant self-sown in crack in pavement, Dunmore East, S689000, P.R. Green, 2005, **herb. P.R. Green**. Parent plant in neighbouring garden.
- [158/31.2 *LEUCOJUM VERNUM* 37, Worcs.: Error in VCCC; sole record, in Amphlett & Rea 1909, is a transcription error. Delete.]
- ‡158/32.1x3 *GALANTHUS NIVALIS* × *G. PLICATUS* *H6, Co. Waterford: Two clumps on road verge, Castlerichard, X00589764, P.R. Green, 2005.
- 158/35.1 *RUSCUS ACULEATUS* ‡94, Banffs.: Large patch in woodland south of cemetery, Bellie Hill, NJ354606, I.P. Green, 2005. 1st record since 1970.
- ‡158/36.1 *ALSTROEMERIA AUREA* *94, Banffs.: Two patches, 2.5 x 1.5m and 3 x 2m, in ungrazed area above sea cliff between minor road and coast, west of Whitehills, NJ650654 & NJ649654, A.G. Amphlett, 2005.
- ‡158/ASH.lut *ASPHODELINE LUTEA* *3, S. Devon: Garden escape, Exmouth, SY0080, A. Newton, 1999. Ø
- [‡158/ERI.den *ERYTHRONIUM DENS-CANIS* 85, Fife: Misidentification. Delete VCCC record.]
- ‡158/ERI.rev *ERYTHRONIUM REVOLUTUM* *85, Fife: Now thousands of plants long naturalised in estate woodland, Wemyss Castle grounds, NT327951, G.H. Ballantyne, 1965. In April 2005 it was learnt (from owner of estate) that the plants were *Erythronium revolutum*, not *E. dens-canis*, as previously thought. See *BSBI Scottish Newsletter* no.28 pages 31 & 32. Ø Apparently 1st record for the British Isles.
- ‡159/2.2 *SISYRINCHIUM MONTANUM* *©57, Derbys.: One clump in disturbed ground on old quarrying/mining site, near Bradwell, SK160801, A. Beck, 2005, det. K. Balkow.
- ‡159/2.5 *SISYRINCHIUM STRIATUM* *©57, Derbys.: Amongst rubbish dumped in old gravel pit in open disturbed ground, Derby, SK362359, A. Mylward, 2004, det. A. Willmot.
- ‡159/5.4 *IRIS VERSICOLOR* *©63, S.W. Yorks.: Upper Common, Broomhead Moor, Sheffield, SK2296, J. Middleton, 2005.
- ‡159/8.1 *CROCUS VERNUS* *94, Banffs.: Single clump on road verge, Drybridge, NJ4362, A.G. Amphlett, 2004.

‡159/8.2 CROCUS TOMMASINIANUS *4, N. Devon: Extensively naturalised near a garden, Middleborough, SS6833, N.F. Stewart, 2003. *94, Banffs.: Verge of A97, Aberchirder, NJ627524, A.G. Amphlett, 2004.

‡159/8.angxfla CROCUS xSTELLARIS (CROCUS ANGUSTIFOLIS x C. FLAVUS) *94, Banffs.: Verge of A97, Aberchirder, NJ627524, A.G. Amphlett, 2004.

‡159/SCH.coc SCHIZOSTYLIS COCCINEA *94, Banffs.: 2 plants on edge of trees, east side of B9104, Bogmoor, NJ356632, I.P. Green, 2005.

‡160/3.1 CORDYLINE AUSTRALIS *H12, Co. Wexford: One tree self-sown in pavement at base of wall in Michael Street, New Ross, S71902737, P.R. Green, 2005.

162/8.1 Goodyera repens ®96, Easternness: On slope above 1st bend on path to Falls, Foyers, NH498204, I.P. & P.R. Green, 2002.

162/10.1 HAMMARBYA PALUDOSA ®96, Easternness: 10 plants in area 2m x 3m in hillside flush, S.E. slopes of Meallfuarmhonaigh, NH461220, C. Geddes, 2005.

162/11.1 CORALLORHIZA TRIFIDA ®85, Kinross: Swampy woodland near edge of loch, Levenmouth Plantation, Loch Leven NNR, NO170005, L. Farrell, 2005. 1st record for hectad since 1920.

162/SER.lin SERAPIAS LINGUA *3, S. Devon: Single flowering plant in a hay meadow near the coast, Kingsbridge area, SX74, L.M. Spalton, 1998. See *BSBI News* 79 page 20. Ø

Obituaries

FRANKLYN HUGH PERRING (1927–2003)

Dr Frank Perring, who died of cancer on 11 October 2003, did as much as any other individual to influence the activities of the B.S.B.I. in the second half of the twentieth century. As a young man his partnership with Max Walters ensured the successful completion of the *Atlas of the British Flora* (1962). This initiated a new era in natural history in the British Isles and much of northern Europe, popularising a method of displaying the results of recording which was to become almost universal at both national and local level. Subsequently he led the Society into a close partnership with the Nature Conservancy and its successor bodies with the recording of rare species for the first British *Red Data Book* (Perring & Farrell 1977, 1983), before playing a key role in developing the modern Wildlife Trust movement.

EARLY YEARS

Franklyn was born at Forest Gate, East London, on 1 August 1927, the son of Frank Arthur (an antiques dealer) and Avelyn Millicent Perring. His early years were spent at Woodford Green at the edge of Epping Forest and at a weekend cottage on the Blackwater estuary. Here, encouraged by his Uncle Stanley, a biology teacher, he became interested in natural history, climbing ancient trees, catching crabs, roach and perch and collecting wild flowers and frogspawn. He received a further stimulus from C. J. Sims, his biology master at Earls Colne Grammar School. After National Service in the army in Northern Ireland, India and Malaya he read Natural Sciences at Queens' College, Cambridge, obtaining his B.A. degree in 1951 with a 2i in Botany. He went to University thinking that he wanted to be a plant pathologist, but "six weeks in the long vacation in a Pathology Laboratory cured me of that".

In 1949 Frank and his first-year undergraduate friend Richard West decided that they would like to find somewhere in Britain to carry out a botanical survey in the summer vacation where nobody had ever done

one. Their enquiries in the Outer Hebrides led to a letter from Peter Morrison of Heisgeir (the Monach Isles) which ended "Come on, boys!" Thus encouraged, they hitch-hiked in a lorry to Glasgow and after two whole days arrived at Paible, from which they reached Heisgeir in a lobster-boat. They used the deserted schoolhouse on Ceann Ear, built in the 1880s, as a base for their studies, returning the following year to complete the work, when they were joined by Michael Locke, a like-minded zoology student. Recognising the potential of the building as a base for fieldwork, in 1953 they wrote to Inverness County Council offering to buy it; they received a favourable reply and gave £50 for it, but "got a bit of a shock when £25 was added for legal fees". In 1966 the Monach Isles were declared a National Nature Reserve under agreements with North Uist Estate, the Commissioners for Northern Lighthouses and the three owners of the schoolhouse; subsequently their European importance has been recognised. Frank and Richard returned to Heisgeir in 1970 with Roland Randall, a visit that led to a *Flora of the islands* (Perring & Randall 1972). In 1996 Scottish Natural Heritage took a lease on the schoolhouse and in 2004 a rescue plan was launched, leading to several successful work-weeks. When a charitable Trust for Heisgeir was formed in 2004, together with the Friends of the Schoolhouse (Cairdean an Taigh-Sgoile), the owners gifted the schoolhouse to it.

Frank stayed in Cambridge to obtain a PhD under the supervision of Dr R. E. Hughes at the Department of Agriculture for his thesis *Studies in some chalk grassland plant communities with particular reference to climatic and edaphic gradients* (1956a). This led to three papers in the *Journal of Ecology* (Perring 1958a, 1959, 1960a). When Jon Bennie (2003) repeated Frank's observations 50 years later he commented that his "detailed, legible notes put my rain-smudged notebooks to shame". During his undergraduate and postgraduate years Frank's sense of humour was displayed by the practical jokes he played on the staff, and his editorship of the occasional publication *Tea Phytologist*.



FIGURE 1. Frank Perring at work in the Cambridge office of the B.S.B.I. Maps Scheme. Note the pile of 'bus tickets' on the desk in front of him and the row of county floras behind.

ATLAS OF THE BRITISH FLORA

In 1953 Max Walters asked Frank to become 'Senior Worker' for the B.S.B.I. Distribution Maps Scheme¹, a post he accepted and took up in October 1954. It appears from Frank's account (Perring 1992) that Max "popped the question" on a botanical excursion to Odsey; there is no suggestion that the job was advertised or that other applications were considered. However unorthodox these recruitment procedures may appear to a later generation, this was a job ideally suited to Frank's talents and the one in which he was to make his name. With boundless energy, much charm and a character which was completely impervious to discouragement, Frank set about mobilising the membership of the B.S.B.I., and the wider public, to record the plants of some 3,500 10-km grid squares in Britain and Ireland. The Society, described by Max Walters (1954) at the start of the scheme as "flourishing and expanding", was in a good position to take on the project, but it involved a considerable departure from its traditional practices. Senior figures, long set in their ways and with little experience of co-operative research, had to be persuaded to adopt the new taxonomy of 'CTW' (first published in 1952), trained to read Ordnance Survey grid references and encouraged to use the unfamiliar field cards (hitherto used in only a few county flora schemes). Frank's first lecture on the scheme, he once related, was in North-East England, to an audience which included the formidable

Professor J. W. Heslop Harrison. Frank succeeded in recruiting even him to the cause, and Heslop Harrison was to contribute master cards to the scheme for the Hebridean islands, restricting his objections to occasional taunts in the pages of the *Vasculum*. B.S.B.I. field meetings were arranged to visit areas where resident botanists were absent, and a generation familiar with National Service soon came to refer to the new recording methods as 'square-bashing'. New recruits were sought from the wider public: a single article in *The Observer* by John Gilmour brought over 800 replies. In the Republic of Ireland, where manpower was particularly short, David Webb (sometimes accompanied by Frank) played a crucial role in field recording and data extraction. In addition to field work, the other aspect of data-gathering was the collection of records of rarer species from herbarium specimens and literature sources. In this too Frank played a major role, extracting many thousands of records onto 40-column 'individual record cards', colloquially known as 'bus tickets' (Fig. 1).

The extent to which the scheme drew on all available recorders is illustrated by the concessions made to less expert recorders. A special card was prepared for those unwilling to relinquish the taxonomy of Bentham & Hooker: those species which were too broadly defined to be meaningful in the 1950s were listed but lacked code numbers by the name, so that they would not be entered onto punched cards. Another card, specially designed for use by school children, listed the scientific and English names of 113 common and supposedly unmistakable species.

A key part of the project was the use of mechanised data-handling methods. Field card records were transferred to 'master cards' and then each one punched individually onto the 40-column cards, with holes denoting species code number, vice-county, grid reference and date. The cards (together with the individual record cards) could then be sorted into species and grid square order. They were then fed through a tabulator for mechanical mapping by a specially modified (and, at the time, unique) machine (Fig. 2). As so often happens, the time taken to process the records was underestimated, not least because the success of the scheme had brought in more data than expected. The initial plan to complete data collection in 1959 and publish in 1960 proved impossible and, "to the consternation of the Nature Conservancy", who, with the Nuffield

¹ Walters (1954), Walters & Perring (1956), Perring & Walters (1962), Perring & Sell (1968), Allen (1986), Harding & Sheail (1992) and Perring (1992) describe the scheme from various perspectives.



FIGURE 2. Frank Perring demonstrating the tabulator modified to print the maps for the *Atlas of the British Flora*.

Foundation, had financed the scheme, two extensions of the original deadline were required (Harding & Sheail 1992). The project was successfully brought to completion with the publication of the *Atlas of the British Flora* in 1962. Publication was celebrated at a special dinner in Chelsea on 28 April. It was on this occasion that Frank produced what was perhaps his most celebrated pun when, in paying tribute to Max Walters, he referred to "the most important factor in the Scheme – the 'Max' Factor". In his speech Lord Hurcombe said that "although the Nature Conservancy had spent £25,000 financing the work they felt they now had good value for money". He drew attention to the potential use of the *Atlas* in preventing the loss of treasured national resources, an early appreciation of its potential use in conservation work. Max Nicholson commented that "ornithologists ... had been put to shame by the botanists, and other Societies would soon have to follow the lead given by the B.S.B.I." (Bowen 1962). These were perceptive words, and the *Atlas* proved to be one of the most influential natural history books published in the 20th century.

OTHER WORK AT CAMBRIDGE 1954–1964

While taking part in the more general work of the Botany Department, Frank became interested in *Arctium*. With Peter Sell, he grew a large range of *Arctium* plants in an experiment which covered half an acre of experimental plots in the University Botanic Garden (Sell 2004). This led to an early piece of 'network research' in which B.S.B.I. members were invited to measure plants in the field (Perring 1960b), to Frank's account of *Arctium* in *Flora Europaea* (1976a), his one formal contribution to that major collaborative project, and eventually to the taxonomic conclusions summarised in the recent volume of Sell & Murrell's (2006) *Flora*.

In tandem with work for the *Atlas*, during the 1950s Frank gave special attention to botanical records for Cambridgeshire (v.c. 29). Max Walters was B.S.B.I. vice-county recorder from 1949 to 1961, then handed over to Frank, who served until 1971. They worked on the vice-county records with Peter Sell, publishing lists in the B.S.B.I.'s *Proceedings* and in *Nature in*

Cambridgeshire (e.g. Perring, Sell & Walters 1955, Perring 1956b, 1958b, Perring & Sell 1959) and planning for a new county flora in 1960 to commemorate the tercentenary of John Ray's *Catalogus* (the very first County Flora) and the centenary of C. C. Babington's *Flora of Cambridgeshire*. This was to be based on the Cambridge Natural History Society's card index and site lists, from which and from records submitted for the *Atlas* Frank compiled a master list. In the event *A Flora of Cambridgeshire* appeared in 1964, with a section on Bryophyta by Harold Whitehouse, and was the first County Flora for vascular plants to use O.S. 10-km grid squares (though not as yet dot maps) to indicate plant distributions.

CHARACTER AND INTERESTS

Frank was irrepressibly exuberant, with an infectious enthusiasm and a seemingly inexhaustible fund of ideas (as well as puns, some brilliant, some execrable). He made no real distinction between botany as his profession and as a spare-time passion, whether in fieldwork or when lecturing, teaching and writing. "One of Frank's great assets was his combination of a businesslike and at the same time cheerful manner. Bustle, in the best possible sense of the use of the word, I would always associate with him, and he never allowed rules and regulations to get in his way" (Sell 2004). He would indeed head straight towards his goal, oblivious of the fact that he was cutting across official pathways. When faced with an opposing argument he was never at a loss for a highly plausible response. He was not so much intolerant of opposition as incredulous that it could exist; criticism rolled off him, and he never bore a grudge. Nevertheless, those with more conventional minds could sometimes find him an exasperating colleague, and not all of them shared his forgiving nature. He was at his best with volunteers, whereas his methods could put considerable strain on those who worked under him. Few failed as spectacularly to cope with him as the Monks Wood secretary who, on her first day at work, left in tears at lunchtime, never to be seen again.

In an unpublished 'Biographical Sketch' written in 1965, Frank summed up his non-botanical interests:

"Rarely if ever relax – read perhaps two novels a year – at Christmas and during the summer holiday – nearly always spent abroad ... Favourite reading Jane Austen and

Dickens: take one of the latter on each long journey: I remember reading *Pickwick* in the *Pickwick Hotel*, San Francisco. Very fond of music, especially Mozart and Britten. Britten's *Spring Symphony* and Elgar's *Introduction and Allegro* and *Violin Concerto* spell out for me the Englishness of England which I want to see preserved."

To these could be added some equally English but less highbrow interests, including West Ham football club, rugby, horseracing (but not betting) and bell-ringing. And England was not his only love: he said earlier in the same *Sketch* that his travelling on field meetings had made him "a strong 'Britainophil', particularly fond of Ireland which I try to visit at least once a year – just to enjoy the slower pace and the brighter talk".

HEAD OF THE BIOLOGICAL RECORDS CENTRE

1964–1978

Originally, it was planned that, at the completion of the *Atlas* project, the Nature Conservancy would take over the machinery and record cards "as the basis of a permanent recording system" (Walters 1954). In 1963, the Nature Conservancy agreed to transfer Frank and his staff to the recently opened Monks Wood Experimental Station near Huntingdon. (Frank had become Director of the Distribution Maps Scheme in 1959 when Max Walters resigned after the first five years of the project.) Throughout his period at Monks Wood Frank served on the B.S.B.I. Maps Committee, which was renamed Records Committee in 1966, and he was Secretary of the Records Committee from 1967 to 1981. These twin positions gave him a dominating influence on the recording activities of the Society.

As Head of B.R.C., Frank's job was to continue the work on vascular plants initiated by the *Atlas* project and to set up similar schemes for other groups of organisms. The *Critical Supplement to the Atlas of the British Flora* (Perring & Sell 1968) dealt with several major critical genera, and included complete treatments of *Alchemilla*, *Euphrasia*, *Hieracium* and *Sorbus* and numerous other critical species, hybrids and infraspecific taxa. In the *Critical Supplement* the maps are accompanied by explanatory text, and the volume remains a valuable work of reference. It was another product of Frank's productive partnership with Peter Sell, and the accounts of *Hieracium* and *Pilosella*, contributed by Sell and West, occupied over a third of the book.

Frank had intended to round off the *Atlas* work with a book on the phytogeography of the British flora, and (with Max Walters) he had actually signed a contract to write one. However, even before the publication of the *Critical Supplement* his primary interests had switched to plant conservation, which was henceforth to be his major botanical pre-occupation. The maps in the *Atlas* had provided a very dramatic visual representation of the rarity of some species and the decline of others. Frank decided to focus B.R.C.'s botanical work on gathering more precise data on the distribution of the rarest species, and Miss M. N. Hamilton was recruited as a new member of staff to carry out this work. In 1968–69 lists of the known localities of species believed to be confined to 1–8 and 9–15 10-km squares were circulated to B.S.B.I. vice-county recorders, Nature Conservancy staff and others, with a request for updated information on each population. Additional impetus was given to the work by the Wild Plants Protection Bill, a Private Member's Bill introduced in 1968 by the Conservative MP Peter Mills which failed to pass into law but nevertheless highlighted the need for information on the rarest species. The work was widely publicised (e.g. Perring 1971a, Perring & Walters 1971) and eventually led to the pioneer *British Red Data Books: 1 Vascular Plants* (1977), compiled by Frank and Lynne Farrell, Noelle Hamilton's successor at B.R.C.

Frank's other initiatives at B.R.C. included 'network research' projects. The most successful of these was the Winter Mistletoe Count, a survey conducted in the winters of 1969/70 to 1972/73 to map the distribution of *Viscum album* at tetrad scale (Perring 1973). By 1975 four Network projects were underway, recording arable weeds, black poplars (*Populus nigra*), *Symphytum* taxa and holly (*Ilex aquifolium*) (see *Watsonia* 10: 294–299, 1975). The investigations of the taxonomy and distribution of *Symphytum* arose from the confusion of *S. officinale* and *S. xuplandicum* in the *Atlas* survey (Perring 1969a, 1970a, 1975). Frank took a particular interest in the genus, eventually writing, jointly with Professor Theo Gadella, the account in *The European Garden Flora* (Gadella & Perring 2000).

The early 1970s were a productive period in Frank's career. He edited *The Flora of a changing Britain* (Perring 1970c) and *The British Oak* (Morris & Perring 1974) with an entomological colleague at Monks Wood. This book was based on papers given at a highly

successful B.S.B.I. conference held at the University of Sussex in 1973 and achieved a wide circulation. It was often cited as a recommended text for University courses, not only in Britain but even as far afield as Iceland (where there are no oaks). His contribution (1974) to *The changing flora and fauna of Britain* symposium made effective use of distribution maps to illustrate "changes influenced by man" and "changes not influenced by man", as did several other papers in the same volume. Also published in 1974 was *English names of wild flowers* (Dony, Perring & Rob 1974) which provided standard English names by using hyphenation to generate a series of English 'genera' and 'species'. A standard list was required as 'CTW' did not provide English names for all species, but the subject proved to be remarkably emotive and the treatment developed for this slim volume continues to excite controversy.

Frank played a key part in launching *Atlas Florae Europaeae*. In this project the taxonomic work of *Flora Europaea* (1964–1980), edited by a team of British botanists including Max Walters, was united to the methods developed by Frank and Max for the *Atlas*, with the additional inspiration of Hultén's earlier *Atlas över Växternas utbredning i Norden* (Perring 1967a). As the first volume of *Atlas Florae Europaeae* stated, "a map presented by Dr. Perring at the Tenth International Botanical Congress in Edinburgh, 1964, which showed the 50-km square distribution of *Silene acaulis* in Europe, can be regarded as the starting-point of the present work" (Jalas & Suominen 1972). Frank acted as secretary to the nascent committee, visiting a number of European countries in 1965 and producing a further nine maps at Monks Wood before responsibility for the Secretariat was handed over to Helsinki in December 1965. During his period at B.R.C. he was the British regional collaborator on the Committee for the Mapping of the Flora of Europe, and he remained an active Advisor to the Committee until his death.

In addition to the formal recording initiatives he launched at Monks Wood, Frank gave generously of his time to inexperienced botanists, both young and old. The revival of the county flora tradition in the 1960s owed much not only to the recording methods pioneered by the *Atlas* team but also to the personal encouragement he offered to prospective authors. During 1961 and 1962 he was Secretary of a B.S.B.I. *ad hoc* committee set up, after a conference on Local Floras, to

draw up guidance for Flora writers; the results, including a list of recent and forthcoming Floras, were published in *Proceedings* in 1964 and revised in 1971 (Perring 1964, 1971b). In the preface to his *Flora of Flintshire*, Goronwy Wynne (1993) has recounted what happened when he visited Monks Wood to ask for Frank's advice on what he should do as vice-county recorder. "He suggested in no uncertain terms that it was high time that Flintshire had a county Flora of its own, and that I, as Recorder, should take it on. I left that meeting with a mixture of euphoria and sheer terror ...". Frank also ran many field courses, both for the Field Studies Council (especially at Preston Montford) and the Shropshire Adult College at Attingham Park in Shropshire, one of the counties he 'adopted'. Four of the latter courses, held between 1969 and 1972, led to the production of a duplicated *Flora of Attingham* in 1975. (Sarah Whild and Alex Lockton have recently published a new *Flora* based on a comparison of the current flora with that documented by Frank's teams.) Ten years later *Ecological Flora of the Shropshire Region* was published (Sinker *et al.* 1985). Frank was author of only one chapter, on biogeographical elements, but his influence in the preparation and recording for the project was much greater than this might suggest.

As Head of B.R.C., Frank worked tirelessly to promote biological recording on numerous journeys abroad and in international and national journals (e.g. Perring 1967b, 1969b, 1970b, 1971c, 1972, 1976b, c, Soper & Perring 1967, Heath & Perring 1975) as well as in many local publications. He presided over the computerisation of the database in 1970–71, when record cards were transported to London in batches of 300,000 to be transferred to magnetic tape. Thereafter he promoted the role of the Centre as a computer database and proved adept at publicising its activities. On one occasion in 1972, after an appeal for recorders on the television programme *Tomorrow's World*, B.R.C. was submerged under an avalanche of mail which it took his staff several weeks to process. The role of B.R.C. in zoological recording expanded after 1967, when John Heath was appointed to the staff. Frank was in the forefront of the campaign to establish Local Records Centres (Perring 1976d), although for many years their development was hampered by uncertain funding.

Although Frank's years at B.R.C. were marked by many successes, he was

increasingly hampered by his inability to work with his managers. B.R.C. was run as a self-contained unit which was not well integrated with other sections at Monks Wood. Even in the Nature Conservancy days B.R.C.'s frog emblem (it would now be described as a logo) had come to symbolise Frank's independence of view, and at one meeting Martin Holdgate, then a Deputy Director, commented that, as far as he was concerned, "the frog could jump into the lake". Matters became worse after 1973 when the Nature Conservancy was split to form two organisations, the Nature Conservancy Council and the Institute of Terrestrial Ecology. Frank lobbied as hard as he could to get B.R.C. placed in N.C.C., even inspiring the Earl of Cranbrook to enter a plea for this option in a House of Lords debate (12 April 1973). However, there were influential figures in N.C.C. who were determined not to have him in their organisation, and B.R.C. remained at Monks Wood under the new I.T.E. 'The split' traumatised Monks Wood, and Frank, in particular, was unable to get on with the rather rigid I.T.E. management. One occasion when the Director, John Jeffers, feigned sleep while Frank addressed a party of visiting dignitaries encapsulated the situation and became incorporated into Monks Wood's oral history.

It is also true that Frank was a much better tactician than he was strategist. Current initiatives brought out the best in him, but the long-term planning needed to run a database was often neglected in favour of the short-term fix. In his later years B.R.C.'s technological capacity actually decreased, as the *Atlas* methods became obsolete but I.T.E. failed to invest in adequate replacements. By the late 1970s, for example, mechanical mapping was no longer possible and maps were hand-plotted by members of B.R.C. staff. To some extent the true situation was concealed from the outside world by Frank's presentational skills, although his tendency to over-commit B.R.C. was a further cause of problems, especially as he could not rely on management support in meeting his promises. Frank was never interested in organisational niceties and made no distinction between the activities he undertook for I.T.E. and those which he undertook for B.S.B.I. I.T.E. management increasingly tended to regard him as a B.S.B.I. employee whom they had the misfortune to pay. When he left B.R.C. at the end of 1978 it needed all Dick David's negotiating skills as B.S.B.I. President to ensure that a replacement botanist was appointed to the staff.

BOTANICAL SECRETARY OF THE LINNEAN SOCIETY
1973–1978

Frank was an active Fellow of the Linnean Society of London for 39 years. As Botanical Secretary from 1973 to 1978, he helped to organise a number of successful conferences at Burlington House, including one on bracken, the proceedings of which he edited with Brian Gardiner, the Zoological Secretary, for publication in 1976 (Perring & Gardiner 1976). Professor Irene Manton was then President of the Linnean Society – its first woman President and a forceful character – and she and Frank made a good team. In January 1978 the Society celebrated the bicentenary of Linnaeus' death and Frank also participated in its visit to Sweden at the end of June that year. In April 2002 he organised a well-attended joint Linnean Society/B.S.B.I. meeting entitled *Where do we find and train the next generation of field botanists?*

WORKING AS A VOLUNTEER WITH THE
NATURALISTS' TRUSTS

Frank's involvement with the (then) Naturalists' Trusts began in 1956, when the Cambridgeshire and Isle of Ely Naturalists' Trust (CAMBIENT) was set up. He served on its Council continuously until a revision of the constitution brought about his retirement after a quarter of a century in 1982. He was Secretary of the Technical Committee from 1957 till the end of 1967, a post which gave him useful knowledge of the operation of nature conservation legislation (particularly the S.S.S.I. system) and experience in assessing the value and management requirements of specific sites. He became Secretary of a reformed Field Committee in 1964, a post he held till 1968, when he continued as a committee member. Initially this committee co-ordinated the efforts of 18 voluntary 'regional officers' and 25 'watchdogs' appointed to look out for developments likely to harm sites, and later it took on responsibility also for work parties and field excursions and began the formation of local groups; it thus combined interests which were dear to Frank throughout his life – the harnessing of volunteer labour (for both conservation and recording), and public education. In his 1965 'Sketch' he said, "I spend most of my time in the winter in practical conservation – leading parties bush clearing, or tree felling in the areas owned or administered by the Trust." From 1968 till 1970 he was Chairman of the Executive Committee.

Frank moved to Oundle in 1971 and the focus of his activities moved away from Cambridgeshire. He was already interested in the botany of Northamptonshire, having produced a paper for the B.S.B.I.'s *Proceedings* in 1955 on the plants of the county mentioned in John Clare's poetry and prose works (Perring 1955). By 1976 he was active in fundraising for the Northamptonshire Trust, organising Medieval Fairs at Southwick in 1977 and 1979 and at Ashton in 1981, to help purchase reserves such as Short Wood, Glaphthorn Cow Pastures and Titchmarsh Heronry. He served on the Trust's Council and Executive Committee and as its Chairman from 1985 to 1987. He was joint editor of *The Nature of Northamptonshire* (Colston & Perring 1989). In 1987 Frank formed the Peterborough Wildlife Group, becoming its first Chairman. The Northamptonshire Wildlife Trust celebrated its 30th birthday in 1993; in the same year it, the Cambridgeshire Trust, the Beds & Hunts Trust and the P.W.G. united as a single Wildlife Trust and Frank joined the Editorial Board of its new publication, *Wildlife Action*.

GENERAL SECRETARY OF THE ROYAL SOCIETY FOR
NATURE CONSERVATION
1979–1987

In 1979, at the age of 51, Frank left Monks Wood to become General Secretary of the Society for the Promotion of Nature Conservation, the umbrella body for 41 autonomous Naturalists' and Nature Conservation Trusts, which changed its name to Royal Society for Nature Conservation in 1981. Believing passionately in the importance of the Trusts and their work at the local level, he also recognised that the cause of nature conservation had to be promoted more widely and that the Trusts would benefit from more co-ordination and more financial resources. In 1981, against all odds, Frank was able to launch a new national magazine, *Natural World*, available to all Trust members. He campaigned to standardise the names of the Trusts, suggesting that "Naturalists' Trust" conjured up a 'fuddy-duddy' picture in many people's minds and even (rather implausibly) that there was a danger of confusion with naturalists; he argued forcibly that one name – "Wildlife Trust" – would present the Trusts as a united movement. There was considerable opposition at the time, and not all the Naturalists' Trusts had changed their names by

the time Frank retired, but in the end even the first-established Naturalists' Trust acceded and changed its name to "Norfolk Wildlife Trust" and R.S.N.C. itself has adopted the title "Royal Society of Wildlife Trusts". In October 1985 the Society launched its British Wildlife Appeal under the patronage of the Prince of Wales and the chairmanship of Sir David Attenborough, raising £15 million for the Trusts by the end of 1990. That the concept of a national appeal was accepted by the Trusts as the way forward reflects considerable credit on Frank's powers of argument and persuasion and it undoubtedly enhanced their standing. Frank enthusiastically embraced the burgeoning Urban Wildlife Group movement, successfully bringing it into the R.S.N.C. 'family' and seeing it as an opportunity to engage with a new and often younger audience. During his eight and a half years at R.S.N.C. the number of constituent Trusts rose to 48, Watch Club (created in 1975 for young people) grew rapidly, some 500 nature reserves were established (to reach a total of 1,680), over 30 Urban Wildlife Groups were founded, and the Trusts' membership rose from 129,000 to 180,000.

As in I.T.E., Frank's time at R.S.N.C. was not all plain sailing: he got on well with David Attenborough (Fig. 3), but his relations with Walter Lane, R.S.N.C.'s Executive Chairman, were stormy. Nevertheless, his energy, entrepreneurial flair and cheerful optimism usually triumphed and were widely appreciated by his colleagues. He was appointed O.B.E. in 1988 for services to nature conservation and claimed, characteristically, that it must stand for "Obsessive Enthusiasm".

AN ACTIVE RETIREMENT 1987–2003

Frank retired from R.S.N.C. on 31 July 1987 but continued to work tirelessly. An early project was to write, with Max Walters, *The Macmillan Field Guide to British Wildflowers* (1989), a guide illustrated by Andrew Gagg's photographs. Frank was primarily responsible for the "apt, pithy and sometimes amusing descriptions [which] are, in fact, the greatest merit of the book" (Oswald 1990), e.g. the "rugby-ball-shaped pods" of scurvygrasses and common whitlow-grass and the "wide-awake looking" flowers of common dog-violet. A less well-known publication was the text he wrote



FIGURE 3. Frank Perring with Sir David Attenborough at the President's Reception, Royal Society for Nature Conservation, November 1993. Photograph: R.S.N.C.

(anonymously) for a wild flower poster distributed in *Woman* magazine (14 May 1988); the same issue features "the hottest film heart-throb in Hollywood".

In 1988 Frank set up, with Anne Cryer, and chaired Wildlife Travel, a company offering expert-led overseas holidays in search of flowers and other wildlife and donating its profits to the Wildlife Trusts (more than £100,000 over 17 years). Frank himself led or co-led some 50 of the trips, first to the Mediterranean but later to more distant places including Australia, Nepal, St Petersburg and the Arctic, China and South Africa. Many of the company's clientele became 'regulars' and the annual get-togethers were gatherings of friends rather than customers.

Frank was elected President of the B.S.B.I. at the 1993 A.G.M. at Lincoln, giving his Presidential Address, 'Druce in Northamptonshire', the following year (Perring 1995). He was elected an Honorary Member in 1997. The rather belated Presidency perhaps reflected the reluctance of the Society to give such an unpredictable person a position of at least nominal authority, and the Honorary Membership was certainly long overdue. But as far as one could tell Frank took no offence and continued his cheerful service to the Society in several capacities. He remained a familiar figure at the Society's main meetings, and in particular at the Society's Annual Exhibition Meeting (which he attended for 49 successive years) and the Scottish Exhibition Meeting. When the Society put the sale of its publications in the hands of F. & M. Perring as 'BSBI Books', most members assumed that Frank was in partnership with his wife Margaret; in fact 'F.' was Margaret's father-in-

law Frank, and she fiercely defended her independence in this venture, even after the death of Frank senior in 1982, saying that it was one thing which she was *not* going to allow her husband to take over! However, he was usually to be seen helping on the stall at these B.S.B.I. meetings.

From the time of his PhD study Frank had a special interest in the flora of France. In retirement he took a lead in the B.S.B.I.'s relations with French and other European botanists, taking part in several joint events, culminating in the symposium *Botanical Links in the Atlantic Arc* held in Camborne, Cornwall, in May 2003; this was principally concerned with studies of plant species and species-assemblages occurring on or close to the Atlantic-facing coasts of Europe and was attended by over a hundred delegates from Ireland, Scotland, Wales, England, France and Sweden. The resulting book (Leach *et al.* 2006) is dedicated to Frank's memory; though in failing health, Frank enjoyed the occasion, and he would have enjoyed also the pun in the preface (if indeed he did not originate it): "For a large number of species the Atlantic Arc is clearly an important refuge – not just an 'arc', but also an Atlantic *Ark*."

Over his last ten years Frank led a B.S.B.I. initiative, in collaboration with the Field Studies Council and the University of Birmingham, to help people get to grips with species identification and biological recording. He set up a working group within the B.S.B.I. (a characteristic move, allowing him to bypass the Society's committee structure!) to consider training and education and brought together an impressive array of botanical educators from around the country. Frank's vision was to launch a suite of training courses, backed up by academic accreditation, to provide a rigorous but enjoyable introduction to botanical fieldwork within the context of biological recording. The B.S.B.I. identified a special need among those working in nature conservation, so the main university certificate has been particularly designed for professionals in Wildlife Trusts, consultancies and Government Agencies and those seeking such employment, though keen amateur naturalists are not excluded. Many hundreds of students have now passed through the programme and it is recognised by employers as a course which will give practical and reliable identification skills.

Frank believed passionately in 'catching them young' (see Perring 1969c) and, with

handsome financial donations from the late Allan Hamerschlag, with whom he and Margaret became friends on a Wildlife Travel holiday in Australia, he worked with the F.S.C. to organise 'Spotlight on Plants' courses for sixth-formers at Field Centres. He also collaborated with John Hewitson of Oundle School and 'Science and Plants for Schools' and others to produce *A Key for Identifying British Trees and Shrubs* on the internet (www.saps.plantsci.cam.ac.uk/trees/). This friendship produced spectacular results for the B.S.B.I. after Frank's death, as in 2005 Allan Hamerschlag left the Society its largest ever legacy.

At Frank's funeral, on 24 October 2003, a very large congregation bade him farewell in St Rumbold's Church, Stoke Doyle, Northamptonshire, in a way he would have fully appreciated. Frank had been Secretary to the Stoke Doyle Parochial Church Council, and he was instrumental in changing the management of the churchyard so that it became a flowery meadow. At his remarkable memorial service Max Walters spoke of their long friendship: the text of his address is published in *BSBI News* 95: 66–67 (2004).

FRANK'S CONTRIBUTION TO BRITISH AND IRISH BOTANY

We hope that this obituary gives some idea of the range of Frank's activities, though we have certainly not covered all those that are known to us, and of course there must be others of which we are unaware. Although the *Atlas of the British Flora* was planned before Frank joined the team, his creativity is apparent from his involvement in the *British Red Data Books: 1 Vascular Plants* and in *Atlas Florae Europaeae*, and in his role in reforming the Wildlife Trusts. He was sufficiently unorthodox to come up with new ideas and press for their implementation, while being just sufficiently orthodox to be able to work with established organisations. A constant theme running through his career was his desire to communicate his love of botany and belief in the necessity of plant conservation outward to new audiences. When harnessed, his energies could produce remarkable results, as the Maps Scheme showed. Subsequently no organisation perhaps succeeded in getting the best out of him, and certainly the tensions within the organisations in which he worked were more apparent. Nevertheless, his achievements were

formidable. With the exception of the nine years at R.S.N.C., the B.S.B.I. was central to his activities from the time he was asked to join the 'Maps Scheme' in 1953 until his death fifty years later. Frank can justly be regarded as one of the B.S.B.I.'s pivotal figures in the post-war period, one of those who did most to change it from the Society left by G. C. Druce when he died in 1932 to that which it had become at the end of the millennium.

ACKNOWLEDGMENTS

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REFERENCES

- ALLEN, D. E. (1986). *The botanists*. St Paul's Bibliographies, Winchester.
- BENNIE, J. J. (2003). *The ecological effects of slope and aspect in chalk grassland*. PhD thesis, University of Durham.
- BOWEN, H. J. M. (1962). Dinner to celebrate the publication of the "Atlas of the British Flora". *Proceedings of the Botanical Society of the British Isles* **4**: 490.
- COLSTON, A. & PERRING, F. [H.] (1989). *The Nature of Northamptonshire*. Barracuda Books, Buckingham.
- DONY, J. G., PERRING, F. [H.] & ROB, C. M. (1974). *English names of wild flowers*. Butterworths, London.
- GADELLA, T. W. J. & PERRING, F. H. (2000). *Symphytum* Linnaeus, in CULLEN, J. *et al.*, eds *The European Garden Flora Volume VI Dicotyledons (Part IV)*, pp. 138–141. Cambridge University Press, Cambridge.
- HARDING, P. T. & SHEAIL, J. (1992). The Biological Records Centre: a pioneer in data gathering and retrieval, in HARDING, P. T., ed. *Biological recording of changes in British wildlife*, pp. 5–19. I.T.E. symposium no. 26. HMSO, London.
- HEATH, J. & PERRING, F. [H.] (1975). Biological recording in Europe. *Endeavour* **34**: 103–108.
- JALAS, J. & SUOMINEN, J. (1972). *Atlas Florae Europaeae 1 Pteridophyta (Psilotaceae to Azollaceae)*. Committee for Mapping the Flora of Europe and Societas Biologica Fennica Vanamo, Helsinki.
- LEACH, S. J., PAGE, C. N., PEYTOUREAU, Y. & SANFORD, M. N., eds (2006). *Botanical links in the Atlantic Arc*. B.S.B.I. Conference Report no. 24. Botanical Society of the British Isles.
- MORRIS, M. G. & PERRING, F. H., eds (1974). *The British Oak: its history and natural history*. B.S.B.I. Conference Report no. 14. E. W. Classey, Faringdon.
- OSWALD, P. [H.] (1990). Review: *The Macmillan Field Guide to British Wildflowers*. *Nature in Cambridgeshire* No. 32: 73–76.
- PERRING, F. H. (1955). John Clare and Northamptonshire plant records. *Proceedings of the Botanical Society of the British Isles* **1**: 482–489.
- PERRING, F. H. (1956a). *Studies in some chalk grassland plant communities with particular reference to climatic and edaphic gradients*. PhD thesis, University of Cambridge.
- PERRING, F. H. (1956b). An ms. in Wisbech museum. *Proceedings of the Botanical Society of the British Isles* **2**: 133.
- PERRING, F. [H.] (1958a). A theoretical approach to a study of chalk grassland. *Journal of Ecology* **46**: 665–679.
- PERRING, F. H. (1958b). Additions to the vascular flora of Cambridgeshire. *Nature in Cambridgeshire* No. 1: 27–29.
- PERRING, F. [H.] (1959). Topographical gradients of chalk grassland. *Journal of Ecology* **47**: 447–481.
- PERRING, F. [H.] (1960a). Climatic gradients of chalk grassland. *Journal of Ecology* **48**: 415–442.
- PERRING, F. [H.] (1960b). Report on the survey of *Arctium* L. agg. in Britain, 1959. *Proceedings of the Botanical Society of the British Isles* **4**: 33–37.
- PERRING, F. [H.], comp. (1964). A guide for local Flora writers. *Proceedings of the Botanical Society of the British Isles* **5**: 283–302.
- PERRING, F. H. (1967a). Mapping the flora of Europe. *Proceedings of the Botanical Society of the British Isles* **6**: 354–357.
- PERRING, F. H. (1967b). The processing of biological data. *Institute of Biology Journal* **14**: 17–19.
- PERRING, F. [H.] (1969a). *Symphytum* survey. *Proceedings of the Botanical Society of the British Isles* **7**: 553–556.
- PERRING, F. [H.] (1969b). Mapping the flora and fauna of the British Isles. *Country-side* **Spring 1969**: 100–104.
- PERRING, F. [H.] (1969c). The demand for and supply of field biologists. *Journal of Biological Education* **3**: 123–129.
- PERRING, F. H. (1970a). The B.S.B.I. *Symphytum* survey. *Watsonia* **8**: 91.
- PERRING, F. [H.] (1970b). The British biological recording network, in CUTBILL, J. L., ed. *Data Processing in Biology and Geology*, pp. 115–121. Systematics Association Special Volume no. 3. Academic Press, London.

- PERRING, F. H., ed. (1970c) *The Flora of a changing Britain*. B.S.B.I. Conference Report 11. E. W. Classey, Hampton.
- PERRING, F. H. (1971a). Rare plant recording and conservation in Great Britain. *Boissiera* **19**: 73–79.
- PERRING, F. H. (1971b). The vice-county guide. *Watsonia* **8**: 435–447.
- PERRING, F. H. (1971c). The Biological Records Centre – a data centre. *Biological Journal of the Linnean Society* **3**: 237–243.
- PERRING, F. [H.] (1972). The great wildlife plot. *Birds* **4**: 72–76.
- PERRING, F. [H.] (1973). Mistletoe, in GREEN, P.S., ed. *Plants wild and cultivated*, pp. 139–145. E. W. Classey, Hampton.
- PERRING, F. H. (1974). Changes in our native vascular plant flora, in HAWKSWORTH, D. L., ed. *The changing flora and fauna of Britain*, pp. 7–25. Academic Press, London.
- PERRING, F. H. (1975). *Symphytum* L., in STACE, C. A., ed. *Hybridization and the Flora of the British Isles*, pp. 353–355. Academic Press, London.
- PERRING, F. H. (1976a). *Arctium* L., in TUTIN, T. G. *et al.*, eds *Flora Europaea Volume 4 Plantaginaceae to Compositae (and Rubiaceae)*, p. 215. Cambridge University Press, Cambridge.
- PERRING, F. H. (1976b). The future and electronic data processing, in SIMMONS, J. B., BEYER, R. I., BRANDHAM, P. E., LUCAS, G. LL. & PERRY, V. T. H., eds *Conservation of threatened plants*, pp. 113–117. Plenum Press, New York and London.
- PERRING, F. [H.] (1976c). Records for leisure and profit. *New Scientist* **23/30 December 1976**: 725–727.
- PERRING, F. H. (1976d). The value of museums as records centres, in BOYLAN, P. J., ed. *Museums Association Annual Conference Bristol 1976*, pp. 19–21. Museums Association, London.
- PERRING, F. H. (1992). BBSI distribution maps scheme – the first 40 years, in HARDING, P. T., ed. *Biological recording of changes in British wildlife*, pp. 1–4. I.T.E. symposium no. 26. HMSO, London.
- PERRING, F. [H.] (1995). Presidential Address, 1994. Druce in Northamptonshire. *Watsonia* **20**: 185–194.
- PERRING, F. H. & FARRELL, L., comp. (1977). *British Red Data Books: 1. Vascular Plants*. Society for the Promotion of Nature Conservation, Lincoln.
- PERRING, F. H. & FARRELL, L., comp. (1983). *British Red Data Books: 1. Vascular Plants*, 2nd ed. Royal Society for Nature Conservation, Lincoln.
- PERRING, F. H. & GARDINER, B. G., eds (1976). The biology of bracken. *Botanical Journal of the Linnean Society* **73**: 1–302.
- PERRING, F. H. & RANDALL, R. E. (1972). An annotated Flora of the Monach Isles National Nature Reserve, Outer Hebrides. *Transactions of the Botanical Society of Edinburgh* **41**: 431–444.
- PERRING, F. H. & SELL, P. D. (1959). Further notes on the flora of Cambridgeshire. *Proceedings of the Botanical Society of the British Isles* **3**: 165–171.
- PERRING, F. H. & SELL, P. D., eds (1968). *Critical supplement to the Atlas of the British Flora*. Thomas Nelson & Sons, London.
- PERRING, F. H. & WALTERS, S. M., eds (1962). *Atlas of the British Flora*. Thomas Nelson & Sons, London.
- PERRING, F. H. & WALTERS, S. M. (1971). Conserving rare plants in Britain. *Nature* **229**: 375–377.
- PERRING, F. [H.] & WALTERS, [S.] M. (1989). *The Macmillan Field Guide to British Wildflowers*. Macmillan Press, London and Basingstoke.
- PERRING, F. H., SELL, P. D. & WALTERS, S. M. (1955). Notes on the Flora of Cambridgeshire (v.c. 29). *Proceedings of the Botanical Society of the British Isles* **1**: 471–481.
- PERRING, F. H., SELL, P. D., WALTERS, S. M. & WHITEHOUSE, H. L. K. (1964). *A Flora of Cambridgeshire*. Cambridge University Press, Cambridge.
- SELL, P. [D.] (2004). Obituary: Franklyn Hugh Perring (1927–2003). *Nature in Cambridgeshire* No. 46: 95–97.
- SELL, P. [D.] & MURRELL, [J.] G. (2006). *Flora of Great Britain and Ireland. Volume 4. Campanulaceae–Asteraceae*. Cambridge University Press, Cambridge.
- SINKER, C. A., PACKHAM, J. R., TRUEMAN, I. C., OSWALD, P. H., PERRING, F. H. & PRESTWOOD, W. V. (1985). *Ecological Flora of the Shropshire region*. Shropshire Trust for Nature Conservation, Shrewsbury.
- SOPER, J. H. & PERRING, F. H. (1967). Data processing in the herbarium and museum. *Taxon* **16**: 13–19.
- WALTERS, S. M. (1954). The Distribution Maps Scheme. *Proceedings of the Botanical Society of the British Isles* **1**: 121–130.
- WALTERS, S. M. & PERRING, F. H. (1956). B.S.B.I. Distribution Maps Scheme; Survey of 1955 recording, and suggestions for recording in 1956. *Proceedings of the Botanical Society of the British Isles* **2**: 10–17.
- WHILD, S. & LOCKTON, A., eds (2005). *New Flora of Attingham Park*. University of Birmingham & Shropshire Botanical Society, Shrewsbury.
- WYNNE, G. (1993). *Flora of Flintshire*. Gee & Son, Denbigh.

C. D. PRESTON & P. H. OSWALD

JOYCE LAMBERT
1916–2005

Dr. Joyce Lambert, the first to demonstrate that virtually all the c. 50 lakes in Broadland are man-made, died on May 4 2005. Born in 1916 at Herne Hill, the only child of an estate-agent father, Joyce was educated at the Norwich High School for Girls. Afterwards, she studied botany at the University College of Wales, Aberystwyth, graduating in 1939. Three years later, after a spell as a school teacher in Norwich, she was appointed a lecturer in botany at London University's Westfield College, now incorporated in Queen Mary College. Her Aberystwyth training had shown her the value of seeing plants in the field and she encouraged her students to get into the field. She had a good eye for spotting, and could communicate the "jizz" of plants stressing the use of vegetative characters, an aspect she put to use in her later ecological work.

Prompted by suggestions made towards the end of the Second World War by local naturalist, Ted Ellis, and another Norfolk man, A. R. Clapham, then of Oxford University, she commenced an ecological study of the fens bordering the River Yare in the Surlingham-Rockland area. She published her findings in a series of papers from 1946 onwards, and in 1948 moved to Cambridge University where she received encouragement from such luminaries as Harry Godwin and Alfred Steers. While at Cambridge she turned her attention to the fens located in the valley of the Bure, working in partnership with J. N. Jennings, a stratigrapher then based at Leicester University. In 1951 the two of them published in the *Journal of Ecology* three classic papers relating the alluvial stratigraphy of the Bure valley to the types of vegetational succession which occur there. Jennings meantime had been working on the stratigraphy of other parts of the region, and when writing up his results in the form of a memoir for the Royal Geographical Society (published in 1952 under the title 'The Origin of the Broads') had concluded that most of the broads in the region, if not all, had been formed by natural processes. Meantime Joyce had been carrying out further investigations into the ecology and stratigraphy of the Yare valley broads and fens. Using a small peat borer she put down a series of closely-spaced cores around various broads in 1952. These revealed to her amazement that

what had previously been thought to be natural lakes had near-perpendicular walls; moreover their floors, some 3 metres or so below the present fen surface, were almost flat. Clearly, these water bodies had originated as peat diggings whose angular shape had been concealed by the overgrowth of fen vegetation once they had become permanently water-filled.

Joyce had not made this discovery when she gave her Presidential address to the Norfolk & Norwich Naturalists' Society in April 1952, but she was able to incorporate her new findings when this was published in that society's transactions the following year. This startling information, later published in a brief paper in the March 1953 issue of the *Geographical Journal*, caused a sensation. Indeed, her totally unexpected discovery was sceptically received by those understandably puzzled as to how such extensive excavations could have been dug by hand within areas of the flood plain now subject to regular inundation. To answer these and many other questions, a multi-disciplinary team was established which included a historical geographer, archaeologist and a civil engineer. The joint results of their investigations were published in 1960 in *Memoir no. 3* of the Royal Geographical Society - 'The Making of the Broads'. Briefly, the team found documentary evidence that proved that substantial amounts of peat for fuel had been dug between the 12th and 14th centuries in a region which was then one of the most economically successful and populous parts of the country. The team did, however, demonstrate that many of the parishes in the region had 'rights of turbary' to dig peat within their areas, and that in many cases the boundaries of two, three or more neighbouring parishes are aligned in such a way as to indicate that each of them had rights to extract peat from what later became a single broad. They also concluded that those involved in the industry had considered it worthwhile to excavate to a depth of two to three metres to gain access to brushwood peat, the calorific value of which is superior to that of the material obtainable from near the surface, but that virtually all the excavations in the region had been abandoned by the end of the 14th century as a result of their increasing susceptibility to flooding.

Joyce was appointed a lecturer in botany at Southampton University in 1950, but continued to work closely with the other authors of the R.G.S. memoir. Despite this, she carried out a number of ecological studies on the saltmarshes bordering Southampton Water and other sites, being particularly interested in the spread of the invasive grass, *Spartina*. Later, she studied the plant communities of the New Forest, developing in conjunction with Professor Bill Williams a computer-based methodology for their classification.

Joyce's colleagues at Southampton greatly admired her razor-sharp intellect as well as the competence with which she carried out her administrative duties, and she was largely instrumental in setting up a new combined honours degree course in botany and geography.

She was regarded by all who knew her as a very caring person. As a consequence of these attributes, she was greatly respected and liked by her students. She retired in 1979 and returned to Norfolk to live at Brundall. She never married.

Sadly, Joyce became so physically incapacitated that she was obliged to spend the last three years of her life in a nursing home at Colney. Nevertheless, she retained her close interest in Broadland, a region now universally regarded as the best example of a lowland wetland system in Britain. One of its particular features of interest is the relationship between its ecology and its land use history, and Joyce's contribution towards an improved understanding of this will always be remembered.

MARTIN GEORGE & CLIVE JERMY

RICHARD FITTER

1913–2005

Hands up all of those who learned their flowers from the books of Richard Fitter - or R.S.R. Fitter as he usually signed himself. The words Fitter and field guides surely go together like peaches and cream. Nearly half a century separates his last botanical field guide, *Wild Flowers of Britain and Ireland* (2003), written with his son Alastair, now Professor of Biology at the University of York, from his first, the famous *Collins Pocket Guide to Wild Flowers* (1956), written with the late David McClintock. In between he wrote some thirty books, including a round dozen field guides on plants, birds, pond life and the countryside.

Richard Fitter was that now three-star rarity, an all-round naturalist. He knew his birds as well as his flowers, was pretty familiar with insects and other invertebrates, knew London and the Home Counties inside out, and apparently never forgot anything. He once showed me his card-index system, box piled on box, which he used as a reference system. My impression was that he barely needed it. I have a vivid memory of a half-day in the field with him on his home turf near Chinnor in the Chilterns about twenty years ago. He was the only botanist I've known who could clearly identify every chirp and whistle from the bushes while searching for budding *Gentianella ciliata* with his nose glued to the turf. He knew the history of the local Black Poplars, why they grew where they did, and

why they were that shape. He proved incredibly knowledgeable about some piddling plant I was interested in at the time. He seemed, like Linnaeus, a 'compleat naturalist'. Despite that he was a modest man, without airs and graces. He was the opposite of that contemporary horror, the TV celebrity-naturalist, yet he was a perfectly good lecturer and could spin a good story like the best of them.

Merely to list Fitter's major publications would take up a fair space. His first book was *London's Natural History* (1945), one of the first volumes in the famous Collins New Naturalist library. He told me he wrote most of it in the evening after a day at the operational research section of Coastal Command during the war. Instead of simply writing about wildlife localities in the capital he took a novel, thematic approach, examining the influences of trade, smoke, sport and water supply on the city's wild plants and animals, as well as the role of the blitz in creating a temporarily weed-rich city.

Fitter's relations with Collins blossomed after the war with his authorship of a series of pocket guides, effectively the first modern field guides published in Britain and much influenced by the American bird guides of Roger Peterson. *The Pocket Guide to Wild Flowers* was the first pocket-sized flora to include nearly all the British wild flowers (apart from grasses and sedges). To help the

beginner find their way through the jungle of plants Fitter and McClintock took the bold and controversial step of ranking the flowers by their colour. Fitter had already used a similar approach in his *Pocket Guide to British Birds* published four years earlier in which birds were grouped by colour, size and habitat. Rarities were marked by stars and the text pruned to the bare essentials of identification. The weak point of *Wild Flowers* was the illustrations which had to be corralled into plates rather than set next to the text. But despite its limitations *The Pocket Guide* served a whole generation of British botanists. It was one of those books people fall in love with. Later Fitter wrote a companion volume, *Finding Wild Flowers* (1972), a guide based on habitats and counties.

Richard Fitter was born and bred in London. He was a keen naturalist from boyhood and was particularly interested in birds. As he grew up he became a very active member of the London Natural History Society, surveying starling roosts and heronries in and around London, as well as studying two new species that had begun to nest there, the Black Redstart and the Little Ringed Plover. However, encouraged by his father to take up business studies, Fitter enrolled at the London School of Economics and after graduation became a social scientist, working at the Institute for Political and Economic Planning (PEP) and later Mass Observation. His knowledge of the different worlds of planning and of natural history made him an asset on the Wildlife Special Committee, chaired by Julian Huxley after the war, on which Fitter served as secretary. One of his 'jobs' was to visit places the Committee thought worthy of protection to find out what state they were in after six years of war. Even amongst luminaries like James Fisher and Max Nicholson, Fitter's ability to see wild places in the round was valuable. With his death, the last survivor of that august company of conservation pioneers has passed away.

Meanwhile, having married Maisie, his lifelong collaborator and companion, and with two sons and a daughter to feed, he needed more regular work. Fitter became a journalist, helping to edit *The Countryman*, and for a while acted as 'open air correspondent' of *The Observer*. At the same time the Fitters became a kind of family book business. Among their productions were the popular *Penguin Dictionary of Natural History* (1967), which Richard wrote with Maisie, and the later *Collins Guide to the Grasses, Sedges, Rushes*

and *Ferns* (1984) and *Guide to the Countryside* (1984) and *Guide to the Countryside in Winter* (1988), which he did with his son Alastair.

He and Alastair also teamed up with Marjorie Blamey to produce the well-known *Wild Flowers of Britain and Northern Europe* (1974), this time with much better pictures placed opposite to the text. Finally, a generation on in 2003, Richard now aged 91, with Blamey, aged 86, and Alastair produced *Wild Flowers of Britain and Ireland* which thankfully jettisoned the continental plants and reverted in part to Fitter's earlier scheme of grouping plants by resemblance and common habitat. Altogether the three "Fitter Floras" offer an evolving record of botanical illustration and identification that is hard to match anywhere.

When not writing books, Richard Fitter was a very active conservationist. For a long time he and Maisie practically ran the Fauna and Flora Preservation Society (now F.F.I., Fauna and Flora International) in Britain. He was also a member of the I.U.C.N. Species Survival Commission, and did a stint as the Council for Nature's information officer as well as becoming successively secretary and treasurer of the British Trust for Ornithology. He was a founder member of 'BBONT', the Bucks, Berks and Oxon Wildlife Trust and was involved with such bodies as the British Deer Society, the Worldwide Fund for Nature and, latterly, the Galapagos Conservation Trust, where first his son Julian, and now his grandson Daniel, worked as a wildlife guide.

Yet what may prove to be one of the most important acts of his long career was something Richard Fitter did instinctively and without a thought that it would one day form a valuable record: he kept detailed notebook records. Made over fifty years, his first flowering dates of wild flowers provide an unusual continuous run of data revealing the effects of climate warming. He and Alastair wrote an often quoted paper on it for the journal *Science*. And shortly before his death at the age of 92 Richard appeared on BBC2s *Springwatch* programme to talk about it, one of his relatively few television appearances.

Richard Fitter was a member of the B.S.B.I. since 1952 and was later made an honorary member. Particularly later in his life he often came to field meetings and conferences. In 1978 he was admitted to the Order of the Golden Ark for his work on threatened species. He also received the Peter Scott medal from the British Naturalists' Association and the

Christopher Cadbury medal from the R.S.N.C. (now the Wildlife Trusts). Never one to be inactive, he was working on three books, including a flora of France, when he died in September 2005.

The name of Richard Fitter will long be remembered by the generations of B.S.B.I. members who grew up with McClintock and

Fitter, and later turned to Fitter, Fitter and Blamey to sort out problem plants. Few have ever used their natural history skills to better effect, whether to produce books tailored to our needs, to promote good causes or simply to put on public record one's observations and thoughts on wildlife. There are not many left like him.

PETER MARREN



NAMES OF VICE-COUNTIES IN WATSONIA

S (113) Channel Islands

ENGLAND

- | | | |
|---------------------|--------------------------|--------------------------|
| 1. West Cornwall | 21. Middlesex | 54. North Lincolnshire |
| 1b. Scilly | 22. Berkshire | 55. Leicestershire |
| 2. East Cornwall | 23. Oxfordshire | 55b. Rutland |
| 3. South Devon | 24. Buckinghamshire | 56. Nottinghamshire |
| 4. North Devon | 25. East Suffolk | 57. Derbyshire |
| 5. South Somerset | 26. West Suffolk | 58. Cheshire |
| 6. North Somerset | 27. East Norfolk | 59. South Lancashire |
| 7. North Wiltshire | 28. West Norfolk | 60. West Lancashire |
| 8. South Wiltshire | 29. Cambridgeshire | 61. South-east Yorkshire |
| 9. Dorset | 30. Bedfordshire | 62. North-east Yorkshire |
| 10. Isle of Wight | 31. Huntingdonshire | 63. South-west Yorkshire |
| 11. South Hampshire | 32. Northamptonshire | 64. Mid-west Yorkshire |
| 12. North Hampshire | 33. East Gloucestershire | 65. North-west Yorkshire |
| 13. West Sussex | 34. West Gloucestershire | 66. County Durham |
| 14. East Sussex | 36. Herefordshire | 67. South Northumberland |
| 15. East Kent | 37. Worcestershire | 68. North Northumberland |
| 16. West Kent | 38. Warwickshire | 69. Westmorland |
| 17. Surrey | 39. Staffordshire | 69b. Furness |
| 18. South Essex | 40. Shropshire | 70. Cumberland |
| 19. North Essex | 53. South Lincolnshire | 71. Isle of Man |
| 20. Hertfordshire | | |

WALES

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|---------------------|---------------------|------------------|
| 35. Monmouthshire | 45. Pembrokeshire | 50. Denbighshire |
| 41. Glamorgan | 46. Cardiganshire | 51. Flintshire |
| 42. Brecknockshire | 47. Montgomeryshire | 52. Anglesey |
| 43. Radnorshire | 48. Merioneth | |
| 44. Carmarthenshire | 49. Caernarfonshire | |

SCOTLAND

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|-----------------------|-------------------------|----------------------|
| 72. Dumfriesshire | 86. Stirlingshire | 99. Dunbarton |
| 73. Kircudbrightshire | 87. West Perthshire | 100. Clyde Isles |
| 74. Wigtownshire | 88. Mid Perthshire | 101. Kintyre |
| 75. Ayrshire | 89. East Perthshire | 102. South Ebuades |
| 76. Renfrewshire | 90. Angus | 103. Mid Ebuades |
| 77. Lanarkshire | 91. Kincardineshire | 104. North Ebuades |
| 78. Peeblesshire | 92. South Aberdeenshire | 105. Wester Ross |
| 79. Selkirkshire | 93. North Aberdeenshire | 106. Easter Ross |
| 80. Roxburghshire | 94. Banffshire | 107. East Sutherland |
| 81. Berwickshire | 95. Moray | 108. West Sutherland |
| 82. East Lothian | 96. Easternness | 109. Caithness |
| 83. Midlothian | 96b. Nairnshire | 110. Outer Hebrides |
| 84. West Lothian | 97. Westernness | 111. Orkney |
| 85. Fife & Kinross | 98. Main Argyll | 112. Shetland |

IRELAND

- | | | |
|----------------------|------------------------|----------------------|
| H1. South Kerry | H15. South-east Galway | H29. Co. Leitrim |
| H2. North Kerry | H16. West Galway | H30. Co. Cavan |
| H3. West Cork | H17. North-east Galway | H31. Co. Louth |
| H4. Mid Cork | H18. Offaly | H32. Co. Monaghan |
| H5. East Cork | H19. Co. Kildare | H33. Fermanagh |
| H6. Co. Waterford | H20. Co. Wicklow | H34. East Donegal |
| H7. South Tipperary | H21. Co. Dublin | H35. West Donegal |
| H8. Co. Limerick | H22. Meath | H36. Tyrone |
| H9. Co. Clare | H23. Westmeath | H37. Co. Armagh |
| H10. North Tipperary | H24. Co. Longford | H38. Co. Down |
| H11. Co. Kilkenny | H25. Co. Roscommon | H39. Co. Antrim |
| H12. Co. Wexford | H26. East Mayo | H40. Co. Londonderry |
| H13. Co. Carlow | H27. West Mayo | |
| H14. Laois | H28. Co. Sligo | |

NOTES

NOTES

INSTRUCTIONS TO CONTRIBUTORS

Scope: Authors are invited to submit Papers and Notes concerning British and Irish vascular plants, their taxonomy, biosystematics, ecology, distribution and conservation, as well as topics of a more general or historical nature. Authors should consult the Hon. Receiving Editor for advice on suitability or any other matter relating to submission of manuscripts.

Papers and Notes must be submitted *in duplicate*, typewritten on one side of the paper, with wide margins and double-spaced throughout. Pages should be numbered. Submission of final edited copy on computer disc will be requested, but two hard copies of the text are acceptable if computer facilities are not available.

Format should follow that used in recent issues of *Watsonia*. Underline where italics are required. Names of periodicals should be given in full, and herbaria abbreviated as in *British and Irish herbaria* (Kent & Allen 1984). The Latin names and English names of plants should follow the *New Flora of the British Isles* (Stace 1997). Further details on format can be obtained from the Hon. Receiving Editor or by viewing the website at:
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Tables, figure legends & appendices should be typed on separate sheets and attached at the end of the typescript.

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Watsonia

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Editors: M. Briggs, M. J. Y. Foley, D. L. Kelly,
D. R. McKean, M. S. Porter, C. D. Preston, M. N. Sanford



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The cover illustration of *Primula scotica* Hook. (Scottish Primrose) was drawn by Rosemary Wise.

Max Walters Memorial Issue of *Watsonia*

This issue of *Watsonia* is dedicated to the memory of S. M. Walters (1920–2005). It is fitting that B.S.B.I. should commemorate Max's immense contribution to British and European Botany in this way. Max was an inspiration to all the many B.S.B.I. Projects in which he was involved. He will probably be best known to British botanists as co-editor with Frank Perring of the landmark *Atlas of the British Flora*, published in 1962. He belonged to that great generation of phytogeographers that included Max's close friends Frank Perring and David Webb, who quite literally put British Botany on the map. Max's interests were, of course, much wider than distribution mapping and the bibliography (pp. 220–227) gives an idea of the broad range of material that he published over some 60 years. Indeed, his interests were so wide-ranging that it was relatively easy to pull together a set of appropriate papers for this memorial issue. His work ranges from the parochial to the international; from single species studies to overviews of plant taxonomy; from historical to modern day; all of it written in an elegant, self-effacing style which never allows the author's ego to get in the way of the information. It is notable how much of his publishing was as a joint author or collaborator - indeed, in his Presidential Address to the B.S.B.I. in 1974 he spoke of the "real pleasure" he gained from collaborative work. This was a reflection both of his generous nature and of a deeply felt belief in co-operation at both the national and international level.

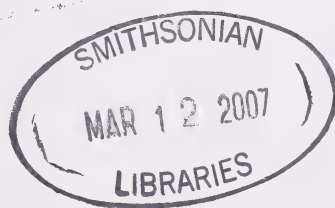
The task of putting this issue together was made easier through the generous assistance of members who either suggested relevant work or made contributions themselves. I am grateful to Chris Preston for his suggestion that we produce this memorial issue and for his contribution on species at the northern or southern edges of their European range in the British Isles - a subject of particular relevance given Max's involvement in *Flora Europaea*. Chris has also been involved in Mark Gurney's studies on Oxlip hybridisation in Cambridgeshire; together with Max's long-standing friend David Briggs, they have shed some light on a subject Max himself had examined in 1968.

Joachim Kadereit, one of Max's PhD students, has kindly contributed a paper on European phylogeography. Peter Sell has put together an excellent obituary and bibliography. Kevin Walker has followed up some of Max's predictions from 1970 published in *The flora of a changing Britain*. David Pearman has explained the thinking behind the categorisation of neophytes in the *New Atlas*; the links with historical botany and garden literature are very relevant to Max's interests.

Several other papers in this issue were already in the pipeline before we had considered dedicating it to Max. Nevertheless, *Teucrium scordium* in Cambridgeshire, the taxonomy of *Eleocharis mamillata* and the history and contents of the Hull Herbarium are all of particular relevance to Max's work.

Max's son, Martin has kindly provided the photograph overleaf, taken by Philip Mynott in June 2000. I am sure Max would be pleased to herald the use of colour in this journal.

MARTIN SANFORD
Receiving Editor, *Watsonia*





Max Walters in the wildflower garden of Great St Andrews Church, Cambridge, in June 2000.

Obituary

STUART MAX WALTERS (1920–2005)

Max Walters was a leading light in the world of plant taxonomy and the conservation of the countryside, and he was renowned for his co-operation with fellow-workers in continental Europe for over fifty years. He had a natural gift for bringing together people from all walks of life for the common cause. I have a vivid memory of him with a group of people so brought together to perform the first coppicing in Hayley Wood for over forty years: most of them had never before used the motley array of saws, axes, slashers, billhooks, sickles and scythes, but the job was done.

Max was born in Oughtibridge near Sheffield on 23 May 1920; his father Bernard was a furnace foreman in a steel rolling mill who had been apprenticed to his own father, and his mother was a teacher. Soon after 1920 they moved a short distance to Stocksbridge, where Max spent his boyhood. Both towns lay in the smoke-filled valley in what was termed 'the Socialist Republic of South Yorkshire'. The Grammar School that he attended at Penistone, between Sheffield and Huddersfield, was founded in 1392.

He went up to St John's College, Cambridge, in 1938 with an Open Exhibition from the College and a County Major Scholarship from the West Riding. His elder brother Alec, a mathematician, had preceded him to Cambridge at Peterhouse. Max was promoted to an Open Scholarship after one year and gained First Class Honours in Part I of the Natural Sciences Tripos in 1940.

From his parents Max inherited the deep Christian faith and socialist principles that guided his whole life. As a pacifist, he spent the War Years from 1940 to 1945 working in hospitals, first in Sheffield and then near Bristol.

Although he had been fascinated by plants and their variation since childhood, he left school expecting to become a biochemist. However, he was greatly impressed by a trip to the Swiss Alps made between school and university on a travelling scholarship from the West Riding, by a visit to the Cairngorms on a high-powered field trip from the Cambridge Botany School, and especially by the teaching

at Cambridge of Humphrey Gilbert Carter, Director of the University Botanic Garden, and Harry Godwin, who later became Professor of Botany and received a knighthood.

On returning to Cambridge in 1945, Max achieved a First in Part II Botany in 1946. Later that year he commenced research for a PhD on a DSIR grant. In the introduction to his dissertation, submitted and approved in 1950, he noted that he had been introduced to the taxonomic problems of *Eleocharis* which he was studying for his PhD by a Norfolk amateur botanist, Richard Libbey, when they were identifying the Cyperaceae of Norfolk fens. His doctoral work included the relatively new field of experimental taxonomy, which involved cultivating plants in uniform conditions. Much of his experimental work was done at Wicken Fen. He received only light guidance from his supervisor Harry Godwin, who recognised Max's self-motivation.

In 1947 Max spent the summer at Uppsala in Sweden where some of the seminal work in experimental taxonomy was carried out; he had learned Swedish in Cambridge from Brita Mortensen, a granddaughter of the dramatist August Strindberg. Latin, French and German he learned at school and the use of German Floras with Gilbert Carter in practicals in which the class named plants with Garcke's *Flora von Mittel- und Nord-Deutschland*. Later he learned Russian. His linguistic abilities were to serve him well in his co-operation with many continental botanists.

In 1948 he married his childhood sweetheart Lorna Strutt, who was to be his bedrock for a long and happy family life.

In 1949 Max was elected to a three-year Research Fellowship at St John's. Later in the year he was made Curator of the Herbarium at Cambridge, a post which had been vacant since 1931. In the beginning of 1950 I returned to that herbarium from doing my National Service. The whole of the Botany School was being renovated, its museum disbanded and its herbarium moved to the room occupied by the former museum. The old herbarium was a dull and dismal place with brown cupboards, poor lighting and few visitors. The new herbarium

was more spacious, with white cupboards and modern lights. Max was to turn this new herbarium into a hive of activity over the next 20 years as more and more money became available. As well as myself, three young lady technicians worked full-time on the general herbarium and Dorothy Soden part-time on the mosses. Professor E. J. H. Corner was to work on tropical botany and fungi. It was a very happy place to work in.

Max devoted much time to teaching. He gave second year students lectures on experimental taxonomy, variously entitled 'Evolution and reproduction', 'Taxonomy and evolution' and 'Genetics and experimental taxonomy'. He continued Humphrey Gilbert Carter's practice of teaching the third year students the families of flowering plants in a global context, as well as using Garcke's *Flora von Mittel- und Nord-Deutschland* to teach them elementary German. Max also followed Gilbert Carter in taking students, and anyone else who asked to come along, on afternoon cycle rides to get to know about the local flora. He gave tutorials to first year students in Botany up to 1964 and in the Biology of Organisms from 1966; this involved a whole range of disciplines from morphology and anatomy through physiology to ecology.

In the Easter vacation or in the summer Max took students on excursions covering taxonomy and ecology, mostly abroad, to Sweden (1950), Portugal (1951), Scotland (1953), the Austrian Alps (1954), Wales (1955), Ireland (1959), Bavaria (1961), Slovakia (1963), southern France (1965), Slovenia (1967), Majorca (1969 and 1973) and Montenegro (1971).

Max supervised a number of PhD students – Eklas Bari (*Silene*), Christopher Cook (*Ranunculus* subgenus *Batrachium*), Shahina Ghazanfar (*Silene*), Keith Goodway (*Galium*), Geoffrey Halliday (*Arenaria*), Joachim Kadereit (*Senecio*), Alan Leslie (*Ranunculus auricomus* agg.), Neville Marchant (*Veronica*), Pierre Morisset (*Ononis*), David Ockendon (*Linum*), Honor Prentice (*Silene*), Gordon Smith (*Potentilla*) and Fenella Wrigley (*Silene*). *Alchemilla* was probably his favourite genus, followed by *Aphanes*, *Montia*, *Silene*, *Betula* and *Viola*.

In April 1954, the B.S.B.I. appointed Max as part-time Director of a scheme to map the distribution of British and Irish plants; Frank Perring became the 'Senior Worker' in the scheme the following October. The *Atlas of the British Flora* was published in 1962. From the records accumulated in Cambridgeshire for the *Atlas*, with those in the Cambridge Natural

History Society's card index, *A Flora of Cambridgeshire* by Max, Franklyn, Harold Whitehouse and myself was published in 1964.

During the International Botanical Congress in July 1954, in a brasserie on the banks of the Seine, an informal meeting of Tom Tutin, Roy Clapham, John Gilmour, Alan Burges, David Valentine and Vernon Heywood (all Cambridge students) took a decision that a *Flora of Europe* could and should be written. In January 1955 David Webb was added to the group and in March 1956 Max was invited to join the committee. The Linnean Society of London acted as sponsors and Cambridge University Press offered to publish it. Volume 1 was published in 1964, Volume 2 in 1968, Volume 3 in 1972, Volume 4 in 1976 and Volume 5 in 1980. As well as editing 23 of the families including the Caryophyllaceae and half of the Compositae Max wrote 19 genera, including *Alchemilla* with B. Pawloski and *Senecio* with Arthur Chater. *Flora Europaea* was one of the most important taxonomic works published in that century; it brought to the Cambridge Herbarium visiting botanists from all over the world and they were regularly entertained by Max and his family. The final conference was held at King's College, Cambridge, between 31 August and 4 September 1977 and brought a total of 131 visitors from 30 countries. Max had become a Fellow of King's in 1964 and bore the brunt of the organisation, together with Gigi Crompton. It was probably the last time that great group of Cambridge botanical taxonomists who originated as Gilbert Carter students in the 1930s, which included the editors of *Flora Europaea*, and those who were Max's students between 1950 and 1970 came together in one place.

As well as the *Atlas*, *Flora Europaea* and *A Flora of Cambridgeshire* Max's curatorship days brought several other major publications. Two New Naturalist books became bibles for many field botanists – *Wild Flowers* with John Gilmour, then Director of the Botanic Garden, and *Mountain Flowers* with John Raven. This reminds me of Max's height: he was well over six feet and had very long legs, which were similar to those of John Raven, both of whom I had to run to keep up with when going down a mountain. Perhaps the most important of his writings, however, was *Plant Variation and Evolution*, written with David Briggs, which has held its own at universities and institutes for over 30 years. With B. Pawlowski he wrote the 50-species account of *Alchemilla* for the *Flora of Turkey*.

Max also had an active role in the Cambridge Natural History Society. He joined in 1938 and was elected Junior Secretary in 1939 and Senior Secretary in 1940. He was Botanical Curator from 1947 to 1961, Botanical Recorder from 1961 to 1974, President from 1973 to 1975 and Vice-President from 1975 to 1994. He retired from Council only recently, after being continuously on it for 53 years. He exhibited at the annual *conversazione* for many years.

Max gave a huge amount of his time to conservation, especially the Cambridgeshire and Isle of Ely Naturalists' Trust. He was one of a small band of enthusiasts who established first CAMBIENT and then *Nature in Cambridgeshire*, which was sponsored equally at the start by the Natural History Society and the Naturalists' Trust. From the inauguration of CAMBIENT in 1956 until 1965 he was Secretary for Cambridgeshire, while Tony Vine was Secretary for the Isle of Ely. He was Vice-President from 1965 to 1975 and President from 1975 to 1986. In 1962 CAMBIENT bought its first major reserve, Hayley Wood, which is now world-famous. With Robert Payne, the Honorary Secretary, Max bore the brunt of organising the appeal for the £5000 needed to buy it. In 1975 it gave him great pleasure to write the introduction to Oliver Rackham's pioneering book *Hayley Wood: Its History and Ecology*.

Max must be credited also with a significant role in getting the Society for the Protection of Nature Reserves, now the Royal Society of Wildlife Trusts, reinvigorated in the late 1950s, although the chief role was played by Ted Smith of Lincolnshire. When a buffet supper was held on 15 November 1996 to mark the fortieth anniversary of CAMBIENT, Ted Smith made a speech in which he paid special tribute to Max's part in arranging the meeting on 19–20 June 1957 which led to the 'Cambridge Declaration' on the need for an 'Association of Trusts'.

Max had a pivotal role in the running of *Nature in Cambridgeshire*. There was a very slender issue in 1985 after none at all in 1984. That it continued was very much due to his determination. Knowing of the late William Palmer's enthusiasm for the journal, he successfully argued for the use of half the money raised in his memory to become a 'float' to relaunch it. He persuaded Philip Oswald to continue as Editor and invited him and others to form an independent Editorial Board, which he himself chaired. Over the



Max Walters in 1965.

years he contributed 15 standard articles, seven book reviews, five obituaries, five notes or reports and two 'state of the nation' reports on *Nature in Cambridgeshire*.

Of all the nature reserves he had an interest in, Wicken Fen, belonging to the National Trust, held a special place in his heart. He first visited it in 1939, by bicycle and boat with Humphrey Gilbert Carter, and he did much work there in his PhD days. He was a member of the National Trust's local Committee from 1949 to 1995, the Botanical Secretary from 1949 to 1976 and 1986 to 1990 and Chairman from 1979 to 1985, and he continued to advise until 2004.

When Upper Teesdale came under threat from being flooded for a reservoir, with Harry Godwin he stoutly defended it as a unique site of relict communities of plants and gave evidence to Parliament in an attempt to save it. When they lost their appeal he sent two trips from the Cambridge Herbarium to collect a series of the plants which grew there and a set of the Teesdale *Alchemilla* species.

When Max became the Director of the Botanic Garden in 1973, its future seemed rather uncertain. Undergraduates rarely went there and specimens sent to the Botany School for practicals had greatly declined. Max encouraged people of all kinds and ages to visit the Garden and emphasised its role in education. He insisted on first-rate labelling of

all the species. He relaunched the Friends of the Botanic Garden organisation, which had lapsed after its foundation in the 1930s. He encouraged Roland Randall to write the first modern educational leaflets for the Garden, those on native trees and shrubs being illustrated by Rosemary Nicholls.

At the time when Max moved to the Garden, Gigi Crompton, whom he first met over conservation of an orchid meadow at Thriplow, had been given a contract by the Nature Conservancy Council to survey rare species in eastern England. He provided her with a base in the Garden and developed the project by gaining extra funds from the N.C.C. to employ a succession of conservation gardeners to study the responses of these rare species in cultivation. Later Gigi was to help him organise many Cambridge events and excursions. Max supervised the construction of a new display bed of rare plants of the region and provided a home for conservation of rare plants of Majorca and St Helena. He was among the first Directors of the great gardens to concern themselves with conservation.

When visiting the Royal Botanic Garden, Edinburgh, in the summer of 1976, Max talked to James Cullen and found that they both had the same idea about producing a flora of garden plants. So was born the *European Garden Flora* in six volumes, edited by James, Max and 19 others. Max wrote the accounts of 25 genera. Volume 1 was published in 1986, Volume 2 in 1984, Volume 3 in 1989, Volume 4 in 1995, Volume 5 in 1997 and Volume 6 in 2000.

Max also developed an interest in the history of botany, which he tied up with his philosophy of plant classification. Like John Gilmour, he believed that dividing plants into genera was mostly artificial and mainly a matter of convenience, and it was very difficult to persuade him to alter concepts and long-established names. While at the Botanic Garden he wrote *The Shaping of Cambridge Botany* in 1981, and in 2001 in his retirement, he wrote with Anne Stow, formerly Head of the Scientific Periodicals Library, *Darwin's Mentor: John Stevens Henslow 1796–1861*. For the centenary of the official opening of the new building of the Botany School in 2004, Peter Grubb, Anne Stow and he produced *100 Years of Plant Sciences in Cambridge 1904–2004*. From 1982 until his death he was an active Editor of the *New Naturalist* series, for which he wrote *Wild and Garden Plants* in 1993. In 1989 he and Frank Perring produced a popular

identification book, *The Macmillan Field Guide to British Wildflowers*, with specially commissioned photographs by Andrew Gagg, which was reprinted in 1994. His last published book, with John and Jill White, *Trees: a Field Guide*, appeared in 2005. His final publication has just appeared and is a substantial essay to accompany the facsimile edition of John Ray's *The Wisdom of God* to mark the tercentenary of that author's death.

Max was a keen supporter of my own and Gina Murrell's *Flora of Great Britain and Ireland*, christened 'FOGBI' by Frank Perring. He was always much interested in variation and was quick to realise the significance of early-flowering variants introduced to this country: hence his articles in the *Grantchester Parish Magazine* on Snowdrops and on *Sorbus*. He also fully understood the taxonomy of apomicts. He wrote the forewords to Volumes 4 and 5 of FOGBI. My last long talk with him was about how we hoped almost all his work and that of his students on the British flora since 1950 would come together in the five volumes. His last active part in it was to sit in the Cambridge Botanic Garden on a beautiful June morning and select typical specimens from two large beds for nearly all the British *Alchemilla* species for me to describe.

In his last years Max visited the Botanic Garden once a week, and on another day, with his daughter Stella, the Herbarium, where he spent time clearing up all the odds and ends accumulated over the years. He gave loyal support to the Cambridge U3A Botany Group for many years: from 1990 to 2002 he usually gave the opening lecture or took the members for a spring walk along the Backs.

Throughout his life Max was so often the calming influence between two antagonistic bodies, particularly on the numerous committees on which he served. There never seemed to be a lost cause: he would find some way of keeping it going. He never seemed to be in a hurry and his very calmness always gave him a good start in any argument. Considering that many meetings often took place in the evening, sometimes very late, and the number that he attended, it was a wonder he kept going, but I only once saw him completely exhausted. What helped was that, like his predecessor at the Botanic Garden, Humphrey Gilbert Carter, whenever possible he took a short siesta after lunch.

On the summer excursions Sunday was always a day off for everybody to do as they pleased. Max always enjoyed a good laugh.

I remember standing with him at a village fair on the Slovakian–Romanian border watching our students go round and round on the merry-go-round singing ‘On top of old Smokey’, and on another occasion we watched a student rush all over a marsh on a very hot day trying to flush a ventriloquial Corncrake so that she could tick it on her list. He could also let annoyance turn into laughter. Once, when I had kept the busload of students waiting for half an hour in Yugoslavia, he greeted me with ‘Where on earth have you been?’ I replied ‘Watching the antics of a pair of Sombre Tits’, and the bus dissolved into laughter. When the laughter died down, he said ‘There’s no answer to that; we’d better move on.’ He was a great fan of the Goons and of Monty Python, and he once laughed so much at Monty Python’s antics that he pulled an intercostal muscle and had to have treatment.

As a final note of appreciation of Max’s great kindness and understanding I have to add a vote of personal thanks. He did everything it was possible to do to help me in a lifelong study of the British flora and in a way which was the embodiment of a great University at a time before it became obsessed with money. From an amazing 2000-mile trip round Ireland in 1952 with Tom Tutin, Tige Böcher, David Webb, Donald Pigott and Roy Clapham, through all the student excursions, both at home and abroad, he nearly always took me with him.

Max joined the B.S.B.I. in 1944, served on the Council from 1957 to 1962 and 1966 to 1969, was Vice-President from 1962 to 1966 and President from 1973 to 1975, served on the Conservation Committee from 1958 to 1969, the Maps Committee from 1959 to 1965, the Publications Committee from 1958 to 1969, the Records Committee from 1966 to 1969 and the Wild Plant Protection Working Party from 1965 to 1969, and was vice-county recorder for Cambridgeshire from 1949 to 1961. He was referee for *Montia* from 1951 to 1986, for *Potentilla* from 1973 to 1979, for *Aphanes* from 1950 to 2005, for *Eleocharis* from 1949 to 2005, for *Betula* from 1983 to 1995, for

Alchemilla from 1949 to 2005 and for *Silene* from 1962 to 2005. He was awarded his ScD at Cambridge in 1980, the Royal Horticultural Society’s Victoria Medal of Honour in 1984 and the Linnean Medal of Botany in 1995. He became an Honorary Fellow of the Linnean Society and an Honorary Member of the B.S.B.I. At King’s College he served on the Garden Committee. He sat on the R.H.S. Scientific Committee from 1976 to 1994.

Max was at various times active in the Fellowship of Reconciliation, the Campaign for Nuclear Disarmament and Christian Aid. He had been to Sarajevo for a three-month visit on a British Council grant, so, after the civil war, he worked hard with his son Martin for the restoration of the Botanic Garden and Museum there. A fountain in that Botanic Garden records his enthusiasm and generosity.

During Max’s curatorship years the Walters family lived in a flat at 1 Brookside overlooking the Botanic Garden. Later he was the last Director to live in Cory Lodge in the Garden. In his retirement he lived at Grantchester, where he was Churchwarden from 1995 to 2001 and wrote 207 articles for the *Grantchester Parish Magazine*, some of which were botanical; a full set of this magazine from March 1986 is available in the Cambridgeshire Collection in Cambridge City Library. I believe that, unless one has read these articles, one does not understand the complete man.

Max died on 11 December 2005, aged 85. A thanksgiving service for his life was held at 2.30 p.m. on Saturday, 3 June 2006, in Grantchester Parish Church. His wife Lorna survives him together with their three children, Philip and the twins Martin and Stella. He will be much missed by his many friends.

I am greatly indebted to Peter Grubb for much of the information and dates concerned with the University of Cambridge, to Mary Briggs, Gwynn Ellis and David Pearman for information about the B.S.B.I., and to Philip Oswald and Arthur Chater for general help.

PETER SELL

Publications of Dr Max Walters (1920–2005)

1944

Walters, S.M. Notes on White-flowered *Viola odorata* L. in the Bristol District. *Proc. Bristol Nat. Soc.* **27**: 41–45.

1946

Walters, S.M. Observations on varieties of *Viola odorata* L. *Bot. Soc. Exch. Cl. Rep.* **13**: 834–839.

1948

Walters, S.M. *Glyceria declinata* Bréb., en förbisedd nordisk art. *Bot. Not.* **1948**: 430–440.

Walters, S.M. *Alchemilla vulgaris* agg. in northern England. *The Naturalist* **1948**: 41–43.

1949

Walters, S.M. *Alchemilla vulgaris* agg. in Britain. *Watsonia* **1**: 6–18.

Walters, S.M. *Aphanes microcarpa* (Boiss. et Reut.) Rothm. in Britain. *Watsonia* **1**: 163–169.

Walters, S.M. Biological flora of the British Isles. *Eleocharis* R.Br. *Journ. Ecol.* **37**: 192–206.

1950

Walters, S.M. On the vegetative morphology of *Eleocharis* R.Br. *New Phytol.* **49**: 1–7.

Walters, S.M. On *Arabis turrita* L. in the Fellows' Garden. *The Eagle* **54** (no. 237): 148–150.

1951

Walters, S.M. The study of plant distribution. In Lousley, J.E. (Edit.) *The study of the distribution of British plants*, pp. 12–23.

1952

Walters, S.M. *Alchemilla subcrenata* Buser in Britain. *Watsonia* **2**: 277–278.

1953

Walters, S.M. Review of An introduction to historical plant geography by E.V. Wulff with a translation by E. Brissendon. *Watsonia* **2**: 214–216.

Walters, S.M. The continental element of our flora. In Lousley, J.E. (Edit.) *The changing flora of Britain*, pp. 124–129.

Pigott, C.D. & Walters, S.M. Is the Box-tree a native of England? (Exhibit) In Lousley, J.E. (Edit.) *The changing flora of Britain*, pp. 184–187.

Walters, S.M. *Montia fontana* L. *Watsonia* **3**: 1–6.

Walters, S.M. *Eleocharis mamillata* Lindb. fil. and allied species. *Ber. Schweiz. Bot. Ges.* **63**: 271–286.

1954

Pigott, C.D. & Walters, S.M. On the interpretation of the discontinuous distributions shown by certain British species of open habitats. *Journ. Ecol.* **42**: 95–116.

Walters, S.M. Distribution maps of the British flora. *Nature* **173**: 1079–1080.

Walters, S.M. *Veronica spicata* L. and *V. hybrida* L. *Proc. Bot. Soc. Brit. Isles* **1**: 89.

Walters, S.M. The distribution maps scheme. *Proc. Bot. Soc. Brit. Isles* **1**: 121–130.

Walters, S.M. Sur quelques plants récoltées dans le Nord-Ouest de la France. *Monde Pl.* **1954**: 303–304.

Gilmour, J.S.L. & Walters, S.M. *Wild Flowers*. London.

1955

Perring, F.H., Sell, P.D. & Walters, S.M. Notes on the flora of Cambridgeshire (v.c. 29). *Proc. Bot. Soc. Brit. Isles* **1**: 471–481.

Walters, S.M. Review of Nordisk Kärnväxflora **1** by N. Hylander. *Watsonia* **3**: 179–180.

Walters, S.M. Welsh recording for the B.S.B.I. distribution maps scheme. *Nature in Wales*: **1**(2): 68–71.

1956

Walters, S.M. & Lambert, C. [A] M. A reconsideration of *Silene caelata* C. Reid. *New Phytol.* **55**: 133–135.

- Walters, S.M. Mapping the British flora. *Country-side* n.s. **17**: 410–414.
- Walters, S.M. *Selinum carvifolia* (L.) L. in Britain. *Proc. Bot. Soc. Brit. Isles* **2**: 119–122.
- Walters, S.M. *Eriophorum gracile* Roth. *Proc. Bot. Soc. Brit. Isles* **2**: 23–24.
- Walters, S.M. & Perring, F.H. B.S.B.I. Distribution map scheme survey of 1955 recording and suggestion for recording in 1956. *Proc. Bot. Soc. Brit. Isles* **2**: 10–17.
- Walters, S.M. & Webb, D.A. *Calystegia*. *Proc. Bot. Soc. Brit. Isles* **2**: 22–23.
- Raven, J. & Walters, S.M. *Mountain Flowers*. London.
- 1957
- Walters, S.M. Distribution maps of plants: an historical survey. In Lousley, J.E. (Edit.) *Progress in the study of the British flora*. Arbroath.
- Walters, S.M. Mapping the distribution of plants. *New Biology* **24**: 93–108.
- Walters, S.M. Babington's Yew-tree. *The Eagle* **100**: 35–37.
- 1959
- Coombe, D.E., Perring, F.H. & Walters, S.M. *Lythrum hyssopifolia* L. *Proc. Bot. Soc. Brit. Isles* **3**: 286–288.
- Walters, S.M. *Heleocharis austriaca* Hayek and *Glyceria declinata* Bréb. Two plants new to the flora of Poland. *Frag. Flor. Geobot.* **5**: 239–244.
- 1960
- Walters, S.M. Suggested treatment for *Alchemilla* in *Flora Europaea*. *Feddes Repert.* **63**: 127–131.
- Walters, S.M. Field Meetings 1958, July 27 to August 3 1958. Tralee, Co. Kerry. *Proc. Bot. Soc. Brit. Isles* **3**: 461–463.
- 1961
- Walters, S.M. The shaping of angiosperm taxonomy. *New Phytol.* **60**: 74–84.
- Walters, S.M. Wild Juniper on Fleam Dyke. *Nature in Cambridgeshire* **4**: 40–41.
- Bradshaw, M.E. & Walters, S.M. A Russian *Alchemilla* in south Scotland. *Watsonia* **4**: 281–282.
- Walters, S.M. Review of A cytogenic study of the genus *Geum* by W. Gajewski. *Watsonia* **4**: 256–257.
- 1962
- Walters, S.M. Generic and specific concepts and the European flora. *Preslia* **34**: 207–226.
- Walters, S.M. Botanical classification. *Aslib Proc.* **14**: 231–233.
- Walters, S.M. Atlas of the British flora. *Country-side* **19**: 8–9.
- Perring, F.H. & Walters, S.M. *Atlas of the British flora*. London & Edinburgh.
- 1963
- Bradshaw, M.E., Sell, P.D. & Walters, S.M. The nomenclature of *Alchemilla minor* auct. brit. *Watsonia* **5**: 259–261.
- Walters, S.M. Botanical nomenclature, punched cards, and machines – a comment. *Taxon* **12**: 249–250.
- Walters, S.M. Abstracting and indexing data. *Webbia* **18**: 19–22.
- Walters, S.M. Methods of classical plant taxonomy. In T. Swain (Edit.) *Chemical Plant Taxonomy*, pp. 1–15. London.
- Gilmour, J.S.L. & Walters, S.M. Philosophy and classification. In Turrill, W.B. (Edit.) *Vistas in Botany* **4**: 1–22. London.
- Walters, S.M. *Eleocharis austriaca* Hayek, a species new to the British Isles. *Watsonia* **5**: 329–335.
- Perring, F.H., Sell, P.D., Walters, S.M. & Whitehouse, H.L.K. Exhibits which illustrate some past, present and future floras. Flora of Cambridgeshire. In P.J. Wanstall (Edit.) *Local Floras*, pp. 113–114. London.
- 1964
- Chater, A.O. & Walters, S.M. Flora Europaea Notulae. *Silene* L. *Feddes Repert.* **69**: 46–47.
- Walters, S.M. et al. (Edits). *Flora Europaea* **1**. Cambridge. Wrote: *Betula*, *Boussingaultia*, *Corrigiola*, *Cucubalus*, *Draba*, *Erophila*, *Holosteum*, *Montia*, *Papaver* (with A.B. Mowat), *Petrocallis*, *Portulaca*, *Pteranthus* (with P.D. Sell), *Silene* (with A.O. Chater).

- Walters, S.M. Obituary of Gordon Levesley Smith (1937–1963). *Proc. Bot. Soc. Brit. Isles* **5**: 417–418.
- Walters, S.M. Principles of taxonomy. *Development in Industrial Microbiology* **5**: 169–172.
- Perring, F.H., Sell, P.D. & Walters, S.M. *Flora of Cambridgeshire*. Cambridge.
- 1965
- Walters, S.M. Introduction to a general discussion on Phenetic and Phylogenetic Classification. *Syst. Assoc. Publ.* **6**: 157–164.
- Walters, S.M. 'Improvement' versus stability in botanical classification. *Taxon* **14**: 6–10.
- Walters, S.M. Documentation and abstracting for the European flora. *Rev. Roum. Biol. Ser. Bot.* **10**: 123–124.
- Walters, S.M. Natural History. In Steers, J.A. (Edit.) *The Cambridge Region*.
- 1966
- Walters, S.M. The taxonomic implications of apomixis. In Hawkes, J.G. (Edit.) *Reproductive biology and taxonomy of flowering plants*, pp. 162–168.
- Bingley, F. & Walters, S.M. *Wicken Sedge Fen: a typographical and botanical guide*.
- 1967
- Godwin, H. & Walters, S.M. The scientific importance of Upper Teesdale. *Proc. Bot. Soc. Brit. Isles* **6**: 348–351.
- Walters, S.M. Identification of British *Eleocharis*. *Proc. Bot. Soc. Brit. Isles* **6**: 384–386.
- Walters, S.M. & Bosman, V.G. Exhibition meeting 1966. *Alchemilla faerensis* (Lange) Buser and *A. alpina* L. *Proc. Bot. Soc. Brit. Isles*, **7**: 83.
- Walters, S.M. *List of vascular plants of Wicken Fen*.
- Crompton, G. & Walters, S.M. Thriplow meadows grazing experiments 6. *Nature in Cambridgeshire* **10**: 21–23.
- 1968
- Walters, S.M. *Betula* L. in Britain *Proc. Bot. Soc. British Isles* **7**: 179–180.
- Sell, P.D. & Walters, S.M. Notes on Slovakian Plants. *Acta Univ. Comen. Bot.* **14**: 13–19.
- Walters, S.M. *et al.* (Edits.) *Flora Europaea* **2**. Cambridge. Wrote: *Acer*, *Alchemilla* (with B. Pawlowski), *Aphanes*, *Linum* (with D.J. Ockendon), *Potentilla* (with P.W. Ball and B. Pawlowski) and *Radiola*.
- Walters, S.M. Chromosome numbers of European species of *Potentilla* L. *Grex Aureae* Wolf. *Acta Univ. Comen. Bot.* **14**: 7–11.
- Walters, S.M. Review of *Botanical Latin* by W.T. Stearn. *Watsonia* **6**: 391.
- 1969
- Ockendon, D.J., Walters, S.M. & Whiffen, T.F. Variation within *Centaurea nigra* L. *Proc. Bot. Soc. Brit. Isles* **7**: 549–552.
- Walters, S.M. Review of *Mountain Flowers in Colour* by A. Huxley. *Watsonia* **7**: 181–182.
- Walters, S.M. Obituary Mr H. Gilbert Carter, *Nature* **221** No. 5179, 497–498.
- Walters, S.M. Cambridgeshire ferns - ecclesiastic and ferroviatic. *Nature in Cambridgeshire* **12**: 22–25.
- Walters, S.M. Report on index to European taxonomic literature, V. *Simposio de Flora Europaea* 11–13.
- Briggs, D. & Walters, S.M. *Plant variation and evolution*. Cambridge.
- Gilmour, J.S.L., Walters, S.M., & King, C.J. *Humphrey Gilbert Carter: A memorial volume*. Cambridge.
- 1970
- Ockendon, D.J. & Walters, S.M. Studies in *Potentilla anserina* L. *Watsonia* **8**: 135–144.
- Sell, P.D. & Walters, S.M. Exhibition meeting Report for 1968. Two species new to Cambridgeshire. *Watsonia* **8**: 93.
- Walters, S.M. Dwarf variants of *Alchemilla* L. *Fragm. Flor. Geobot.* **16**: 91–98.
- Walters, S.M. The next twenty-five years. In Perring, F.H. (Edit.) *The flora of a changing Britain*, pp. 136–141.

Pankhurst, R.J. & Walters, S.M. Generation of keys by computer. In Cutbill, J.L. (Edit.) *Data processing in biology and geology*, pp. 189–203.

1971

Perring, F.H. & Walters, S.M. Conserving rare plants in Britain. *Nature* **229**: 375–377.

Walters, S.M. Taxonomic and floristic aspects of plant conservation. In Davis, P.H. *et al.* (Edits.) *Plant life in south-west Asia*, pp. 293–296.

Smith, G.L. Augmented by Bozman, V.G. & Walters, S.M. Studies in *Potentilla* L. III. Variation in British *P.tabernaemontani* Aschers and *P.crantzii* (Cr.) Beck ex Fritsch. *New Phytol.* **70**: 607–618.

Walters, S.M. Index to the rare endemic vascular plants of Europe. *Boissiera* **19**: 87–89.

Bosman, V.G., Smith, G.L. & Walters, S.M. Studies in *Potentilla* 3. Variation in British *P. tabernaemontani* Ascherson and *P. crantzii* (Cr.) Beck ex Fritsch. *New Phytol.* **70**: 607–618.

Walters, S.M. Christians and conservation. *Reconciliation Quarterly* 23–28.

1972

Walters, S.M., & Webb, D.A. Taxonomic and nomenclatural notes on *Veronica* L. *Bot. Jour. Linn. Soc.* **65**: 266–269.

Walters, S.M. Endemism in the Genus *Alchemilla* in Europe. In Valentine, D.H. (Edit.) *Taxonomy, Phytogeography and Evolution*, pp. 301–305.

Walters, S.M. & Pawlowski, B. *Alchemilla* in Davis, P.H. (Edit.) *Flora of Turkey* **4**: 80–104. Edinburgh.

Walters, S.M. *et al.* (Edits.) *Flora Europaea* **3**. Cambridge. Wrote: *Veronica* (with N.G. Marchant & D.A. Webb).

Gilmour, J.S.L. & Walters, S.M. *Wild Flowers*. Ed. 2. London.

Adam, P., Birks, H.J.B. & Walters, S.M. A contribution to the study of the flora and vegetation of the Budva area, Montenegro. *Glas. Repub. Zavoda Zašt. Priv. Mus. Titograd* **4**: 41–72.

1973

Birks, H.J. & Walters, S.M. The flora and vegation of Barno Jezero, Durmitor, Montenegro. *Glas. Repub. Zavada. Zašt. Priv. Mus. Titograd* **5**: 5–23.

Walters, S.M. *Alchemilla*. In Green, P.S. (Edit.) *Plants wild and cultivated*, 48–50.

Walters, S.M. Obituary of Nils Hylander (1904–1970). *Watsonia* **9**: 295–296.

Walters, S.M. The role of botanic gardens in conservation. *Jour. Roy. Hort. Soc.* **98**: 311–315.

1974

Walters, S.M. Exhibition Meeting 1973. *Veronica spicata* in Cambridgeshire. *Watsonia* **10**: 232.

Walters, S.M. The rediscovery of *Senecio paludosus* L. in Britain. *Watsonia* **10**: 49–54.

Edmonds, J.M., Sell, P.D. & Walters, S.M. Some British chromosome counts in the Compositae subfamily Chichorioideae. *Watsonia* **10**: 159–161.

1975

Gilmour, J.S.L., Walters, S.M. & King, C.J. *Humphrey Gilbert Carter: a memorial volume*.

Walters, S.M. Obituary of Ian Hepburn. *Nature in Cambridgeshire* **18**: 4–5.

Walters, S.M. Traditional methods of biological identification. In Pankhurst, R.J. *Biological identification with computers*, 3–8.

Walters, S.M. Presidential address 1974. Botanical Co-operation. *Watsonia* **10**: 325–330.

Walters, S.M. *Silene* L. 168–170; *Betula* L. 299–300; *Veronica* L. 371–372; *Tragopogon* L. 430–431. In Stace, C.A. (Edit.) *Hybridization and the Flora of the British Isles*. London.

Walters, S.M. Two famous medicinal herbs in 'new' Cambridgeshire localities. *Nature in Cambridgeshire* **18**: 16–18.

Walters, S.M. & King, C.J. *European floristic and taxonomic studies*.

1976

Walters, S.M. The conservation of threatened vascular plants in Europe. *Biological Conservation* **10**: 31–41.

Walters, S.M. Review of *Det Grønne Grønland* by T.W. Böcher. *Watsonia* **11**: 171.

Perring, F.H. & Walters, S.M. *Atlas of the British flora*. Ed. 2. London and Edinburgh.

Walters, S.M. *et al.* (Edits.) *Flora Europaea* **4**. Cambridge. Wrote: *Adoxa* L. and *Senecio* L. (with A.O. Chater).

1977

Walters, S.M. *A guide to the University Botanic Garden.*

Walters, S.M. Review of *Flora Republicae Popularis Bulgaricae* **6**. (Edit. by D. Jordanov). *Watsonia* **11**: 417.

Walters, S.M. The role of European Botanic Gardens in the conservation of rare and threatened plant species. *Gärtnerisch-Botanischer Brief (Hamburg)* **51**: English pp. 2–22, German pp. 22–43, French pp. 43–62.

1978

Walters, S.M. British endemics. In Street H.E. (Edit.) *Essays in plant taxonomy*, pp. 263–274.

Walters, S.M. Editorial on European nature conservation. *Naturopa* **31**: 3.

Walters, S.M. Review of *Henslow of Hitcham* by J. Russell-Gebbett. *Watsonia* **12**: 185–186.

1979

Walters, S.M. The University Botanic Garden. *Mag. Cambridge Soc.* **4**: 42–52.

Walters, S.M. Conservation of the European flora: *Aldrovanda vesiculosa* L., a documented case-history of a threatened species. *Syst. Bot. Plant Util. Biosphere. Conserv.* 72–82.

Walters, S.M. Progress in biological conservation in Cambridge. In Smith, D. (Edit.) *Landscape towards 2000*, pp. 56–58.

Walters, S.M. *Epilobium lanceolatum* Seb. and Mauri – a plant to look for in your garden. *Watsonia* **12**: 399.

Walters, S.M. Education in the modern botanic garden. *The Garden* **104**: 374–379.

Walters, S.M. The eastern England rare plant project in the University Botanic Garden Cambridge. In H. Synge & H. Townsend, *Survival or Extinction*, pp. 37–46.

Donald, D. & Walters, S.M. Some plants from the conservation section of the University Botanic Garden, Cambridge. *Watsonia* **12**: 192.

Walters, S.M. The role of Mediterranean botanic gardens in plant conservation. *Webbia* **34**: 109–116.

Donald, D. & Walters, S.M. Exhibition Report: some plants from the conservation section of the University Botanic Garden, Cambridge. *Watsonia* **12**: 392–393.

1980

Walters, S.M. Apomictic endemism in *Alchemilla* and *Hieracium*. *Watsonia* **13**: 73.

Walters, S.M. Plant refuge in an English garden. *Garden* **4**: 20–23.

Walters, S.M. *Apium repens* (Jacq.) Reichb.f. *Watsonia* **13**: 170.

Walters, S.M. *et al.* (Edits.) *Flora Europaea* **5**. Cambridge. Wrote: *Eleocharis*.

1981

Walters, S.M. The future of the countryside. *The Cambridge Review* **102**: 82–84.

Walters, S.M. Aims and methods in mapping the endemic vascular plants of the Balkan Peninsula. In S. Kozuharov (Edit.) *Mapping the flora of the Balkan Peninsula*, pp. 83–94. Sofia.

Walters, S.M. Henslow's vasculum. *Watsonia* **13**: 369.

Walters, S.M. Priorities in rare species conservation for the 1980s. In Synge, H. (Edit.) *The biological aspects of rare plant conservation*, pp. xxv–xxviii.

Walters, S.M. Historical background to the Garden anniversary in *University Botanic Garden, Cambridge 150th Anniversary Celebrations 9th to 14th July 1981*.

Walters, S.M. *The shaping of Cambridge botany*. Cambridge.

Walters, S.M. Review of science and colonial expansion: the role of the British Royal Botanic Gardens by L.H. Brockway. *Watsonia* **18**: 355–356.

Briggs, M., Leslie, A.C. & Walters, S.M. Exhibition report: *Lemna minuscula* Herter, an American duckweed, as a member of the British flora. *Watsonia* **13**: 360–361.

1982

Leslie, A.C., Pannell, C.M. & Walters, S.M. Varieties in *Viola odorata* L. in Suffolk and Cambridgeshire. *Watsonia* **14**: 73–74.

Walters, S.M. Review of *Fotoatlas der Alpenblumen* by W. Lippert. *Watsonia* **14**: 217–218.

Walters, S.M. Some thoughts arising from the publication of a complete catalogue of plants from the Garden. *Gärtn Bot. Briefe* **72**: 23–26.

Rowell, T.A., Walters, S.M. & Harvey, H.J. The rediscovery of the Fen Violet, *Viola persicifolia* Schreber, at Wicken Fen, Cambridgeshire. *Watsonia* **14**: 183–184.

1983

Walters, S.M. Fen Violets at Wicken Fen, Cambridge, v.c. 29. *Watsonia* **14**: 457.

Leslie, A.C. & Walters, S.M. The occurrence of *Lemna minuscula* Herter in the British Isles. *Watsonia* **14**: 243–248.

Perring, F.H. & Walters, S.M. *Atlas of the British Flora*. Ed. 3. London and Edinburgh.

1984

Walters, S.M. The relation between the British and the European floras. *New Phytol.* **98**: 3–13.

Briggs, D. & Walters, S.M. *Plant variation and evolution*. Ed. 2. Cambridge.

Walters, S.M. The role of Botanic Gardens in plant conservation in south-east Asia. *Conservation of tropical plant resources* **1984**: 230–235.

Walters, S.M. *et al.* (Edits.) *The European Garden Flora* **2**. Cambridge. Wrote: *Carex*, *Cyperus*, *Eleocharis*, *Lemna*, *Scirpus*, *Spirodela*, *Wolffia* and *Wolffiella*.

1985

Walters, S.M. The utilization of national plant collections. *Scientific Horticulture* **36**: 79–82.

Walters, S.M. Lost and gone for ever. *Natural World* **15**: 17–18.

Walters, S.M. The problems of wild plant conservation. *Publ. Naturhist. Gen. Limburg* **35**: 56–59.

1986

Walters, S.M. *Stellaria palustris* – a declining or overlooked species? *Ann. Rep. Huntingdonshire Fauna Flora Soc.* **38**: 8–10.

Walters, S.M. The name of the Rose: a review of ideas on the European bias in angiosperm classification. *New Phytol.* **104**: 527–546.

Walters, S.M. The future of *Flora Europaea*. *Veröff. Geobot. Inst. ETH. Stiftung Rübel* **87**: 91–99.

Walters, S.M. Review of *God's Acre: the flowers and animals of the parish churchyard* by F. Greenoak. *Watsonia* **16**: 207–208.

Walters, S.M. *et al.* (Edits.). *The European Garden Flora*. **1**. Cambridge.

Walters, S.M. *Alchemilla*: a challenge to biosystematists. *Acta Univ. Ups. Symb. Bot. Ups.* **27**: 193–198.

1987

Walters, S.M. Obituary: John Scott Lennox Gilmour (1906–1986). *Linnean* **3**: 35–36.

Akeroyd, J.R. & Walters, S.M. *Flora Europaea*: the background to the revision of volume one. *Bot. Jour. Linn. Soc.* **95**: 223–226.

1988

Walters, S.M. The Backs of the colleges. *Cambridge Review* **109**: 42–44.

Swan, G.A. & Walters, S.M. *Alchemilla gracilis* Opíz, a species new to the British flora. *Watsonia* **17**: 133–138.

Walters, S.M. Note on cultivated *Alchemilla* species resembling *A. mollis*. *The Garden* **113**: 535.

Akeroyd, J.R. & Walters, S.M. *Flora Europaea*: Notulae Systematicae. Taxonomic notes on *Silene* L. *Bot. Jour. Linn. Soc.* **97**: 338–342.

Walters, S.M. The purposes of systematic botany. *Symb. Bot. Uppsala* **28**: 13–20.

Walters, S.M. A wild and garden *Sagina*. *B.S.B.I. News* **49**: 52.

1989

Walters, S.M. Experimental and orthodox taxonomic characters and the deme terminology. *Pl. Syst. Evol.* **167**: 35–41.

Walters, S.M. *Alchemilla mollis* (Buser) Roth and related species in gardens. *B.S.B.I. News* **51**: 23–24.

Walters, S.M. (Edits.) *The European Garden Flora*. **3**. Cambridge. Wrote: *Agrostemma*, *Alnus* (with K. Ashburner), *Arenaria*, *Betula* (with K. Ashburner), *Cerastium*, *Cucubalus*, *Dianthus* (with A.P. Hamilton), *Gypsophila*, *Herniaria*, *Lychnis*, *Minuartia*, *Moehringia*, *Paronychia*, *Petrocoptis*, *Pterorophagia*, *Sagina*, *Saponaria*, *Scleranthus*, *Silene*, *Vaccaria*.

- Walters, S.M. Obituary of John Scott Lennox Gilmour. *Pl. Syst. Evol.* **167**: 93–95. (Also two early papers on classification, with a foreword by S.M. Walters.)
- Walters, S.M. Ferns at Wicken Fen. *Nature in Cambridgeshire* **31**: 61.
- Perring, F.H. & Walters, S.M. *The Macmillan field guide to British wildflowers*. London.
- 1990
- Walters, S.M. The taxonomy of garden plants. The naming game. *The Garden* **115**: 324–327.
- Chater, A.O. & Walters, S.M. Flora Europaea: Notulae systematicae ad Floram Europaeam specialities. Notes on *Silene vulgaris* (Moench) Garcke and *S. uniflora* Roth. *Bot. Jour. Linn. Soc.* **103**: 213–216.
- 1991
- Walters, S.M. *Alchemilla* update. *The Garden* **116**: 62–63.
- Walters, S.M. Review of *Atlas Florae Europaeae* **8**: Nymphaeaceae to Ranunculaceae, edited by J. Jalas and J. Suominen. *Watsonia* **18**: 326–337.
- Walters, S.M. Ray's Butterbur still in Paradise. *Nature in Cambridgeshire* **33**: 25–26.
- Walters, S.M. Review: I.P. Schönfelder (Trans. C.J. King) *Wild flowers of the Mediterranean*. *Nature in Cambridgeshire* **33**: 41.
- Walters, S.M. *King's College Fellows' Garden*. Cambridge.
- Walters, S.M. Wall Lettuce, *Mylcelis muralis* in the Cambridge area. *Nature in Cambridgeshire* **33**: 54–59.
- Walters, S.M. Professor Maria Skalińska: an appreciation from England. *Polish Bot. Stud.* **2**: 17–18.
- 1992
- Walters, S.M. An *Alchemilla* newly discovered in Norway: might it be in Britain. *B.S.B.I. News* **60**: 68.
- Walters, S.M. *Alchemilla* in *The New Royal Horticultural Society Dictionary of Gardening* **1**: 100–104.
- Walters, S.M. W.T. Stearn: The complete naturalist. *Bot. Journ. Linn. Soc.* **109**: 437–442.
- Walters, S.M. *Notable trees and shrubs in King's College Fellows' Garden*.
- 1993
- Walters, S.M. A brief history of the Backs, *Cambridge Univ. Alumni Mag.* 10–11 (Easter term 1993).
- Walters, S.M. *Wild & garden plants*. London.
- Dickson, J.H., Huber, R. & Walters, S.M. *Alchemilla acutiloba* Opiz new to Scotland. *Bot. Jour. Scotland* **46**: 499–502.
- Walters, S.M. Herbaria in the 21st century: why should they survive? *Webbia* **48**: 673–682.
- Walters, S.M. *Stellaria neglecta* Weihe in Cambridgeshire. *Nature in Cambridgeshire* **35**: 61–63.
- Walters, S.M. *et al.* (Edits.) *Flora Europaea*. **1**. Ed. 2.
- 1994
- Walters, S.M. Obituary: Professor David Webb. *The Independent* (11 October 1994).
- Walters, S.M. Classic wildlife sites: Wicken Fen Nature Reserve. *British Wildlife* **6**: 5–13.
- 1995
- Walters, S.M. The taxonomy of European vascular plants; a review of the past half century and the influence of the *Flora Europaea* project. *Biol. Rev.* **70**: 361–374.
- Walters, S.M. Four dwarf Caucasian *Alchemillas* for the rock garden. *The New Plantsman* **2**: 185–189.
- Walters, S.M. Obituary: Richard William (Dick) David (1912–1993). *Watsonia* **20**: 320–321.
- Walters, S.M. *et al.* *The European Garden Flora*. **4**. Cambridge.
- Walters, S.M. & Oswald, P. *Persicaria* species at More Fen, Swavesey. *Nature in Cambridgeshire* **37**: 46–47.
- 1996
- Walters, S.M. *et al.* *Cambient 40th Anniversary*. 15 November 1996.
- Walters, S.M. News from the Sarajevo Botanic Garden. *Friends of the Botanic Garden newsletter* **41**: 19–21.

- Walters, S.M. Obituary: David Allardice Webb (1912–1994). *Watsonia* **21**: 3–7.
- Walters, S.M. David Webb's contribution to the distribution maps scheme. *Watsonia* **21**: 7.
- Walters, S.M. Swamp Stonecrop, *Crassula helmsii* in Cambridgeshire. *Nature in Cambridgeshire* **38**: 24–26.
- Hedberg, O. & Walters, S.M. Optimizing the use of herbarium resources. *Taxon* **45**: 93–94.
- 1997
- Walters, S.M. Botanic records and floristic studies. In Friday, L.E. (Edit.) *Wicken Fen the making of a wetland nature reserve*.
- Friday, L.E., Walters, S.M. & Lock, J.M. Carr and woodland. In Friday, L.E. (Edit.). *Wicken Fen the making of a wetland nature reserve* pp. 82–97.
- Walters, S.M. & Preston, C. Profiles of new Honorary Members, Peter Sell. *B.S.B.I. News* **76**: 7–8.
- Walters, S.M. *Eleocharis quinqueflora* at Wicken Fen. *Nature in Cambridgeshire* **39**: 53–54.
- Walters, S.M. *et al.* (Edits.) *The European Garden Flora*. **5**. Cambridge. Wrote *Viola*.
- Briggs, D. & Walters, S.M. *Plant variation and evolution*. Ed.3.
- 1998
- Walters, S.M. Review of *Cultivating women, cultivating science, Floras' daughters and botany in England 1760–1860* by A.B. Shteir. *Watsonia* **22**: 200–201.
- 1999
- Walters, S.M. The changing flora of Cambridgeshire. B.S.B.I. Druce lecture. Cambridge 6 February 1999. *B.S.B.I. News* **81**: 65–70.
- 2000
- Walters, S.M. U3A excursion to Knapwell Wood. *Nature in Cambridgeshire* **42**: 68.
- Walters, S.M. *et al.* (Edits.) *The European Garden Flora*: **6**. Cambridge. Wrote *Veronica* and *Veronicastrum*.
- Walters, S.M. History of the *Dahlia*. In C. Jennings, *Samuel Widnall and His Dahlias*.
- 2001
- Walters, S.M. & Stow, E.A. *Darwin's Mentor: John Stevens Henslow, 1796–1861*. Cambridge
- 2004
- Walters, S.M. Grubb, P. & Stow, E.A. *100 years of Plant Sciences in Cambridge 1904–2004*. Cambridge.
- 2005
- Walters, S.M., White, J. & White, J. *Trees: a field guide*.
- Walters, S.M. Essay to accompany the Ray Society's facsimile (publication 167) of John Ray's *Wisdom of God manifested in the works of the Creation*. Special publication of the Ray Society, London.
- 2006
- Cullen, J. & Walters, S.M. Flowering plant families: how many do we need? In Leadley, E. & Jury, S.L. (Edits.) *Taxonomy and plant conservation* pp.45–90.
- A BOTANICAL SAMPLE OF THE 207 POPULAR ARTICLES IN THE PARISH MAGAZINE, GRANCHESTER.
- A fine Snowdrop year! March 1994.
- Bindweeds and Morning Glory. October 1994.
- Snowdrops. February 1995.
- Flowering Cherries and Plums. April 1995.
- Speedwells. May 1997.
- Violets and Pansies. May 2001.
- Dandelions and their relatives. September 2001.
- The Swedish Whitebeams on Pearce's Green. November 2004.

Determinants of phylogeographic structure: a comparative study of seven coastal flowering plant species across their European range

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ABSTRACT

We here synthesize our own mostly published work on the phylogeographic structure of seven flowering plant species (*Cakile maritima*, *Calystegia soldanella*, *Eryngium maritimum*, *Salsola kali*, *Halimione portulacoides*, *Triglochin maritima* and *Crithmum maritimum*) widely distributed along the European coasts. Three categories of factors were identified to determine phylogeographic structure and are illustrated with examples. These are 1) historical abiotic factors such as Quaternary climatic changes resulting in sea level changes which may explain, e.g., a phylogeographic break in the Dardanelles and Bosphorus straits, 2) modern abiotic factors such as sea currents important for the dispersal of fruits or seeds of most of the species investigated which may explain, e.g., a phylogeographic break in the Strait of Gibraltar, and 3) factors related to the specific biology of the species which may explain, e.g., the absence of phylogeographic structure in *Calystegia soldanella* resulting from clonal growth and long-distance dispersal. These factors also act in all possible combinations. The combination of 1) and 2) may be responsible for differential magnitudes in different species of the Dardanelles and Bosphorus genetic breaks, that of 2) and 3) for interspecific differences in the Gibraltar break, and 1) and 3) may explain the existence of phylogeographic breaks along the north coast of the west Mediterranean basin present in only some species, and also the deviant behaviour of *Triglochin maritima* which colonized northern European coasts from inland refugia.

KEYWORDS: phylogeography, coastal plant species, glacial distribution areas, sea water dispersal.

INTRODUCTION

In recent years, the development of appropriate molecular methods has enabled the analysis of the geographical distribution of intraspecific genetic variation. The phylogeographic structure most commonly found is interpreted as the result of range shifts in response to Quaternary

climatic oscillations (reviewed in, e.g., Soltis *et al.* 1997; Comes & Kadereit 1998, 2003; Taberlet *et al.* 1998; Hewitt 2000, 2004; Abbott & Brochmann 2003; Brochmann *et al.* 2003; Stehlik 2003; Tribsch & Schönswetter 2003; Lascoux *et al.* 2004). Intraspecific genetic structure, however, is also likely to be determined by species-specific biological attributes (Hamrick & Godt 1989; Nybom & Bartish 2000), and by modern barriers to gene flow. These three categories of factors influencing phylogeographic structure are not easy to separate.

In this context, we chose to investigate the geographical distribution of intraspecific variation in seven widely and largely co-distributed European coastal plant species of partly contrasting biology. We believe that coastal plant taxa offer several advantages when trying to infer distributional history and recognize the effects of current barriers to gene flow and of species-specific biology. First, they often are azonally distributed and have both latitudinally and longitudinally large geographical ranges. These ranges, more than in narrowly distributed taxa, are likely to still contain both refugial and recolonized areas. Second, coastal species have an essentially linear distribution range. This limits the spatial options for migration and facilitates the reconstruction of distributional limits in Quaternary glacials.

The seven plant taxa investigated are Sea Rocket *Cakile maritima* Scop. (Brassicaceae), an annual often growing in the drift-line of sandy beaches or on shingle, Prickly Saltwort *Salsola kali* L. subsp. *kali* (Chenopodiaceae), another annual from essentially the same habitat as *Cakile maritima*, Sea Holly *Eryngium maritimum* L. (Apiaceae), a perennial from mostly stabilized sandy habitats such as dunes, Sea Bindweed *Calystegia* (= *Convolvulus*) *soldanella* (L.) R. et Sch. (Convolvulaceae), a

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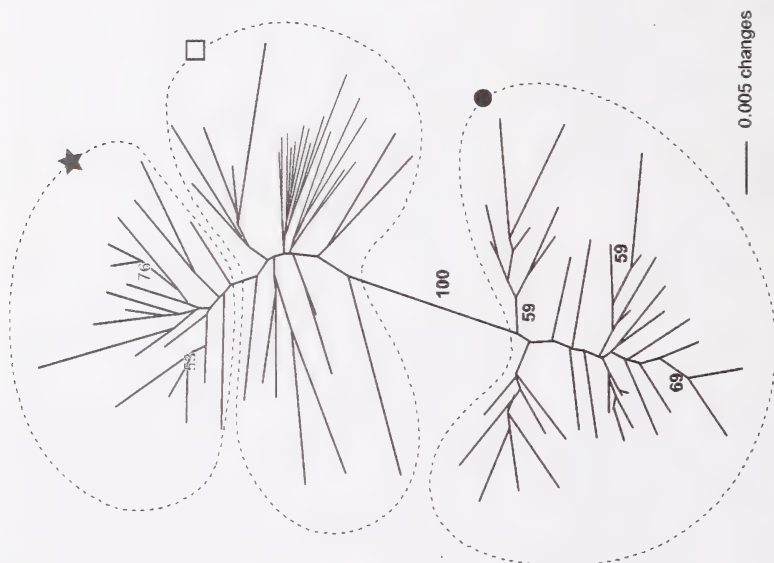


FIGURE 1. Geographical distribution of clusters obtained by Neighbor Joining analysis of Nei and Li's genetic distances between individuals. The analysis is exemplified with *E. maritimum*. The NJ phenogram was inspected for genetic clusters of individuals originating from a geographically cohesive area. Such clusters and the sampling localities of their constituent individuals are marked with the same symbol. The population genetic data of *E. maritimum* from sea straits have been analyzed separately and the results have been incorporated in the figure (see below). For *C. maritima*, *H. portulacoides* and *S. kali* the positions of intraspecific genetic gaps are indicated by thick lines (numbered from one to six). The location of these gaps are (1) the Strait of Gibraltar (*C. maritima*, *H. portulacoides*, *S. kali*), (2) southwest France (*C. maritima*, *Cr. maritimum*, *H. portulacoides*, *S. kali*), (3) south Italy (*C. maritima*, *Cr. maritimum*, *H. portulacoides*, *S. kali*), (4) south Greece (*C. maritima*, *Cr. maritimum*, *E. maritimum*, *H. portulacoides*, *S. kali*), (5) the Dardanelles strait (*C. maritima*) and (6) the Bosphorus strait (*C. maritima*, *E. maritimum*).

perennial creeper from dunes and sandy beaches, Rock Samphire *Crithmum maritimum* L. (Apiaceae), a perennial from rocky shores, and Sea Purslane *Halimione portulacoides* (L.) Aellen (Chenopodiaceae) and Sea Arrowgrass *Triglochin maritima* L. (Juncaginaceae), both perennials from salt marshes.

We here summarize our published studies on these seven species (Kadereit *et al.* 2005; Arafeh & Kadereit 2006; Lambracht *et al.* 2007) and unpublished work on population level analyses of *Cakile maritima* and *Eryngium maritimum* across sea straits between the North and Baltic Seas, the Atlantic Ocean and the Mediterranean Sea, and the Aegean, Marmara and Black Seas (Westberg & Kadereit in prep.). Based on previous conclusions, we here offer a new synthesis of our results.

MATERIAL AND METHODS

PLANT MATERIAL

Leaf material of the seven species was collected every 100–200 km along the coast from the Turkish coast of the Black Sea to the southeast coast of Sweden on the Baltic Sea and dried in silica gel to preserve DNA. A few collections from outside this range were also included as well as inland material of *S. kali* and *T. maritima*. The latter species is rare in the Mediterranean area and is therefore represented from only three localities in that region. A few localities were represented by up to seven individuals in each species (Kadereit *et al.* 2005), and seven additional populations were sampled in *C. soldanella* from the same general range (Arafeh & Kadereit 2006). In *C. maritima* and *E. maritimum* population samples were taken on a more regional scale around the Bosphorus and Dardanelles straits, the Strait of Gibraltar and along the coast of west France, as well as in the Baltic Sea and Kattegat in *C. maritima*. Usually, ten individuals from ten populations were sampled in each region.

AFLP PROCEDURE AND DATA ANALYSIS

Details of DNA isolation and the AFLP protocol (amplified fragment length polymorphism; Vos *et al.* 1995) can be found in Kadereit *et al.* (2005), Arafeh & Kadereit (2006) and Lambracht *et al.* (2007). To detect geographical structure of genetic variation, cluster analyses were performed on the AFLP data. In most cases individuals were clustered

with Neighbour Joining (NJ; Saitou & Nei 1987) based on Nei and Li's genetic distances (Nei & Li 1979). In general bootstrap support for clusters was low. Therefore, the resulting phenograms were visually inspected for clusters or groups of genetically similar clusters corresponding to cohesive geographical areas. Such clusters or groups of clusters contained all or nearly all individuals from a continuous area (see Fig. 1 for more details). For the population samples of *C. maritima* and *E. maritimum* individuals were clustered with a Bayesian method implemented in BAPS 3.2 (Corander *et al.* 2003; 2006). With this method clusters are recognized without using information on the geographical origin of samples. For more details about methods see Kadereit *et al.* (2005), Arafeh & Kadereit (2006), Lambracht *et al.* (2007) and Westberg & Kadereit (in prep.).

RESULTS

CAKILE MARITIMA, *CRITHMUM MARITIMUM*, *ERYNGIUM MARITIMUM*, *HALIMIONE PORTULACOIDES* AND *SALSOLA KALI*

Little geographic substructure was found along the Atlantic and northern European coasts. Only in *C. maritima* a genetic cluster dividing Baltic Sea material (including Skagerrak and Kattegat) from the rest was detected.

Atlantic – Mediterranean subdivision. In four (*C. maritima*, *E. maritimum*, *H. portulacoides* and *S. kali*) of the five species sampled from southern Iberia a genetic gap was found between Atlantic and Mediterranean material. This gap coincided with the Strait of Gibraltar in *C. maritima*, *H. portulacoides* and *S. kali*, and included one sample slightly east of the strait in *E. maritimum* (Fig. 1). The differentiation between these two clusters was especially marked in *E. maritimum* and *S. kali*, whereas in *C. maritima* and *H. portulacoides* the genetic gap was of smaller magnitude. In *Cr. maritimum* no genetic gap was found between the Atlantic and Mediterranean material, and instead the Atlantic cluster traverses the Strait of Gibraltar and reaches the Mediterranean coast of northeast Spain.

The population level analysis of *C. maritima* and *E. maritimum* from this area also showed a distinct gap between Atlantic and Mediterranean samples, in both species occurring between Tarifa and Algeciras. As in the large scale analysis, the magnitude of differentiation between the two regions was higher in *E. maritimum* than in *C. maritima*.

The Mediterranean. In three species the clustering showed a subdivision of material along the south coast of France (Fig. 1). Samples of *H. portulacoides* from east Spain appear as a distinct cluster and material from France and western Italy forms several closely related clusters. A similar pattern is seen in *Cr. maritimum* where the Atlantic cluster reaches northeast Spain. In *C. maritima* two western Mediterranean clusters overlap in northeast Spain and southern France. In *E. maritimum* and *S. kali* the samples from the west Mediterranean basin all fall into the same geographical cluster or the same group of clusters.

In all species except *E. maritimum* there is a subdivision of eastern and western Mediterranean samples with Sicily as the approximate geographical border. Italian samples of *S. kali* from the Ionian Sea fall into the western Mediterranean cluster but otherwise samples from the Adriatic and Ionian Seas fall into their own cluster in *C. maritima*, *Cr. maritimum*, *H. portulacoides* and *S. kali*. With the exception of *C. maritima* this cluster additionally includes some samples from the western Aegean Sea. East of the Ionian Sea the Aegean and Black Sea samples form additional geographical clusters in all five species. Although no further subdivision of these clusters was found in the large-scale analysis, the population level analysis from the straits between the Black Sea, Marmara Sea and Aegean Sea revealed clear genetic gaps at the Bosphorus strait in *C. maritima* and *E. maritimum* as well as at the Dardanelles strait in *C. maritima*. The amount of genetic differentiation in the Bosphorus was higher than in the Dardanelles in *C. maritima*, but in both cases lower than in *E. maritimum* from the Bosphorus.

TRIGLOCHIN MARITIMA

In the NJ (Fig. 2) and Bayesian analyses two groups were inferred. One Atlantic group contained samples from the Portuguese, Spanish and French coasts and the British west coast, and another group consisted of material from the North Sea, Baltic Sea and Mediterranean coasts as well as Norwegian and Central European inland material.

CALYSTEGIA SOLDANELLA

The results from *C. soldanella* contrasted with those from the other species in that no geographical clusters could be identified in the

NJ analysis (Fig. 3). Any genetic cluster recognized in the large scale or population level analyses consisted of geographically widely scattered individuals.

DISCUSSION

Our comparative analysis of phylogeographic patterns in seven flowering plant species of partly different biology, and the consideration of historical and modern abiotic factors allow us to formulate hypotheses about the possible causes of the patterns observed.

DARDANELLES AND BOSPORUS: EVIDENCE FOR THE PERSISTENCE OF HISTORICAL GENE FLOW BARRIERS
In the population level analysis of *C. maritima* and *E. maritimum*, a distinct genetic gap was found in the Bosphorus, and also in the Dardanelles in *C. maritima*. This gap was not detected either in these two species or in the other species investigated in the large scale analysis of Kadereit *et al.* (2005), probably as a result of limited sampling of only individual genotypes in this area. Following Kadereit *et al.* (2005), both species could have grown along the coasts of this area during the last glacial maximum (LGM). During the Quaternary glacials the sea levels of the Black Sea, the Sea of Marmara and the Aegean Sea were repeatedly lower than the sills of the Dardanelles and the Bosphorus (Aksu *et al.* 2002). This resulted in the isolation of the three seas from each other during such periods. As a consequence, populations in these areas would have been isolated from each other. On the other hand, currents in both the Bosphorus and the Dardanelles are unidirectional outflows from the Black Sea to the Marmara Sea and from here to the Aegean Sea. These currents should result in high westward gene flow. The combination of geological history and modern sea currents in conclusion suggest that the genetic differentiation across the Bosphorus (and the Dardanelles in *C. maritima*) is the result of historical isolation during the LGM.

STRAIT OF GIBRALTAR: SEA CURRENTS AS A BARRIER TO GENE FLOW

For all species growing in the Gibraltar area except *Cr. maritimum* a more or less distinct genetic gap was found. This gap is most pronounced in *E. maritimum* and *S. kali*, and less distinct in *H. portulacoides* and *C. maritima* in the large scale analysis (Kadereit

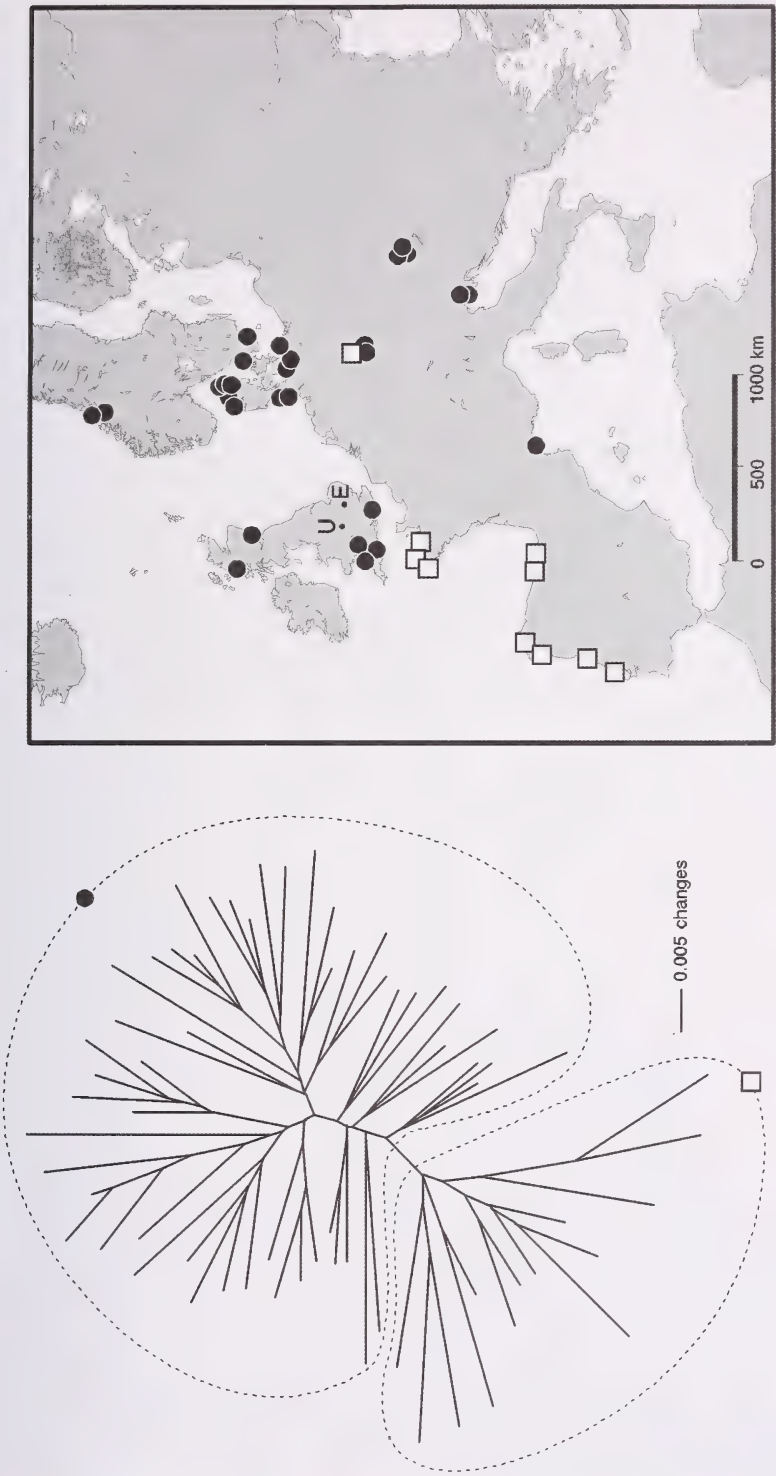


FIGURE 2. Neighbor Joining analysis and geographical distribution of clusters in *T. mariima*. Squares represent individuals belonging to an Atlantic group and circles samples assigned to a North Sea/Baltic Sea group that also contains Mediterranean and Norwegian inland material. The letters E and U indicate sites of fossil *T. mariima*.

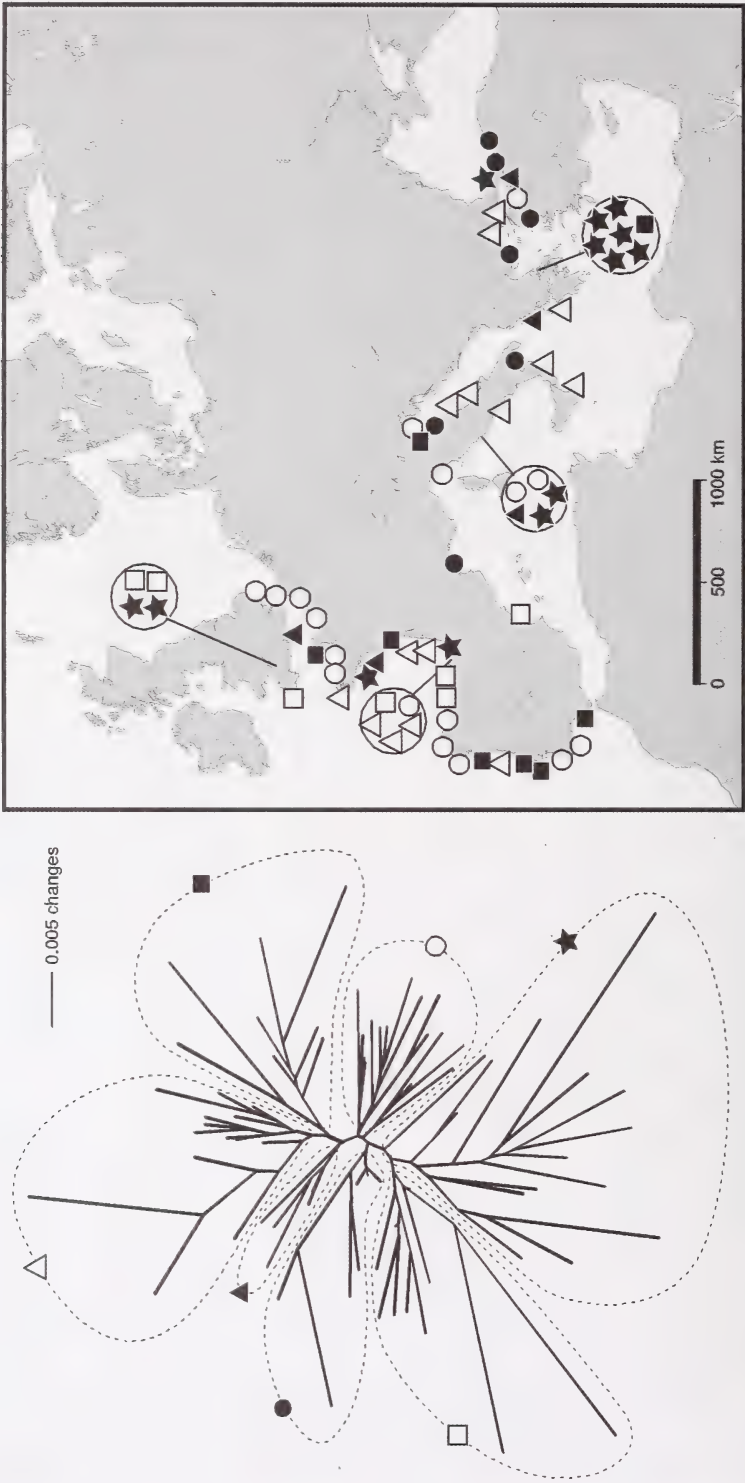


FIGURE 3. Neighbour Joining analysis and geographical distribution of clusters in *C. soldanella*. Individuals do not group according to geographical origin.

et al. 2005), and distinct and of geographically identical position in the population level analysis of *C. maritima* and *E. maritimum*. Except for *H. portulacoides*, it is the clearest separation in terms of among region genetic differentiation (Kadereit *et al.* 2005). The Strait of Gibraltar has been open for the last c. 5my (Krijgisman *et al.* 1999), and the coasts of the area were likely to have been inhabitable for all species concerned during the LGM (Kadereit *et al.* 2005). This implies that only a modern barrier to gene flow across the Gibraltar strait can be responsible for the genetic gap found. This gene flow barrier could be in the form of sea currents. The surface currents in the Strait of Gibraltar are influenced by the tidal differences between the Gulf of Cadiz to the west and the Alboran Sea on the east side of the strait (Rey 1983). During high tide surface water is flowing east into the Mediterranean and at low tide the currents are reversed. Possibly the gene flow barrier arises because the changes in sea current direction make it difficult for seeds to pass the strait. This explanation implies that dispersal of the coastal flowering plant species investigated here is largely by sea currents. Similar explanations have been proposed to explain the existence of a genetic gap in the Gibraltar area in several (but not all) marine organisms investigated (Magoulas *et al.* 1996; Borsa *et al.* 1997a, b; Pérez-Losada, *et al.* 1999; Rios *et al.* 2002; Bargelloni *et al.* 2003; Nikula & Väinölä 2003; Waters & Roy 2003; Olsen *et al.* 2004). The exceptional behaviour of *Cr. maritimum*, where the eastern Spanish material is very clearly part of the larger Atlantic cluster (Kadereit *et al.* 2005) is perhaps best explained by a recent colonization of the Mediterranean coast of Spain from the Atlantic coast. This does not explain, however, how *Cr. maritimum* could surmount the Gibraltar barrier postulated here to act in the other species investigated.

CALYSTEgia SOLDANELLA: CLONAL GROWTH AND LONG-DISTANCE DISPERSAL PREVENT THE FORMATION OF PHYLOGEOGRAPHIC PATTERN

Among the species investigated, *C. soldanella* is exceptional in showing essentially no phylogeographic structure. This was found not only in the large scale analysis, but also in a population level study where individuals from geographically widely separated populations did not group according to population (Arafeh & Kadereit 2006). A postglacial arrival of *C. soldanella* in the study area as explanation for

the absence of phylogeographic pattern was ruled out by Arafeh & Kadereit (2006) on the basis of interglacial fossil evidence for the species in the British Isles (Godwin 1975) and on the basis of the observation that the magnitude of intraspecific genetic differentiation in *C. soldanella* is as high as in the other species investigated. Instead, Arafeh & Kadereit (2006) argued that the exceptional behaviour of *C. soldanella* is best explained by its biology. The species shows substantial clonal growth, and seeds have been reported to be able to float in sea water for at least 27 months (Arafeh & Kadereit 2006) and to have 90% viability after 1 year of floating (Arafeh & Kadereit 2006) and 30% viability after 18 months of floating (Ridley 1930). The exceptional floating ability results from a very robust seed coat in combination with an air cavity in the seeds. Arafeh & Kadereit (2006) argued that the absence of phylogeographic structure is the combined result of a high frequency of long-distance dispersal resulting from long floating time and long viability of the seeds, and clone longevity, where the age of clones, however, is unknown. High longevity of clones implies that even if establishment of seeds after long-distance dispersal is rare, the chance of their detection is increased by their long persistence. If this interpretation of *C. soldanella* is correct, it would illustrate that the formation of phylogeographic pattern through historical or modern abiotic factors can be prevented by a species' biology.

THE DARDANELLES AND BOSPORUS GENETIC BREAKS: THE INTERACTION OF HISTORICAL AND MODERN ABIOTIC FACTORS

As discussed above, distinct genetic gaps are found in *C. maritima* across the Dardanelles and across the Bosphorus. In view of ongoing gene flow in this area, these gaps were interpreted as signatures of the closure of these two straits during Quaternary glacials. Interestingly, differentiation among regions in *C. maritima* is stronger across the Bosphorus than across the Dardanelles. This, in our opinion, reflects the interaction of modern and historical abiotic factors. Whereas the Dardanelles land barrier was broken c. 12 kyr ago (Aksu *et al.* 2002), the reconnection of the Marmara Sea to the Black Sea happened c. 9.5 kyrs ago (Bahr *et al.* 2006; Mudie *et al.* 2004). Accordingly, erosion of the signal left by the glacial closure of the two straits started some

2.5 kyrs earlier in the Dardanelles than in the Bosphorus, and this is recognizable in the weaker differentiation across the Dardanelles than across the Bosphorus. The comparison of these two areas offers the unique opportunity to calculate rates of gene flow through seed dispersal and to predict when the historical signal recognizable will be completely eroded.

INTERSPECIFIC DIFFERENCES IN GIBRALTAR: THE MAGNITUDE OF MODERN BARRIERS TO GENE FLOW DEPENDS ON SPECIES BIOLOGY

The population-level comparison of *C. maritima* and *E. maritimum* across the Strait of Gibraltar revealed the existence of a distinct phylogeographic gap at exactly the same location. Considering the history of the Strait of Gibraltar, which has been continuously open for the last c. 5 my, and the failure to identify a terrestrial barrier to gene flow in the area, modern sea currents were hypothesized to explain the Gibraltar gap found. When comparing the two species investigated, the gap in *C. maritima* is noticeably smaller than in *E. maritimum*. This difference can be attributed to the differential dispersability of the two species, where dispersability in terms of floating time in sea water and viability of seeds is higher in *C. maritima* than in *E. maritimum*. This finding illustrates that sea currents in the Gibraltar area are not an unsurmountable barrier to gene flow, and, more importantly in the present context, that the strength of modern gene flow barriers is relative and depends on species-specific dispersability.

HISTORICAL FACTORS LEAVE SPECIES-SPECIFIC SIGNATURES

Among the species investigated, differences in phylogeographic structure exist in the west Mediterranean basin (southwest Italy/Sicily to Gibraltar; Fig. 1). Material from this area falls into one genetic cluster in *S. kali*, and into several genetically similar clusters in *E. maritimum*. In *C. maritima*, *H. portulacoides* and *Cr. maritimum* material essentially separates into two groups, of which a western group (e.g., southeast Spain in *C. maritima*) is more similar to Atlantic material, and an eastern group (e.g., northeast Spain and west Italy in *C. maritima*) is more similar to Adriatic/east Mediterranean material. The difference between these two species groups (*C. maritima*, *Cr. maritimum*, *H. portulacoides* vs. *E. maritimum*, *S. kali*) probably can be explained with species-specific responses to Quaternary climatic changes (Kadereit *et al.* 2005). When

considering the geographical position of June/July/August temperature isotherms now found at the northern distributional limits of the species investigated (*C. maritima* subsp. *maritima*: 12°C, *S. kali* subsp. *kali* and *E. maritimum*: 14°C, *H. portulacoides* and *Cr. maritimum*: 16°C) during the last glacial maximum (van Andel 2002), and when assuming that these summer isotherms are either directly, as postulated for *H. portulacoides* by Chapman (1950), or indirectly responsible for the northern distributional limit of the species investigated, it is likely that *E. maritimum* and *S. kali* could have persisted along the entire north coast of the west Mediterranean basin during the LGM, whereas *Cr. maritimum* and *H. portulacoides* had to retreat south. Retreat along the coasts would have meant retreat to the southwest and southeast. The phylogeographic subdivision of the latter two species along the north coast of the west Mediterranean basin would then be the result of re-colonization from these two directions. No explanation can be offered for *C. maritima* which, considering its temperature requirements, might have persisted along the entire north coast but still shows a subdivision similar to that of *Cr. maritimum* and *H. portulacoides*. The among-species phylogeographic incongruencies in the west Mediterranean basin thus illustrate that responses to historical climatic changes are species-specific and leave a distinct phylogeographic signal which may eventually disappear through ongoing gene flow.

Among the species investigated by us, the most striking example for a species-specific response is provided by *Triglochin maritima*. Today, *T. maritima* can grow much further north than the remaining species, and its northern distributional limit is correlated with the 8°C July isotherm. This, the identification of an Atlantic cluster and a cluster containing all material sampled from the North Sea area, the Baltic Sea area, Central European inland localities, the northern Adriatic Sea coast and the Mediterranean coast of southwest France, and the existence of macrofossils of *T. maritima* near Earith and Upton Warren in southern England (Fig. 3) dated to approximately 40 000 years ago (Bell 1969), led Lambracht *et al.* (2007) to postulate that modern populations of this species from the North and Baltic Sea areas originated from inland populations rather than from Atlantic Ocean populations as in the other species investigated.

CONCLUSIONS

The above hypotheses on the possible causes of phylogeographic structure in the species investigated certainly can be taken to even higher levels of complexity. It should be noted, however, that all hypotheses formulated are the result of a comparative approach and are based on rather incomplete knowledge of past and present abiotic factors considered relevant for the distribution of species. Because the plant species compared differ in a large number of characters beyond those discussed above, and the effect of historical and modern abiotic factors on these species may well have been quite different from what we assume, our

interpretations should be considered with the necessary caution.

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REFERENCES

- ABBOTT, R. J. & BROCHMANN, C. (2003). History and evolution of the arctic flora: in the footsteps of Eric Hultén. *Molecular Ecology* **12**: 299–313.
- AKSU, A. E., HISCOFF, R. N., MUDIE, P. J., ROCHON, A. *et al.* (2002). Persistent Holocene outflow from the Black Sea to the Eastern Mediterranean contradicts Noah's Flood hypothesis. *GSA Today* **12**: 4–10.
- ARAFEH, R. & KADEREIT, J. W. (2006). Long-distance seed dispersal, clone longevity and lack of phylogeographical structure in the European distributional range of the coastal *Calystegia soldanella* (L.) R. Br. (Convolvulaceae). *Journal of Biogeography* **33**: 1461–1469.
- BAHR, A., ARZ, H., LAMY, F. & WEFER, G. (2006). Late glacial to Holocene paleoenvironmental evolution of the Black Sea, reconstructed with stable oxygen isotope records obtained on ostracod shells. *Earth and Planetary Science Letters* **241**: 863–875.
- BARGELLONI, L., ALARCON, J. A., ALVAREZ, M. C., PENZO, E. *et al.* (2003). Discord in the family Sparidae (Teleostei): divergent phylogeographical patterns across the Atlantic-Mediterranean divide. *Journal of Evolutionary Biology* **16**: 1149–1158.
- BELL, F. G. (1969). The occurrence of southern, steppe and halophyte elements in the Weichselian (last glacial) floras from southern Britain. *New Phytologist* **68**: 913–922.
- BORSA, P., BLANQUER, A. & BERREBI, P. (1997). Genetic structure of the flounders *Platichthys flesus* and *P. stellatus* at different geographic scales. *Marine Biology* **129**: 233–246.
- BORSA, P., NACIRI, M., BAHIRI, L., CHIKHI, L. *et al.* (1997). Zoogéographie infra-spécifique de la mer Méditerranée. Analyse des données génétiques populationnelles sur seize espèces atlanto-méditerranéennes (Poissons et Invertébrés). *Vie Milieu* **47**: 295–305.
- BROCHMANN, C., GABRIELSEN, T. M., NORDAL, I., LANDVIK, J. Y. *et al.* (2003). Glacial survival or tabula rasa? The history of North Atlantic biota revisited. *Taxon* **52**: 417–450.
- CHAPMAN, V. J. (1950). Biological Flora of the British Isles: *Halimione portulacoides* (L.) Aell. *Journal of Ecology* **38**: 214–222.
- COMES, H. P. & KADEREIT, J. W. (1998). The effect of Quaternary climatic changes on plant distribution and evolution. *Trends in Plant Science* **3**: 432–438.
- COMES, H. P. & KADEREIT, J. W. (2003). Spatial and temporal patterns in the evolution of the flora of the European Alpine System. *Taxon* **52**: 451–462.
- CORANDER, J., WALDMANN, P. & SILLANPÄÄ, M. J. (2003). Bayesian analysis of genetic differentiation between populations. *Genetics* **163**: 367–374.
- CORANDER, J., MARTTINEN, P. & MÄNTYNIEMI, S. (2006). A Bayesian method for identification of stock mixtures from molecular marker data. *Fishery Bulletin* **104**: 550–558.
- GODWIN, H. (1975). *The History of the British Flora*. 2nd edn. Cambridge University Press, Cambridge.
- HAMRICK, J. L., GODT, M. J. (1989). Allozyme diversity in plant species, in A. H. D. BROWN, M. T. CLEGG, A. L. KAHLER & B. S. WEIR (eds) *Plant Population Genetics, Breeding and Germplasm Resources*, pp. 43–63. Sinauer, Sunderland, Mass.
- HEWITT, G. M. (2000). The genetic legacy of the Quaternary ice ages. *Nature* **405**: 907–913.
- HEWITT, G. M. (2004). Genetic consequences of climatic oscillations in the Quaternary. *Philosophical Transactions of the Royal Society of London, Series B: Biological Sciences* **359**: 183–195.
- KADEREIT, J. W., ARAFEH, R., SOMOGYI, G. & WESTBERG, E. (2005). Terrestrial growth and marine dispersal? Comparative phylogeography of five coastal plant species at a European scale. *Taxon* **54**: 861–876.

- KRIJGSMAN, W., HILGEN, F. J., RAFFI, I., SIERRO, F. J. *et al.* (1999). Messinian astrochronology and the synchronicity of the salinity crisis. *Nature* **400**: 652–655.
- LAMBRACHT, E., WESTBERG, E. & KADEREIT, J. W. (2007). Phylogeographic evidence for the postglacial colonization of the North and Baltic Sea coasts from inland glacial refugia by *Triglochin maritima* L. *Flora* **202**: 79–88.
- LASCoux, M., PALMÉ, A. E., CHEDDADI, R. & LATTA, R. G. (2004). Impact of ice ages on the genetic structure of trees and shrubs. *Philosophical Transactions of the Royal Society of London, Series B: Biological Sciences* **359**: 197–207.
- MAGOULAS, A., TSIMENIDES, N. & ZOUROS, E. (1996). Mitochondrial DNA phylogeny and the reconstruction of the population history of a species: the case of the European anchovy (*Engraulis encrasicolus*). *Molecular Biology and Evolution* **13**: 178–190.
- MUDIE, P. J., ROCHON, A., AKSU, A. E. & GILLESPIE, H. (2004). Late glacial, Holocene and modern dinoflagellate cyst assemblages in the Aegean-Marmara-Black Sea corridor: statistical analysis and re-interpretation of the early Holocene Noah's Flood hypothesis. *Review of Palaeobotany and Palynology* **128**: 143–167.
- NEI, M. & LI, W.-H. (1979). Mathematical model for studying genetic variation in terms of restriction endonucleases. *Proceedings of the National Academy of Sciences of the United States of America* **76**: 5269–5273.
- NIKULA, R. & VÄINÖLÄ, R. (2003). Phylogeography of *Cerastoderma glaucum* (Bivalvia: Cardiidae) across Europe: a major break in the Eastern Mediterranean. *Marine Biology* **143**: 339–350.
- NYBOM, H., & BARTISH, I. V. (2000). Effects of life history traits and sampling strategies on genetic diversity estimates obtained with RAPD markers in plants. *Perspectives in Plant Ecology, Evolution and Systematics* **3**: 93–114.
- OLSEN, J. L., STAM, W. T., COYER, J. A., REUSCH, T. B. H. *et al.* (2004). North Atlantic phylogeography and large-scale population differentiation of the seagrass *Zostera marina* L. *Molecular Ecology* **13**: 1923–1941.
- PEREZ-LOSADA, M., GUERRA, A. & SANJUAN, A. (1999). Allozyme differentiation in the cuttlefish *Sepia officinalis* (Mollusca: Cephalopoda) from the NE Atlantic and Mediterranean. *Heredity* **83**: 280–289.
- REY, J. C. (1983). El paso del atún rojo, *Thunnus thynnus* (Linnaeus, 1758), a través del Estrecho de Gibraltar y su relación. Esquemas de migración. *Boletín del Instituto Español de Oceanografía* **1**: 85–94.
- RIDLEY, H. N. (1930). *The dispersal of plants throughout the world*. Reeve, Ashford, Kent.
- RIOS, C., SANZ, S., SAAVEDRA, C. & PEÑA, J. B. (2002). Allozyme variation in populations of scallops, *Pecten jacobaeus* (L.) and *P. maximus* (L.) (Bivalvia: Pectinidae), across the Almeria-Oran front. *Journal of Experimental Marine Biology and Ecology* **267**: 223–244.
- SAITOU, N. & NEI, M., (1987). The neighbor-joining method: a new method for reconstructing phylogenetic trees. *Molecular Biology and Evolution* **4**: 496–425.
- SOLTIS, D. E., GITZENDANNER, M. A., STRENCE, D. D. & SOLTIS, P. S. (1997). Chloroplast DNA intraspecific phylogeography of plants from the Pacific Northwest of North America. *Plant Systematics and Evolution* **206**: 353–373.
- STEHLIK, I. (2003). Resistance or emigration? Response of alpine plants to the ice ages. *Taxon* **52**: 499–510.
- TABERLET, P., FUMAGALLI, L., WUST-SAUCY, A. G. & COSSON, J. F. (1998) Comparative phylogeography and postglacial colonization routes in Europe. *Molecular Ecology* **7**: 353–364.
- TRIBSCH, A. & SCHÖNSWETTER, P. (2003). Patterns of endemism and comparative phylogeography confirm palaeo-environmental evidence for Pleistocene refugia in the Eastern Alps. *Taxon* **52**: 477–497.
- VAN ANDEL, T. H. (2002). The climate and landscape of the middle part of the Weichselian glaciation in Europe: the stage 3 project. *Quaternary Research* **57**: 2–8.
- VOS, P., HOGERS, R., BLEEKER, M., REIJANS, M., *et al.* (1995). AFLP: a new technique for DNA fingerprinting. *Nucleic Acids Research* **23**: 4407–4414.
- WATERS, J. M. & ROY, M. S. (2003). Global phylogeography of the fissiparous sea-star *Coscinasterias*. *Marine Biology* **142**: 185–191.
- WESTBERG, E. & KADEREIT, J. W. (in prep). Determinants of phylogeographic structure: a comparative analysis of two coastal flowering plant species across three sea straits of different history and along a continuous stretch of coast.

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Hybridisation between Oxlip *Primula elatior* (L.) Hill and Primrose *P. vulgaris* Hudson, and the identification of their variable hybrid *P. ×digenea* A. Kerner

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ABSTRACT

Hybrids between Oxlip *P. elatior* and Primrose *P. vulgaris* are commonly recorded in mixed populations of the two species, but there has been debate as to whether or not backcrossing and introgression occur. Allozyme electrophoresis has demonstrated that backcrossed or F₁ hybrids are frequent in a mixed population of the species in Cambridgeshire (v.c. 29). Molecular analysis reveals that the hybrid or backcrossed plants are very variable in morphology, and some cannot be distinguished from Oxlips in the field. However, whilst some hybrids are intermediate in character and some are identical, or almost identical, to Oxlips, all were easily distinguished from Primrose. Oxlip is easily separated from the widespread hybrid between Cowslip and Primrose, *P. veris* × *vulgaris*.

KEYWORDS: Buff Wood, introgression, *Primula veris*, *Primula ×polyantha*, Primulaceae.

INTRODUCTION

HYBRIDS BETWEEN YELLOW-FLOWERED PRIMULAS IN BRITAIN

All three of the British yellow-flowered primulas (Oxlip *Primula elatior*, Primrose *P. vulgaris*, and Cowslip *P. veris*) interbreed to produce hybrids (Valentine 1975). Of the three hybrids, the most widespread is that between *P. vulgaris* and *P. veris*, known as False Oxlip *Primula ×polyantha*. This plant caused considerable consternation among the botanists

of the 19th Century as they debated whether or not the Oxlip was a British plant (Brown 1842; Doubleday 1842; Hill 1842; Leefe 1842; Moxon 1842; Watson 1842; Gibson 1844). The False Oxlip has been recorded as a native from 87 of the 112 Watsonian vice-counties in Britain (Stace *et al.* 1993), and its distribution matches the range of the less widespread parent, *P. veris*, fairly closely (Preston *et al.* 2002). However, the hybrid is rarely present in large numbers (Clifford 1958). The cross between *P. veris* and *P. vulgaris* is more fertile when *P. veris* is the female parent (Darwin 1869), but even so the seeds are less viable than those produced by intraspecific crosses (Valentine 1955). Despite the high viability of seeds from backcrosses to either parent (Valentine 1955), apparent backcross plants or F₂s (crosses between hybrids) are rarely reported in the wild (Clifford 1958; Woodell 1965).

As one would expect from the limited range of *P. elatior*, the hybrids that involve this species have a much more restricted distribution than *P. ×polyantha*. The hybrid between *P. elatior* and *P. veris*, *P. ×media*, is rare. It has been recorded only sporadically from North Essex (Jermyn 1974), Cambridgeshire (Preston 1993), East and West Suffolk (Simpson 1982), East Norfolk (Miller Christy 1922), and Huntingdonshire (Wells 2003). The *P. elatior* × *P. veris* cross very rarely produces viable seed, but when *P. veris*

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is the female parent, a tiny fraction of seeds produced may germinate. Valentine (1952) obtained germination rates of 14/4000 for female *P. veris* $\times$ male *P. elatior*, and 0/2000 for the reciprocal cross with *P. elatior* as the female. Offspring have been produced by backcrossing *P. media* to either parent (Valentine 1952), but the only case of backcrossing in the wild that we are aware of is a rather curious-sounding record by Jermyn (1974) of a "hybrid swarm with no *P. veris* present and only a few roots of *P. elatior* near a railway with scattered hybrids and abundant *P. veris*, and a wood with plentiful *P. elatior*". A triple hybrid between all three species, *Primula* $\times$ *murbeckii*, has been reported from Suffolk where it seems to have been most often found in colonies of *P. elatior* $\times$ *P. vulgaris*, but it is extremely rare (Simpson 1982). There is one record from Cambridgeshire, where an apparent cross between native *P. elatior* and cultivated *P. $\times$ polyantha* has been reported (Preston 1993).

P. $\times$ digenea, the hybrid between *P. elatior* and *P. vulgaris*, has a limited distribution, but it seems to be present at all British sites where both parents occur together. It is certainly in all the woods west of Cambridge that contain both *P. elatior* and *P. vulgaris* (Meyer & Meyer 1951), and in all those known to us east of that city (which divides the British range of *P. elatior* into two separate parts). In contrast to the more widespread *P. $\times$ polyantha*, *P. $\times$ digenea* can be present in large quantities where the parent species meet: in Gamlingay Wood (v.c. 29), Peter Walker (unpublished data) counted 3675 Oxlips, 404 Primroses, and 2131 hybrids in 1992. Populations in woods where hybrids are present have been described as hybrid swarms.

The character of the *P. elatior* $\times$ *P. vulgaris* hybrid is very variable. Simpson (1982) noted that "almost every conceivable form can be found between the species. There are some that might be mistaken for Primroses, or even pure Oxlips". The large numbers of hybrids, and the presence of plants that are almost, but not quite, identical to either parent, suggested that introgression and backcrossing may be frequent. This was disputed by Miller Christy (1922), who was "not conscious of ever having seen a plant which appeared to be a second-cross hybrid", and by morphological investigations by Valentine (1948) and Woodell (1969). However, Valentine (1961) revised this view after a later study, concluding that "At any rate, at present, introgression is certainly occurring."

The variability of the hybrids, and of *P. elatior* itself, means that it is difficult to use morphological characters to distinguish between first (F_1) and later ($F_{>1}$) generation hybrids and backcrosses, and this probably explains the difference in opinion as to whether populations are introgressed.

Using molecular species-specific markers, we have proved that in the well-studied Oxlip population at Buff Wood, Cambridgeshire (v.c. 29), some plants are indeed introgressed or backcrossed (Gurney 2000). Molecular markers also revealed that some plants that were identified as Oxlips using morphological characters were in fact hybrids.

With the interest in hybrids from the new hybridisation and the British flora project (Pearman & Preston 2005), we feel it is timely to review the characters used to identify Oxlips and their hybrids, and to demonstrate the variation that can be found in hybrid swarms. Mixed populations of parent species and putative hybrids are not uncommon in the British flora and have traditionally been investigated by morphological or morphometric studies. Examples include species of *Betula* (Brown *et al.* 1982), *Calamagrostis* (Crackles 1995), *Dactylorhiza* (Heslop Harrison 1949), *Gentianella* (Rich *et al.* 1997), and *Quercus* (Kelleher *et al.* 2003). In some cases cytological evidence has been used to confirm the identity of hybrids in populations where the putative parents differ in chromosome number, such as in the studies of *Eleocharis* by Lewis & John (1961). Only in recent years has it been possible to combine morphological and molecular studies to investigate the identity of putative hybrids, for example in *Potamogeton* (Fant *et al.* 2003), *Trichophorum* (Hollingsworth & Swan 1999), *Salix* (Scottish Montane Willow Research Group 2005), and *Schoenoplectus* (Fay *et al.* 2003). In this study the identity of putative hybrids has been confirmed by allozyme electrophoresis and these plants have been used in assessing the morphological differences between the taxa.

METHODS

MORPHOLOGY

The populations of *P. elatior*, *P. vulgaris*, and *P. $\times$ digenea* at Buff Wood, Cambridgeshire (v.c. 29), National Grid Reference TL2850, have been the subject of previous studies of hybridisation (Valentine 1947, 1948, 1961; Walters & Ockenden 1968). Plants in this

population were compared with those from single-species populations of *P. elatior*, *P. vulgaris*, and *P. veris* ("pure populations"). They were examined and photographed, and characters useful for distinguishing them were noted. From these, drawings were made to show the main characters of each species. Plants of known genotypes at Buff Wood were also drawn and photographed to record the variation in hybrids and backcrossed plants. Specimens of these were deposited in the herbarium of the Department of Plant Sciences, University of Cambridge (CGE). The Buff Wood plants included 26 hybrids of which 11 were non- F_1 hybrids. (Backcrosses are produced by hybrids crossing with one of the parent species, and later generation (F_{2+}) hybrids are formed by crosses between hybrids. Both of these could show exactly the same pattern when examined using allozyme electrophoresis, so we could not distinguish between them. We therefore use the term "non- F_1 hybrid" to describe backcrosses and later generation hybrids (as distinct from first generation F_1 hybrids).)

POLLEN STAINABILITY

One flower was collected from plants selected at Foxley Wood, East Norfolk, v.c. 27, and Wayland Wood, West Norfolk, v.c. 28 (*P. vulgaris* only), and Hayley Wood (*P. elatior* only), Cambridgeshire, v.c. 29, and Buff Wood (both species), also v.c. 29, and stored in 70% ethanol. The number of plants used varied between sites (Table 2) because we wanted to use the same individuals sampled for allozyme electrophoresis so that we could be certain of the genetic identity of the plants. Unfortunately, some of these plants had all their flowers removed by herbivores before they dehisced, so not all could be sampled for pollen stainability. Eight months after collection, the fertility of each flower was estimated by counting the number of round, stainable pollen grains in acetocarmine. This method was used by Woodell (1969) and Valentine (1948), but neither gave details of the protocol used. We followed the method in Gurr (1953), using a solution of 0.4 g carmine in 55 ml water and 45 ml glacial acetic acid. An anther was removed from the flower and placed on a microscope slide and a drop of acetocarmine was added. A coverslip was then placed on top and tapped to disperse the pollen grains. A sample of 200 grains was counted and the

number of unstained, unswollen grains was recorded. Although staining is not necessarily an accurate measure of fertility, this method has been used to distinguish backcrossed plants in previous studies of introgression in *Primula* (Woodell 1965), and combining the staining results with the electrophoresis should allow an assessment of its effectiveness.

RESULTS

MORPHOLOGICAL CHARACTERS OF *P. ELATIOR*, *P. VULGARIS*, *P. VERIS*, AND THEIR HYBRIDS

The most useful characters for distinguishing between *P. elatior* and *P. vulgaris*, based on plants from pure populations, are shown in Figs 1–2 and Table 1. *P. elatior* has smaller flowers than *P. vulgaris*, but there is some overlap. More important are the colour of the flowers and the shape of the markings at their centre, scent, and the hairiness of the pedicels and scape. In the mixed population at Buff Wood, some plants combine characters from both species, and molecular analysis shows that these are a mixture of F_1 and non- F_1 hybrids. Three examples of these are shown: an "intermediate" hybrid (Fig. 3); an "Oxlip-like hybrid" (Fig. 4); and a "Primrose-like hybrid" (Fig. 5). Drawings of *P. veris* and *P. xpolyantha* are shown for comparison in Figs 6–7. The variation in hybrids confirmed by electrophoresis is illustrated in Plates 1–6, and photographs of the parents from pure populations are shown in Plates 7–8.

There is no difficulty in distinguishing between the species, between *P. xpolyantha* and *P. elatior*, and between *P. xpolyantha* and *P. xdigenea*. Hybrids involving *P. veris* reveal their parentage by a dark orange streak at the base of the petal, by an inflated, more bluntly-toothed calyx, and by shorter hairs. *P. vulgaris* appears much more distinct than does *P. elatior*. Many plants at Buff Wood closely resembled *P. elatior* from pure populations but they showed one or more features suggestive of *P. vulgaris*, such as slightly longer hairs than in the pure populations, or larger flowers. If they had been found in pure populations, these would probably have been considered to be just outside the extremes of variation within *P. elatior* and they more or less grade into it. In contrast, all the plants with *P. vulgaris* characters, such as large, pale flowers, or shaggy hairs, were either obviously

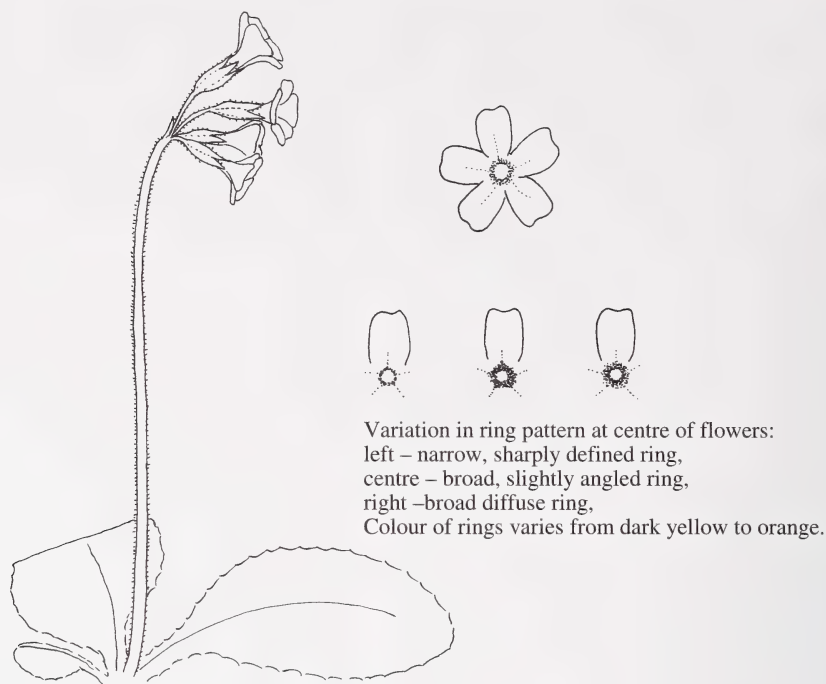


FIGURE 1. *Primula elatior*. Calyx rather narrow. Flowers usually facing to one side. Flowers clear yellow, petals often rather narrow. Leaves hairy, often with distinct petiole, usually rather broad and not reddish at base. Scape shortly hairy. Short pedicels. Scale bar = 1 cm.



FIGURE 2. *Primula vulgaris*. Flowers larger than those of *P. elatior*, with more rounded petals and usually sharper notches. Very pale, almost greenish, yellow flowers with distinct orange star shape at centre, formed by diamond-shaped mark on each petal. Leaves cuneate, with no distinct petiole, often reddish at base. Flowers in a stalk-less umbel. Very rarely on a scape, which is covered in shaggy hairs. Flowers on long pedicels. Pedicel and calyx covered in long shaggy hairs. Scale bar = 1 cm.



FIGURE 3. *Primula* $\times$ *digenea* (intermediate). Flowers on longer pedicels than in *P. elatior*, creating more open inflorescence, and not all facing same way. Flowers variable, but usually paler than in *P. elatior*, and with pentagon or weakly-formed star at centre. Scape, pedicels, and calyx with long shaggy hairs. Leaves broader than in *P. vulgaris*, but with less distinct petiole than in *P. elatior*. Scale bar = 1 cm.

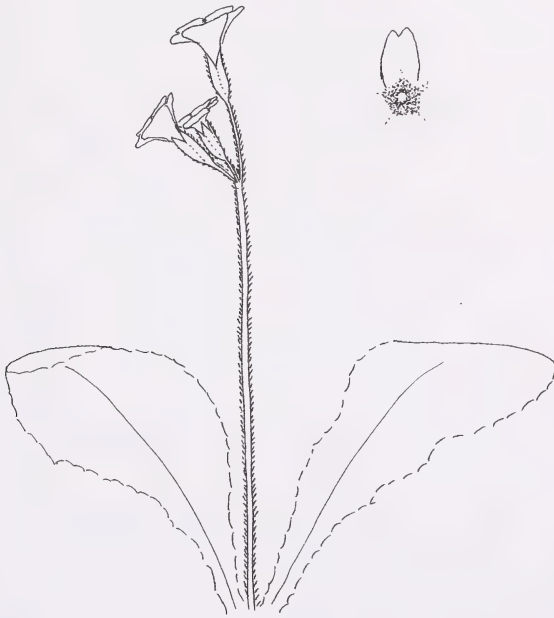


FIGURE 4. *Primula* $\times$ *digenea* (Oxlip-like). Flowers on short pedicels, all facing same way. Flowers pale yellow with clear pentagon mark at centre. Leaves not truncate and not with obvious petiole, but still within range of variation found in *P. elatior*. Shortly hairy scape. Scale bar = 1 cm.

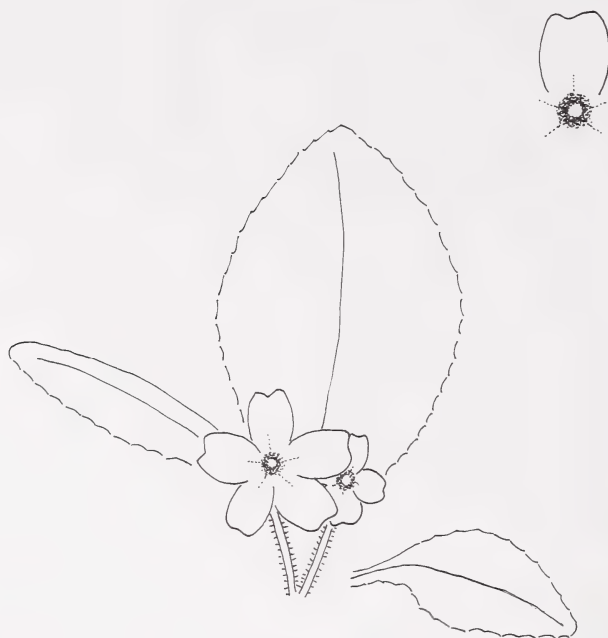


FIGURE 5. *Primula* $\times$ *digenea* (Primrose-like). Flowers close to *P. vulgaris* in colour, in stalkless umbel, but with broad diffuse ring at centre. Flowers like *P. vulgaris* in size and shape. Pedicels with short hairs. Leaves broader than in *P. vulgaris*. Scale bar = 1 cm

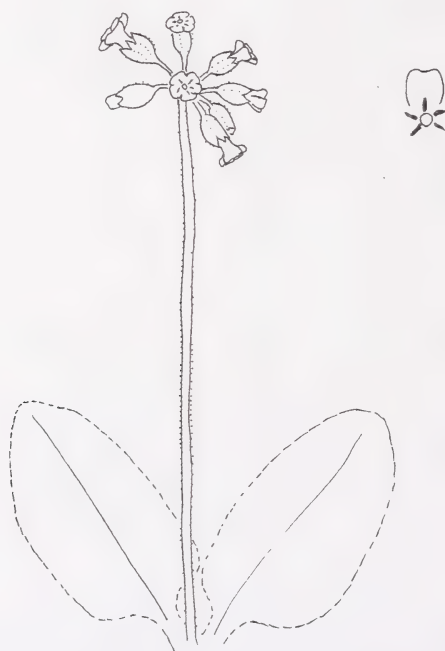


FIGURE 6. *Primula veris*. Broad, inflated calyx with blunt teeth. Flowers with short, round petals. Deep yellow, with sharp dark orange streak at the base of petals. Short pedicels. Leaves glabrous above, very shortly hairy beneath. Leaves sharply truncate. Scape, pedicels, and calyx with very short crisped hairs. Flowers not often facing all same way. Scale bar = 1 cm.



FIGURE 7. *Primula* $\times$ *polyantha*. Long pedicels, flowers not all facing same way. Flowers larger than in *P. veris*, more like *P. vulgaris* in shape. Pale yellow, with orange pentagon at centre, and dark streak on each petal. May rarely have *P. veris*-like flowers at base. Leaves rounded to truncate, shortly hairy. Scape and pedicels very shortly hairy. Scale bar = 1 cm.

intermediate between the two species or looked exactly like pure *P. vulgaris*. An example of a plant that looks superficially like *P. vulgaris* is shown in Fig. 5, but even this is easily distinguished from Primrose by its shortly hairy pedicels and very broad leaves. Therefore, the only possible confusion arises with plants that seem to be close to *P. elatior*, but could be first or later generation hybrids or backcrosses.

POLLEN STAINABILITY

The results of the pollen staining are presented in Table 2. The *P. elatior* samples from the mixed population at Buff Wood and the pure population at Hayley Wood both have very high levels of stainability. This seems to be slightly reduced in the hybrids at Buff Wood, but the *P. vulgaris* from Buff Wood and from the two pure populations also have lower levels

of stainability. Pollen stainability can therefore not be used to differentiate between hybrids and *P. vulgaris*, but there is rarely any difficulty in distinguishing between them using morphological characters anyway. Pollen stainability may be more useful in distinguishing between *P. elatior* and hybrids and backcrosses, but the sample from the pure population at Hayley Wood includes *P. elatior* plants that have relatively low pollen stainability, so this measure is not conclusive. Unfortunately the leaves sampled from these plants degraded before allozymes could be extracted, so we could not combine pollen staining results with those from allozyme electrophoresis.

Our values for stainability are noticeably lower than those of Woodell (1969), and they have higher standard errors. This seems to be

TABLE 1. MAIN CHARACTERS FOR SEPARATING COWSLIP *PRIMULA VERIS*, PRIMROSE *P. VULGARIS*, OXSLIP *P. ELATIOR* AND THEIR HYBRIDS

	Cowslip <i>P. veris</i>	Cowslip × Primrose <i>P. × polyantha</i>	Primrose <i>P. vulgaris</i>	Primrose × Oxlip <i>P. × digenea</i>	Oxlip <i>P. elatior</i>
Flower colour	Deep yellow.	Very variable, from deep to pale yellow, but most typically pale pure yellow.	Pale to very pale yellow.	Very variable, but usually paler than in Oxlip. Pure to pale yellow.	Pure yellow.
Markings on flowers	A narrow dark orange streak at the base of the petals.	Usually with an orange streak at the base of the petals, though this may be much more diffuse than in Cowslip.	An orange star or pentagon in the centre formed by diamonds at the base of the petals.	Often with an orange pentagon or diffuse star at the centre, but may have a broad ring.	A narrow to broad dark yellow to orange ring at centre. Ring may be angled and almost pentagonal.
Scent			Almost soapy.	Often soapy, but not as strongly as in Primrose.	Rather peachy.
Hairs on pedicels, calyx, and scape.	Short and crisp.	Short, but not so crisp as in Cowslip.	Shaggy and long.	Medium to long, may appear shaggy.	Medium to long, but never shaggy as in Primrose.
Calyx	Inflated, with blunt teeth.	Usually slightly inflated, and with blunter teeth than in Primrose.	Narrow, with long teeth.	Narrow, with medium to long teeth.	Narrow with medium teeth.
Inflorescence	Flowers on short pedicels at top of a scape. Flowers usually, but not always, spreading and facing in different directions.	Flowers at the top of a scape or in an umbel. Pedicels usually longer than in Cowslip.	Very rarely with a scape. Flowers often on long pedicels and not so numerous as in Oxlip.	Usually with a scape. Flowers often on long pedicels and not so numerous as in Oxlip.	Flowers on short pedicels at top of a scape. Often, but not always, facing the same direction.



Plate 1. The petals of this individual are rather narrow and the flowers are rather large. Otherwise this plant is very similar to *P. elatior*.



Plate 2. This plant is almost indistinguishable from *P. elatior*. Note, however, the pentagonal ring.



Plate 3. Another plant that is very close to *P. elatior*, but the pedicels are perhaps too shaggily hairy for that species.



Plate 4. An obvious hybrid, with large flowers, long pedicels, a pentagon at the base of the petals, and slightly shaggy hairs on the pedicels. Perhaps superficially similar to *P. xpolyantha*, but that hybrid has a distinct streak at the base of each petal and much shorter hairs.

Plates 1–4. *Primula elatior* × *P. vulgaris* at Buff Wood. The allozyme patterns of these plants is incompatible with that of an F_1 , and they are either backcrosses or later generation hybrids.



Plate 5. Note large flowers with narrow petals and star shape at base of petals, rather shaggy hairs on scape, and red base to leaves.



Plate 6. An obvious hybrid. The flowers are large and pale with a star-pentagon at the base, all facing in different directions, and with narrow petals. The scapes are shaggily hairy and the leaves are narrowed into a petiole.

Plates 5–6. *P. x digenea* from Buff Wood. These plants have allozyme patterns consistent with them being F_1 hybrids.



Plate 7. *Primula elatior*. Note the compact flowers and second inflorescence.



Plate 8. *Primula vulgaris*. Large, cold-toned flowers with a star at the centre.

Plates 7–8. Oxlip *Primula elatior* and Primrose *Primula vulgaris* from pure populations.

TABLE 2. POLLEN STAINABILITY IN OXLIPS *P. ELATIOR* (O), PRIMROSES *P. VULGARIS* (P), AND HYBRIDS (H)

Site	Pollen stainability (%)						n	Mean	S.E.M
	20–60	61–70	71–80	81–90	91–95	96–100			
Hayley (O)			1	1	1	8	11	96.1	1.89
Buff (O)				1	1	8	10	96.8	1.16
Buff (H)			1	2	2	1	6	88.8	3.49
Buff (P)			1	4	2	2	9	89.7	2.36
Foxley (P)	1	1	2	1	1	6	12	86.3	4.74
Wayland (P)	1	1	2	2	4	2	12	80.5	6.26
Marley (P)						60	60	99.9	0.01
Lawn (O)		1	1		1	57	60	98.9	0.66

Hayley Wood, Foxley Wood, and Wayland Wood contain only one of the species, Buff Wood has both. Woodell's (1969) data for 'characteristic' (i.e. single-species) populations at Marley and Lawn Woods are also included for comparison. n = number of plants in sample, S.E.M. = standard error of the mean. The ranges are inclusive (i.e. 20–60 = 20.00...–60.99...).

due to a lower number of plants with very high (96–100%) stainability, especially in *P. vulgaris*.

DISCUSSION

MORPHOLOGICAL CHARACTERS AND INTROGRESSION

P. elatior, *P. ×polyantha*, and *P. ×digenea* all have constant characters that allow them to be separated with certainty. Confusion between *P. elatior* and *P. ×polyantha* probably arose amongst botanists of the 18th and 19th Century because few of them had ever seen *P. elatior* in the field, and they based their opinions upon dried specimens or written descriptions. Many of the useful characters (flower colour and markings, shape of the inflorescence, scent) are not preserved in herbarium specimens, and may not have been emphasised in the written descriptions.

The main identification problem occurs in mixed populations of *P. elatior*, *P. ×digenea*, and *P. vulgaris*. Whilst there is no problem in identifying some hybrids (the classic "intermediate" types), or *P. vulgaris*, separating *P. elatior* from other hybrids becomes difficult for two reasons. First, *P. elatior* is rather variable in its hairiness, flower size and markings, and leaf shape and colour, more so it seems than native British *P. vulgaris* and *P. veris*, and some of the characters that are useful in distinguishing backcrossed or later generation hybrids from most Oxlips can be found in pure populations of *P. elatior* (e.g.

cuneate leaves). Whether or not this variation, even in "pure" Oxlip populations, reflects historic introgression with *P. vulgaris* must remain an open question. However, it is of note that we did not find any populations where hybrids were detectable only through molecular methods: the hybrids were all in woods with populations of Oxlips, Primroses, and obviously intermediate plants. Second, the amount of backcrossing and introgression means that some hybrids can be very close genetically and morphologically to *P. elatior*, and the boundaries of "Oxlip", and "hybrid" become rather arbitrary and meaningless in hybrid swarms. Pollen fertility cannot be used to clarify the situation as it can in many other hybrid complexes, such as that involving Creeping Cinquefoil *Potentilla reptans*, Trailing Tormentil *Potentilla anglica*, and Tormentil *Potentilla erecta* (Harold 2006).

The other potential pitfall is the rare Cowslip × Oxlip hybrid, *P. ×media*. We have not been able to confirm this hybrid using molecular methods, and this would be a useful area of future work if plants could be found for analysis. We have found plants in mixed populations of *P. veris* and *P. vulgaris* that had obvious Cowslip characters, such as dark streaks on the petals, rather short hairs, and slightly inflated calyces, but these were tempered by longer hairs and larger and paler flowers than in *P. veris*. As either Oxlip or Primrose could have provided these features, determining which species is the other parent is more a matter of proximity than of morphology.

The presence of small flowers in a stalkless umbel in *P. elatior* is not associated with any sign of hybridisation (it is found in "pure" populations), and is part of the normal range of variation of the plant. It was noted by Miller Christy (1897), although he does not mention that the flowers were smaller than those on scapes. Miller Christy's flowers were produced only early in the season, and we have seen them on plants before the normal inflorescences are produced. However, they are still in evidence later in the season, although they are much less obvious following the growth of the leaves and other vegetation, and it is possible that Miller Christy overlooked them. Tabor (1998) mentions a second flowering in some plants in June and July, in which the scape is very short. This differs from the sessile umbels that we have described in that the flowers are not carried on long pedicels (see photograph on page 97 of Tabor's article), and we have not seen this ourselves, although similar looking inflorescences can rarely be found on plants during the normal flowering time. Other rare abnormalities we have found in *P. elatior* include the bracts being replaced by small leaves, the development of a second inflorescence lower down the scape, six-petalled flowers, flowers with two ovaries, and flowers with bright red stigmas (the last being a reasonably frequent phenomenon).

EXTINCTION THROUGH HYBRIDISATION: MILLER CHRISTY'S HYPOTHESIS

The view that in Buff Wood *P. elatior* seems to grade into *P. xdigenea*, whilst *P. vulgaris*

remains a discreet entity could be seen as supporting Miller Christy's (1897) suggestion that the "modest and retiring Oxlip is, in this country at least, being gradually hybridized out of existence by the more aggressive Primrose". However, this hypothesis has been rejected by Woodell (1969) and Rackham (1999). Our own investigations (Gurney 2000) found no reduction in fertility or seed production in Oxlips in Buff Wood when compared to those in "pure" populations, and we agree with Rackham that climate, woodland management, and herbivory are likely to be much more important in determining the species' fate.

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REFERENCES

- BROWN, P. J. (1842). [Letter to Mr Edmonston]. *The Phytologist* 1: 192.
- BROWN, I. R., KENNEDY, D. & WILLIAMS, D. A. (1982). The occurrence of natural hybrids between *Betula pendula* Roth and *B. pubescens* Ehrh. *Watsonia* 7: 133–145.
- CLIFFORD, H. T. (1958). Studies in British Primulas VI. On introgression between primrose (*Primula vulgaris* Huds.) and cowslip (*P. veris* L.). *New Phytologist* 57: 1–10.
- CRACKLES, F. E. (1995). A graphical analysis of the characters of *Calamagrostis stricta* (Timm) Koeler, *C. canescens* (Wigg.) Roth and their hybrid populations in S.E. Yorks., v.c. 61, northern England. *Watsonia* 20: 397–404.
- DARWIN, C. (1869). On the specific difference between *Primula veris*, Brit. Fl. (var *officinalis* of Linn.), *P. vulgaris*, Brit. Fl. (var *acaulis* Linn.), and *P. elatior*, Jacq.; and on the hybrid nature of the common Oxlip. With supplementary remarks on naturally-produced hybrids in the genus *Verbascum*. *Journal of the Linnean Society (Botany)* 10: 437–454.
- DOUBLEDAY, H. (1842). Oxlips found at Bardfield, supposed to be identical with the *Primula elatior* of Linnaeus. *The Phytologist* 1: 204.
- FANT, J. B., KAMAU, E. M. & PRESTON, C. D. (2003). Chloroplast evidence for the multiple origins of the hybrid *Potamogeton x sudermanicus* Hagstr. *Aquatic Botany* 75: 351–356.
- FAY, M. F., COWAN, R. S. & SIMPSON, D. A. (2003). Hybridisation between *Schoenoplectus tabernaemontani* and *S. triqueter* (Cyperaceae) in the British Isles. *Watsonia* 24: 433–442.
- GIBSON, G. S. (1844). Note on the *Primula elatior*. *The Phytologist* 1: 996.

- GURNEY, M. (2000). *Population genetics and conservation biology of Primula elatior*. PhD thesis, University of Cambridge.
- GURR, E. (1953). *A Practical Manual of Medical and Biological Staining Techniques*. Leonard Hill, London.
- HAROLD, B. (2006). Pollen (In)fertility. *BSBI News* **101**: 16–17.
- HESLOP HARRISON, J. (1949). Field studies in *Orchis* L. I. The structure of dactylorhizid populations on certain islands in the Inner and Outer Hebrides. *Transactions of the Botanical Society of Edinburgh* **35**: 26–66.
- HILL, R.S. (1842). Note on *Primula elatior*, &c. *The Phytologist* **1**: 187–8.
- HOLLINGSWORTH, P. M. & SWAN, G. A. (1999). Genetic differentiation and hybridisation among subspecies of Deergrass (*Trichophorum cespitosum* (L.) Hartman) in Northumberland. *Watsonia* **22**: 235–242.
- JERMYN, S. T. (1974). *Flora of Essex*. Essex Naturalists' Trust, Colchester.
- KELLEHER, C. T., KELLY, D. L. & HODKINSON, T. R. (2004). Species status, hybridisation and geographic distribution of Irish populations of *Quercus petraea* (Matt.) Liebl. and *Q. robur* L. *Watsonia* **25**: 83–97.
- LEEFE, J. E. (1842). On *Primula veris* and allied species. *The Phytologist* **1**: 191.
- LEWIS, K. R. & JOHN, B. (1961). Hybridisation in a wild population of *Eleocharis palustris*. *Chromosoma* **12**: 433–448.
- MARTIN, M. H. (1968). Conditions affecting the distribution of *Mercurialis perennis* L. in certain Cambridgeshire woodlands. *Journal of Ecology* **56**: 777–793.
- MEYER, H. & MEYER, D. (1951). The distribution of *Primula elatior* (L.) Hill, in J. E. LOUSELY, ed. *The study of the distribution of British plants*, pp. 80–81. Botanical Society of the British Isles, Oxford.
- MILLER CHRISTY, R. (1897). *Primula elatior* Jacquin: its distribution, peculiarities, hybrids and allies. *Journal of the Linnean Society (Botany)* **33**: 172–201.
- MILLER CHRISTY, R. (1922). *Primula elatior* Jacquin: its distribution in Britain. *Journal of Ecology* **10**: 200–211.
- MILLER CHRISTY, R. (1924). *Primula elatior* Jacquin: its distribution in Britain. Supplementary note. *Journal of Ecology* **12**: 314–316.
- MOXON, J. E. (1842). Note on *Primula elatior*. *The Phytologist* **1**: 203.
- PEARMAN, D. & PRESTON, C. (2005). Hybridization and the flora of the British Isles. *BSBI News* **99**: 10–16.
- PRESTON, C. D. (1993). The distribution of the Oxlip *Primula elatior* (L.) Hill in Cambridgeshire. *Nature in Cambridgeshire* **35**: 29–60.
- PRESTON, C. D., PEARMAN, D. A. & DINES, T. D. (2002). *New atlas of the British and Irish flora*. Oxford University Press, Oxford.
- RACKHAM, O. (1999). The woods 30 years on: where have all the Primroses gone? *Nature in Cambridgeshire* **41**: 73–87.
- RICH, T. C. G., HOLYOAK, D. T., MARGETTS, L. J. & MURPHY, R. J. (1997). Hybridisation between *Gentianella amarella* (L.) Boerner and *G. anglica* (Pugsley) E. F. Warb. (Gentianaceae). *Watsonia* **21**: 313–325.
- SCOTTISH MONTANE WILLOW RESEARCH GROUP (2005). *Biodiversity: taxonomy, genetics and ecology of sub-arctic willow scrub*. Royal Botanic Garden, Edinburgh.
- SIMPSON, F. W. (1982). *Simpson's Flora of Suffolk*. Suffolk Naturalists' Society, Ipswich.
- STACE, C. A., ELLIS, R. G., KENT, D. H. & MCCOSH, D. J. (2003). *Vice-county Census Catalogue of the vascular plants of Great Britain*. Botanical Society of the British Isles, London.
- TABOR, R. (1998). The Oxlip in Britain – is its future in doubt? *British Wildlife* **10**: 92–101.
- VALENTINE, D. H. (1947). Studies in British Primulas I. Hybridization between Primrose and Oxlip. *New Phytologist* **46**: 229–253.
- VALENTINE, D. H. (1948). Studies in British Primulas II. Ecology and taxonomy of primrose and oxlip (*Primula vulgaris* Huds. and *Primula elatior* Schreb.). *New Phytologist* **47**: 111–130.
- VALENTINE, D. H. (1952). Studies in British Primulas III. Hybridization between *Primula elatior* (L.) Hill and *P. veris* L. *New Phytologist* **50**: 388–399.
- VALENTINE, D. H. (1955). Studies in British Primulas IV. Hybridization between *Primula vulgaris* Huds. and *P. veris* L. *New Phytologist* **54**: 70–80.
- VALENTINE, D. H. (1961). The future of the British flora. *The Naturalist* no. 876: 3–10.
- VALENTINE, D. H. (1975). *Primula*, in C. A. STACE, ed. *Hybridization and the Flora of the British Isles*, pp. 346–348. Academic Press, London.
- WALTERS, S. M. & OCKENDEN, D. J. (1968). *Study of hybrid Primula population in Buff Wood*. Unpublished report of a practical class at the Botany School [Department of Plant Sciences], University of Cambridge.
- WATSON, H. C. (1842). Note on the Oxlips from Bardfield, &c. *The Phytologist* **1**: 232–233.
- WELLS, T. C. E. (2003). *The Flora of Huntingdonshire and the Soke of Peterborough*. Huntingdonshire Fauna and Flora Society, Peterborough.
- WOODELL, S. R. J. (1965). Natural hybridization between the Cowslip (*Primula veris* L.) and the Primrose (*P. vulgaris* Huds.) in Britain. *Watsonia* **6**: 190–202.
- WOODELL, S. R. J. (1969). Natural hybridization in Britain between *Primula vulgaris* Huds. (the primrose) and *P. elatior* (L.) Hill (the oxlip). *Watsonia* **7**: 115–127.

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Which vascular plants are found at the northern or southern edges of their European range in the British Isles?

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ABSTRACT

The northern and southern limits of the European distributions of native vascular plants in the British Isles are summarised. Of 1346 species considered, 279 reach their absolute northern limits in the British Isles and a further 167 at equivalent latitudes (45°–60° N) elsewhere in Europe. A particularly high proportion of Mediterranean-Atlantic species in the British Isles reach their absolute northern limits here, and a higher proportion of Southern-temperate than Temperate species do so. By contrast, only 35 species are at their absolute southern limits in our area, with a further 7 extending south to equivalent latitudes (50°–60° N) elsewhere. The low southern limit totals reflect the presence of most northern species on high mountains in southern Europe. The range-edge species are listed, but the lists must be regarded as provisional as there are some difficulties in using the secondary sources on which they are based, the most serious being the problem of distinguishing native from introduced occurrences. Some 49% of threatened members of the British flora are at or near their northern or southern European limits in the British Isles. If Continental and Hyperoceanic species are also considered as species at the edge of their range, this figure increases to 64%. The increase is almost entirely due to the addition of many Continental species, which in Britain appear to be an especially threatened group.

KEYWORDS: continental, distribution, major biome, Mediterranean-Atlantic, threat.

INTRODUCTION

Populations of plants at or near the edge of their distributional range are of great interest. In such situations plants may become increasingly restricted in their habitat requirements, and these restrictions can offer considerable insights into the factors which limit the total distribution. Marginal populations (especially of annual species) may also fluctuate greatly in size from year to year, and this also provides evidence of ecologically limiting factors. They are sometimes genetically depauperate compared to core populations, or genetically adapted to specialised local environments. Marginal

populations are especially interesting if the distribution of a species is changing, as they will often be the first ones to show the change. Global warming is widely anticipated in the next few decades and can, for example, be expected to result in a retreat of some species from the southern edge of their ranges accompanied by an expansion northwards. The conservation of species at the edge of their range has often been discussed, with some authors arguing that these populations should be safeguarded because of their intrinsic interest, whereas others caution against concentrating on the conservation of small, marginal populations of species which are more abundant elsewhere.

In view of the general interest of edge-of-range populations, it is perhaps surprising that there is no easy way of identifying species which are at the edge of their range in the British Isles. This paper aims to fill this gap. Some species, especially those in the Mediterranean-Atlantic and Submediterranean-Subatlantic floristic elements such as *Parietaria judaica*, *Polystichum setiferum* (Fig. 1) and *Umbilicus rupestris*, have northern European limits which run diagonally from north-west to south-east Europe, and there is normally little doubt whether or not these reach their absolute northern limit in Britain. However, the northern limit of other species such as *Hydrilla verticillata*, *Rumex conglomeratus* and *Salsola kali* (Fig. 2) runs approximately west-east, and these may extend north to essentially the same latitude in several European countries. It is difficult to identify the precise location of their absolute northern limit, both because much of the available information is insufficiently precise geographically, and because the absolute limit may easily be extended by the discovery of new populations. In this paper, therefore, I have listed the species which reach their northern and southern European limits as native species *either* in the British Isles itself *or* at similar latitudes elsewhere in Europe.

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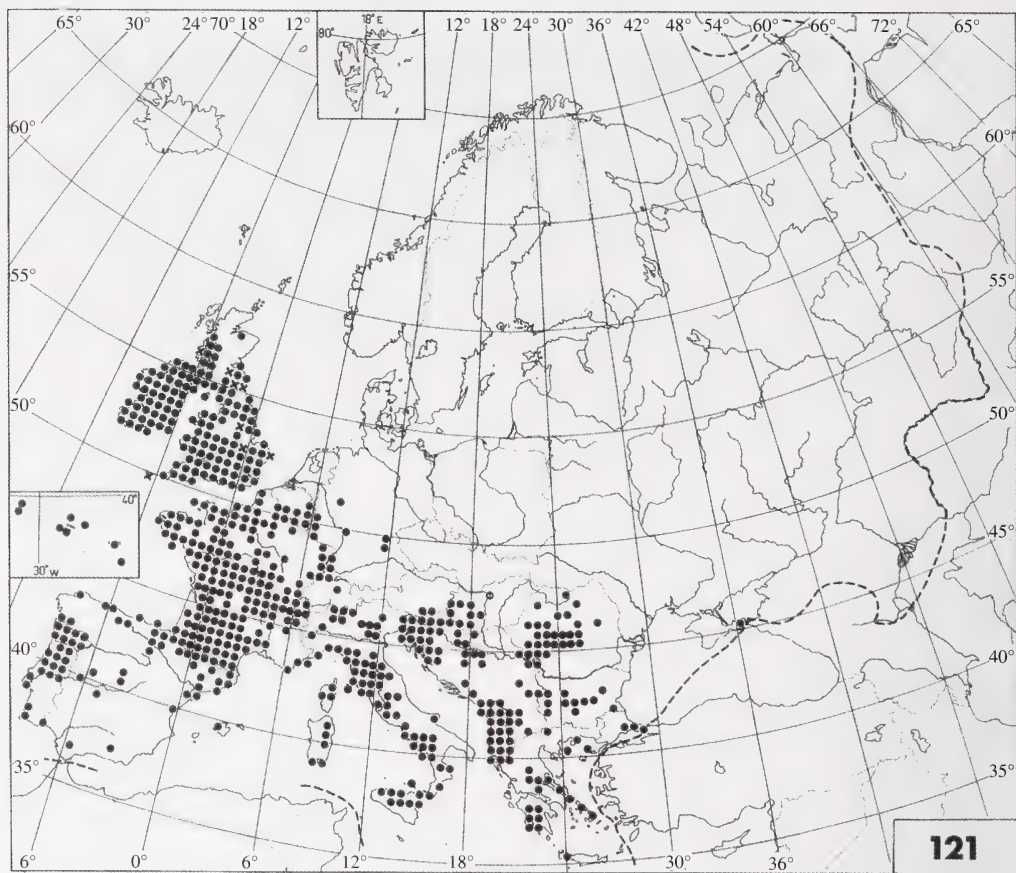


FIGURE 1. The distribution of *Polystichum setiferum* in Europe (Jalas & Suominen 1972). This Submediterranean-Subatlantic species has a northern limit running NW-SE and is clearly at its northern European limit in the British Isles.

IDENTIFYING THE EUROPEAN RANGES OF BRITISH AND IRISH SPECIES

SPECIES CONSIDERED

My aim has been to assess the European distributional limits of all the native species of the British Isles, with the exception of the microspecies of *Hieracium*, *Rubus* and *Taraxacum*. Species which are endemic to the British Isles or are confined in Europe to our area are excluded for the obvious reason that they have no wider European distribution, and infraspecific taxa have not been considered. Taxonomy and nomenclature usually follow Stace (1997) and the species considered are those treated by Preston, Pearman & Dines (2002) as native or doubtfully native ('native or alien'). In a few cases I have departed from these sources to take account of recently

published work or to exclude species with distributions which are not sufficiently well understood for their limits to be assessed. *Asparagus officinalis* subsp. *prostratus* is treated as a species, *A. prostratus*, following Kay, Davies & Rich (2001), and two species added to the flora since 1997, the native *Carex salina* (Dean *et al.* 2005) and the apparently native *Cystopteris diaphana* (Murphy & Rumsey 2005), have been considered. *Cystopteris alpina* has been restored to the British list by Rumsey (2003), although it is now believed to be extinct. Segregates in the *Callitriche hamulata*, *Arctium minus*, *Erophila verna*, *Salicornia europaea*, *S. procumbens* and *Utricularia intermedia* complexes and the species *Carex recta*, *Cystopteris dickieana*, *Dactylorhiza lapponica*, *D. majalis* and *D. traunsteineri* have not been considered because

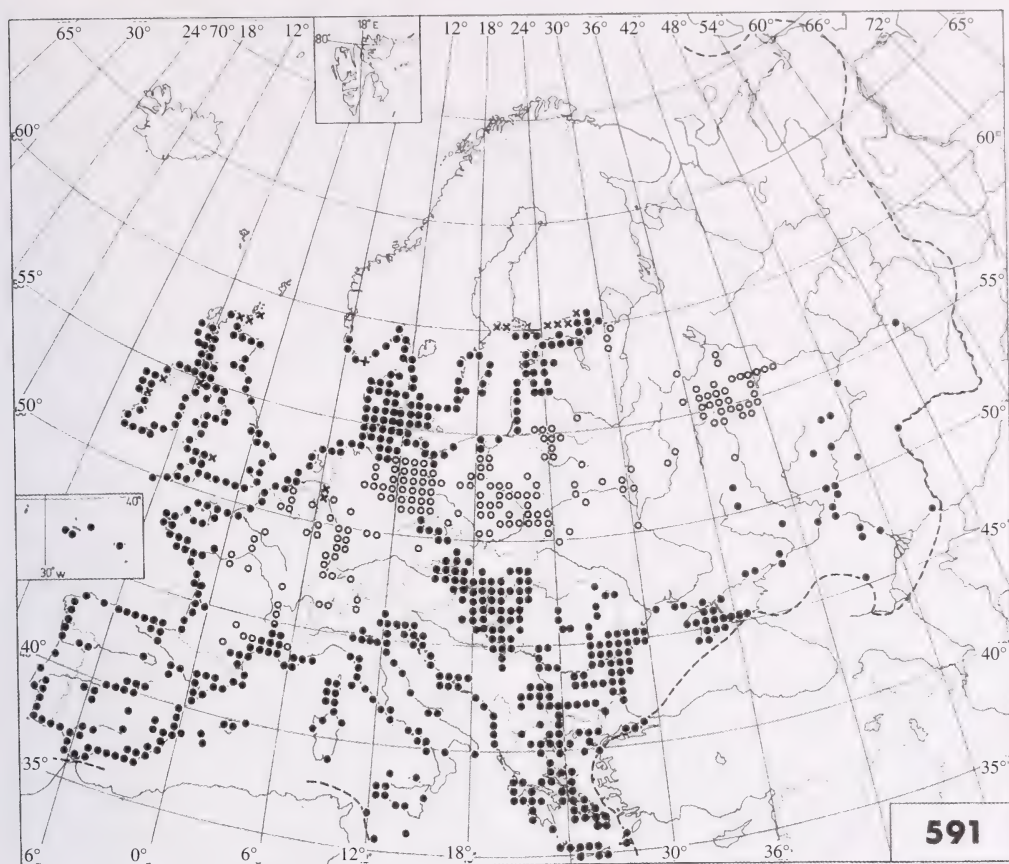


FIGURE 2. The distribution of *Salsola kali* in Europe (Jalas & Suominen 1980). The symbols 'x' and '+' denote 'probably extinct' and 'extinct' respectively, and occurrences as an established alien are shown by open circles. This Eurosiberian Southern-temperate species reaches its northern limit at similar latitudes in Scotland, Norway, Sweden, Finland and Russia.

of doubts about their taxonomic status, distributional uncertainties or because recent taxonomic revisions have reduced them to endemic status. *Viola odorata* and the doubtfully native *Onobrychis viciifolia* and *Ribes rubrum* have also been excluded as their native ranges are so confused by introductions that the northern and southern limits cannot be assigned to the latitudinal bands specified below. *Valerianella eriocarpa*, considered a neophyte by Preston *et al.* (2002), is treated as doubtfully native following a reassessment of its status (Pearman & Edwards 2002). *Symphytum tuberosum* is also treated as doubtfully native; it was considered native, with reservations, by Preston *et al.* (2002) but, as Braithwaite, Ellis & Preston (2006) suggest, it is "much more likely to be a neophyte".

SOURCES OF DISTRIBUTIONAL DATA

In compiling information on the distributional limits of species, I have drawn on published distribution maps, especially those of *Atlas Florae Europaeae* (Jalas & Suominen 1972–1994; Jalas, Suominen & Lampinen 1996; Jalas *et al.* 1999; Kurtto, Lampinen & Junikka 2004) or, for the majority of taxa not yet covered by this *Atlas*, the maps compiled by Hultén & Fries (1986). For plants covered in neither of these works, I have consulted Meusel, Jäger & Weinert (1965), Meusel *et al.* (1978) and Meusel & Jäger (1992) for central European species, and Bolòs & Vigo (1984–2001), who map many southern European species, as well as Tutin *et al.* (1968–1980, 1993). For more detailed information on the distribution of species in countries in the same latitudinal

TABLE 1. SUMMARY OF MAJOR BIOME CATEGORIES (PRESTON & HILL 1997)

Name	Explanation
Arctic-montane	Main distribution in the tundra or above the tree-line in temperate mountains.
Boreo-arctic Montane	In both the tundra and the coniferous forest zones.
Wide-boreal	Extends from the temperate zone to the tundra.
Boreal-montane	Main distribution in the coniferous forest zone.
Boreo-temperate	In both the coniferous and the broadleaf forest zones.
Wide-temperate	Extends from the Mediterranean zone to the coniferous forest zone.
Temperate	Main distribution in the broadleaf forest zone.
Southern-temperate	In both the Mediterranean region and the broadleaf forest zones.
Mediterranean-Atlantic	In the Mediterranean region, and extending north into the broadleaf forest zone in western Europe. Submediterranean-Subatlantic and Mediterranean-montane species are included here.

band as the British Isles, useful sources include Hultén (1971), Mossberg & Stenberg (2003) and Jonsell (2000, 2001) for the Nordic countries, Mennema, Quené-Boterenbrood & Plate (1980, 1985) and van der Meijden, Plate & Weeda (1989) for the Netherlands, Haeupler & Schönfelder (1988) and Benkert, Fukarek & Korsch (1996) for Germany, Institut Floristique Franco-Belge (1978–2001) for Belgium and northern France and Dupont (1962) for species of the Atlantic zone. The native ranges of species in Britain are taken from Preston *et al.* (2002), with additional information from local floras such as Graham (1988), Scott & Palmer (1987) and Swan (1993).

Distributional limits are analysed below in relation to the major biome categories defined by Preston & Hill (1997), Preston *et al.* (2002) and Hill, Preston & Roy (2004) (Table 1). Of the three species recently added to the flora, *Carex salina* and *Cystopteris alpina* have been treated as European Boreo-arctic Montane and *C. diaphana* as Suboceanic Southern-temperate.

CLASSIFICATION OF NORTHERN AND SOUTHERN LIMITS

The above sources were used to classify the northern European limit of the species considered into five latitudinal bands: 45°–50° N, 50°–55° N, 55°–60° N, 60°–65° N and >65° N. Similarly, the southern limits of species were classified into the bands <45° N, 45°–50° N, 50°–55° N and 55°–60° N. Almost all the land area of the British Isles falls within the 50°–55° and 55°–60° bands (Figs 1–2). The only parts of the British Isles south of 50° N are the Channel Islands, the Isles of Scilly and the

southern part of the Lizard peninsula; Shetland alone extends north of 60° N. (None of the species considered has a southern limit in the 60°–65° band, which would imply growing as a native in Shetland but descending no further south in Britain.) The 55° N line of latitude very approximately separates Ireland, Wales and England to the south from Scotland to the north. Thus plants occurring as natives in the British Isles and reaching their northern limits in Europe between 45° and 60° are usually close to their northern limits here, even if they do not reach their absolute European limit in these islands. Similarly most plants extending south to latitudes between 50° and 60° are close to their southern limits in Britain. Species extending south to 45°–50° are not necessarily close to their southern limits in the British Isles as they may extend almost 5° further south; by contrast, a native of the British Isles which reaches its northern limit between 45° and 50° must be near its limit in our area. In addition to allocating the limits of species to these latitudinal bands, I have tried to identify the plants reaching their absolute northern and southern limits in our area. In determining species limits, all recorded native sites are considered, including those at which the species has become extinct in recent times.

The data on distributional limits are summarised in this paper, and species at or near their northern or southern limits in the British Isles are listed in Appendix 1 and 2. The full data have been added to the PLANTATT database (Hill *et al.* 2004) and can be downloaded from the Biological Records Centre website (www.brc.ac.uk).

TABLE 2. NORTHERN EUROPEAN LIMITS OF NATIVE SPECIES IN RELATION TO THEIR OCCURRENCE IN MAJOR BIOMES

Major biome	Number of species at N limit in latitudinal band					Total
	45°–50°	50°–55°	55°–60°	60°–65°	>65°	
Arctic-montane		1*	3*		75	4*+75
Boreo-arctic Montane			1*	1	39	1*+40
Wide-boreal					19	19
Boreal-montane			7*	5	86	7*+91
Boreo-temperate			1*+1	8	212	1*+221
Wide-temperate					33	33
Temperate	2*+1	30*+11	39*+82	5*+192	141	76*+427
Southern-temperate	3*+1	43*+19	37*+38	5*+50	37	88*+145
Mediterranean-Atlantic	3*+1	67*+2	31*+11	1		101*+15
Unknown			1*		1	1*+1
Total	8*+3	141*+32	120*+132	10*+257	643	279*+1067

*The asterisked figures are the number of British species at their absolute northern limit in the British Isles.

RANGE LIMITS IN RELATION TO OCCURRENCE IN MAJOR BIOMES

The northern limits of native species are summarised in Table 2. In all 279 of the 1346 species considered (21%) reach their absolute northern limits in the British Isles, and a further 167 (12%) extend north to equivalent latitudes (45°–60° N) in mainland Europe. These species are listed in Appendix 1. Almost all the species of northern biomes, and the widespread species, extend to latitudes north of 65°. A small number of Arctic-montane and Boreal-montane species occur at the northern edge of their range in Britain, these being Alpine species which are absent from the Arctic, e.g. the Arctic-montane *Minuartia recurva*, *M. sedoides* and *Myosotis alpestris*, the doubtfully native Boreo-arctic Montane *Homogyne alpina* and the Boreal-montane *Meum athamanticum*, *Oxytropis halleri* and *Viola lutea*. *Thlaspi caerulescens* extends north to Scotland as a native, but is very widely naturalised in the Nordic area (Jalas *et al.* 1996) and *Myosotis stolonifera* occurs in the mountains of the Iberian peninsula and the hills of northern England and southern Scotland. Plants of the Temperate and Southern biomes show an obvious tendency to reach their northern limits further south.

Of the species reaching their northern European limits between 45° and 60° N, there is a clear increase in the percentage occurring at their absolute limit in Britain from Temperate (43%) through Southern-temperate (59%) to the Mediterranean-Atlantic (88%)

major biome categories. This presumably reflects the fact that Temperate species may be able to extend further north in mainland Europe because of the warmer continental summers, whereas the Mediterranean-Atlantic species require milder winters and are therefore likely to extend further north in the oceanic west of Europe. The difference between Temperate and Southern-temperate species on the one hand and Mediterranean-Atlantic species on the other is almost inevitable in view of the definition of the major biome categories, as the Mediterranean-Atlantic plants differ from the Temperate and Southern-temperate species in occurring further north in the Atlantic zone of western Europe than they do further east.

There is a rather unexpected trend for a greater proportion of species reaching their northern limit between 50° and 55° N in Europe to have their absolute limit in the British Isles compared to those which extend north into the 55°–60° N band. In the southerly latitudinal band 82% of species reach their northern limits in the British Isles, compared to 48% of those in the northerly band, a highly significant difference ($p < 0.001$). This difference holds within all three of the predominant major biome categories. For Temperate species 73% of the 50°–55° species are at their northern limit here compared with 32% for the 55°–60° plants ($p < 0.001$); the equivalent figures for Southern-temperate species are 69% vs 49% ($p < 0.05$) and for Mediterranean-Atlantic species 97% vs 74% ($p < 0.001$). Most of the (rather few) species in

the 50°–55° zone which reach their absolute limits outside the British Isles extend further north in Germany. The larger group reaching their northern limits outside our area in the 55°–60° zone include many at their northern limits in Denmark or Sweden, smaller numbers in Norway or in the eastern Baltic (including the Baltic states and Baltic Russia) and very few species reaching their limits further east in Russia. The reasons for this shift in northern limits to continental Europe for the more northerly species are not entirely obvious, and the fact that many species have become naturalised after they have been introduced to sites north of their native limits suggests that these reasons are unlikely to be simple. Factors to be considered include differences in the proportion of the total land area in each latitudinal band which lies in the British Isles and the range of climates and habitats provided in southern Britain and Ireland compared to northern Britain. The contrast between the climate of S.W. Ireland and East Anglia in the 50°–55° zone is much greater than the climatic extremes within the northern zone. Another factor is almost certainly the paucity of lowland, calcareous habitats in much of Scotland. Ellenberg R values, which indicate pH preferences from extreme calcifuge ($R = 1$) to calcicole ($R = 9$, see Hill *et al.* 2004) can be used to identify the number of marked calcicoles at their absolute limits in Britain and elsewhere in Europe (Table 3). A few species with $R = 8$ –9 are halophytes rather than calcicoles but they do not greatly affect the percentages in Table 3. The overall proportion of calcicoles is higher for the species with northern limits between 50° and 55° than for those with limits between 55° and 60° N ($p < 0.05$), not unexpectedly in view of the fact that acidic habitats predominate in the Boreal zone. More relevantly, the proportion of calcicoles amongst the species reaching their absolute limits in Britain is significantly lower in the northerly band than in the southerly band ($p < 0.001$). The calcicoles occurring at their northern limits between 55° and 60° N in continental Europe include a small but well-known group of species which extend north to the calcareous islands of Öland and Gotland in the Baltic (e.g. *Aster linosyris*, *Helianthemum oelandicum*, *Orchis laxiflora*, *Potamogeton coloratus*).

Whereas there is a clear relationship between major biome categories and northern limits,

there is no such relationship with southern limits (Table 4). The majority of species in all major biome categories extend south to southern Europe ($< 45^\circ$ N). This reflects the presence of high mountains at southern latitudes in Europe, and hence the availability of habitats above the tree-line. A few Arctic and Boreal species are absent from the southern European mountains, and these represent the majority of species which attain their southern limits in the British Isles. Only 35 species are at their absolute southern limits in our area and a further 7 extend south to equivalent latitudes (50°–60°) in mainland Europe (Appendix 2). The high proportion of these species which are at their absolute southern limit in the British Isles is noteworthy, and indeed all 15 species extending south to between 55° and 60° are at their absolute limit here. There is in fact little high ground in Europe between 50° and 60°, so montane species which extend south to the British Isles but not to the mountains of central Europe are likely to be at their absolute southern limits here.

ARE THREATENED PLANTS IN BRITAIN MAINLY PLANTS AT THE EDGE OF THEIR RANGE?

IUCN threat categories for British species have recently been revised (Cheffings & Farrell 2005). Table 5 summarises the number of threatened species in Britain which are close to their northern or southern limits. Only the species covered in this paper are included in Table 5; other Red Listed species (notably archaeophytes, endemics, plants confined to the British Isles in Europe and infraspecific taxa) are excluded from consideration. I have used the term 'threatened species' to include those classified as Extinct, Extinct in the Wild, Critically Endangered, Endangered, Vulnerable and Near Threatened in the Red List. Of the threatened species considered, almost half (49%) are at or near their northern or southern limits. Although this is a higher percentage than the equivalent figure (36%) for species in our flora as a whole, it is clear that many species at the limits of their latitudinal range are not threatened, and that many threatened species have a very broad latitudinal range in Europe.

It might be argued that some threatened (and non-threatened) species are at their western and eastern limits in our area. In general, western limits are of little interest to British and Irish

TABLE 3. ELLENBERG R VALUES OF SPECIES REACHING THEIR NORTHERN EUROPEAN LIMITS BETWEEN 50° AND 60° N

Northern limit	No. of species	Ellenberg R values		
		Range	Mean	% calcicoles (R = 8–9)
50°–55° N, absolute limit in Britain	140†	1–9	6.4	31
50°–55° N, absolute limit elsewhere	32	4–9	6.8	44
55°–60° N, absolute limit in Britain	120	2–9	6.0	12
55°–60° N, absolute limit elsewhere	131†	2–9	6.7	30

† These totals each exclude one species for which an Ellenberg R value has not been allocated.

TABLE 4. SOUTHERN EUROPEAN LIMITS OF NATIVE SPECIES IN RELATION TO THEIR OCCURRENCE IN MAJOR BIOMES

Major biome	Number of species at S limit in latitudinal band				Total
	<45°	45°–50°	50°–55°	55°–60°	
Arctic-montane	53	7	5*+1	13*	18*+61
Boreo-arctic Montane	29	3	6*+2	1*	7*+34
Wide-boreal	17	2			19
Boreal-montane	78	8	8*+3	1*	9*+89
Boreo-temperate	216	1*+5			1*+221
Wide-temperate	33				33
Temperate	491	12			503
Southern-temperate	232		1		233
Mediterranean-Atlantic	116				116
Unknown	1	1			3
Total	1266	1*+38	19*+7	15*	35*+1311

*The asterisked figures are the number of British species at their absolute southern limit in the British Isles.

botanists, as the British Isles are at the western fringe of Europe. All our species approach their western limits here. Whether or not one of our common species reaches its absolute western European limit in the British Isles therefore depends on whether it occurs on the Atlantic islands of Iceland and the Azores (the only parts of Europe as defined by *Flora Europaea* that are further west than western Ireland) and on the exact details of its distribution in the British Isles, western France and the Iberian peninsula. Although the details of its distribution in the western fringes will be determined by its ecology, the relevant ecological factors will include dispersal mechanisms and habitat preferences which are unlikely to act together to make 'presence at its absolute western limit in Britain' a useful piece of information about the species. Species

which reach a western European limit in eastern Britain are perhaps more clearly at their western limit here, and the more extreme examples are identified as 'Continental' species by Preston & Hill (1997). One small group of species, the 'Hyperoceanic' species, have such western distributions in Europe that they are close to their *eastern* limits in Britain, and these are listed by Preston & Hill (1999).

If the Continental and Hyperoceanic species as well as those close to their northern and southern limits are considered, the percentage of threatened species which are at or near the edge of their range increases from 49% to 64%. This is almost entirely due to the addition of substantial number of Continental species which have a broad latitudinal range but are threatened in Britain. Only a single threatened Hyperoceanic plant is not at either its northern

TABLE 5. EUROPEAN LIMITS OF NATIVE SPECIES IN RELATION TO THEIR IUCN RED LIST CATEGORY
(CHEFFINGS & FARRELL 2005)

Red List category	No. species at northern limit in British Isles	No. species at northern limit between 45° and 60° N elsewhere in Europe	No. species at southern limit in British Isles	No. species at southern limit between 50° and 60° N elsewhere in Europe	No. of additional hyperoceanic or continental species	Total no. of species at or near range limits	No. species extending north of 60° and south of 50° in Europe and neither hyperoceanic nor continental	Total
Extinct	2 (17%)	3 (25%)		1 (8%)	1 (8%)	7 (58%)	5 (42%)	12
Critically endangered	3 (19%)	7 (44%)			5 (31%)	15 (94%)	1 (6%)	16
Endangered	9 (17%)	14 (26%)	2 (4%)	1 (2%)	10 (19%)	36 (68%)	17 (32%)	53
Vulnerable	36 (26%)	22 (16%)	8 (6%)		19 (14%)	85 (62%)	51 (38%)	136
Near threatened	19 (25%)	14 (18%)	3 (4%)	1 (1%)	8 (10%)	45 (58%)	32 (42%)	77
Total threatened	69 (24%)	60 (21%)	13 (4%)	3 (1%)	43 (15%)	188 (64%)	106 (36%)	294
Least concern	187 (18%)	100 (10%)	17 (2%)	3 (<1%)	26 (3%)	333 (33%)	676 (67%)	1009
Data deficient	3 (27%)		5 (46%)			8 (73%)	3 (27%)	11
Not classified*	20 (62%)	7 (22%)				27 (84%)	5 (16%)	32
Total	279 (21%)	167 (12%)	35 (3%)	6 (<1%)	69 (5%)	556 (41%)	790 (59%)	1346

The percentages relate to the totals in each Red List category. Rows and columns in italics are subtotals. *Hydrilla verticillata* reaches both its northern and southern limits between 50° and 60° in mainland Europe. To avoid double-counting, it is included in the northern but not the southern limit totals.

*These species were not classified as they are restricted to those parts of the British Isles outside Great Britain, were included by Cheffings & Farrell (2005) in the 'Waiting List' or are amongst the species I have excluded from consideration in this paper for other reasons.

or southern limit, the Near Threatened *Hymenophyllum wilsonii*. This highlights the threat to Continental species in Britain, a group first discussed in detail by Walters (1953). Of the 88 species which are listed by Preston & Hill (1997) as Continental and considered in this paper, 86 occur in Great Britain and of these 54 (63%) are listed as Extinct (2), Critically Endangered (7), Endangered (12), Vulnerable (22) or Near Threatened (11) by Cheffings & Farrell (2005).

DISCUSSION

LIMITATIONS OF THE SOURCES

The user of secondary sources to identify the limits of the native range of species in Europe is confronted by three major problems. Was the information presented taxonomically accurate at the time of publication, and has it been superseded by subsequent taxonomic revision? Are native records distinguished from alien (including casual) occurrences? Do sources such as small-scale distribution maps provide sufficient geographical precision? All these are serious problems. To a great extent, however, users are in the hands of their sources. It is clearly impractical to investigate the European distribution of all native British species individually, and even if one did there is no likelihood that the result would be any better than the published compilations. By maintaining a semi-critical approach to the sources one can attempt to identify potential problems and check one source against another. Outlying localities on small-scale European maps can be checked against national floras and atlases, for example. These publications can also be used to provide more precise details of the limits of species than are apparent on small-scale maps. More critical accounts of the distribution of some species are available in monographic works. The greatest problem is the identification of native ranges. Even if the native range is known to the local observer, it may not be clear to a compiler working elsewhere in Europe or the compiler may choose not to distinguish alien occurrences on the map. Outlying northern localities on many of the maps compiled by Hultén & Fries (1986), for example, represent introduced or even casual occurrences. In the cases of Scandinavian records, these maps can be checked against Mossberg & Stenberg's (2003) maps and national and regional floras.

However, there are limits to the number of such checks which are either possible or practical in a reasonable time-scale.

The interpretation of the native ranges of British and Irish species is that of Preston *et al.* (2002). The problems associated with assessing native ranges in Britain, which to a large extent reflect those associated with the wider problem in Europe as a whole, are discussed briefly on pp. 10–11 of that work.

For the above reasons, the lists provided in this paper are provisional. I hope that specialists in individual species or genera will be able to review the assessments and correct them where necessary. The lists will also need revision in the light of the critical reviews of the distribution and native or introduced status of Nordic plants which will become available as further volumes of *Flora Nordica* are published.

POTENTIAL USEFULNESS OF INFORMATION ON DISTRIBUTIONAL LIMITS

This paper has been prepared with several potential uses in mind. Authors of local floras can use the lists in Appendix 1 and 2 in conjunction with the maps in Preston *et al.* (2002) to identify those species at their northern or southern limits in their area. The lists could also be used in planning scientific studies that compare populations of species at the edge of their range with those in a more central position. The information on individual species may also be useful in assessing the extent to which edge-of-range populations are conserved in protected sites.

However, one of the main aims of this compilation is to provide a further 'plant attribute' to be used in interpreting the observed changes in the British and Irish flora. Even a simplified version of Preston & Hill's (1997) major biome categories correlated surprisingly well with the changes detected in several Broad Habitats by the BSBI 'Local change' survey (Braithwaite *et al.* 2006). Information on the northern limits is potentially useful, although it may not always prove to be as informative as the classification by major biome categories. The latter summarise the overall range of a species and disregard outlying occurrences, whereas by definition the distributional limits are governed by the outlying occurrences. At outlying localities a population may be dependant on a very specialised microhabitat, or the plants may be relictual, dating from a different climatic

period. Although such relict populations persist they may, in the extreme case of some long-lived species, no longer even be capable of sexual reproduction in the current climatic regime. Once maps such as those published in *Atlas Florae Europaeae* are available for all species it will be possible to use numerical methods to summarise range boundaries, with rules to determine whether or not disjunct localities should be treated as outliers, but at present such maps are available for only a minority of European species. Information on the southern limits of species is much less informative than that on northern limits as, unlike major biome categories, it fails to take into account the altitudinal range of species.

The current interest in the effects of climate change has led to an increasing concentration of research on the behaviour of populations at the edge of their range. It is clear from the results presented here that British and Irish botanists are ideally placed to study the behaviour in the years to come of species at the northern edge of their European ranges. This is surely an area in which the B.S.B.I. could develop one of those “really impressive examples of botanical co-operation in which the amateur and professional talent of our Society is used with great effect” (Walters 1975).

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REFERENCES

- BENKERT, D., FUKAREK, F. & KORSCH, H., eds (1996). *Verbreitungsatlas der Farn- und Blütenpflanzen Ostdeutschlands*. Jena: Gustav Fischer.
- BOLÒS, O. DE & VIGO, J. (1984–2001). *Flora dels Països Catalans*. Volume 1 (1984), 2 (1990), 3 (1995), 4 (2001). Barcelona: Editorial Barcino.
- BRAITHWAITE, M. E., ELLIS, R. W. & PRESTON, C. D. (2006). *Change in the British Flora 1987–2004*. London: Botanical Society of the British Isles.
- CHEFFINGS, C. M. & FARRELL, L., eds (2005). *The vascular plant Red Data List for Great Britain*. Species Status no. 7. Peterborough: Joint Nature Conservation Committee.
- DEAN, M., HUTCHEON, K., JERMY, A. C., CAYOUE, J. & ASHTON, P. A. (2005). *Carex salina* – a new species of sedge for Britain. *BSBI News* **99**: 17–19.
- DUPONT, P. (1962). *La flore atlantique européenne*. Documents pour les cartes des productions végétales serie Europe-Atlantique, vol. 1. Toulouse: Faculté des Sciences.
- GRAHAM, G. G. (1988). *The flora & vegetation of County Durham*. Durham Flora Committee & Durham County Conservation Trust.
- HAEUPLER, H. & SCHÖNFELDER, P., eds (1988). *Atlas der Farn- und Blütenpflanzen der Bundesrepublik Deutschland*. Stuttgart: Eugen Ulmer.
- HILL, M. O., PRESTON, C. D. & ROY, D. B. (2004). *PLANTATT: attributes of British and Irish plants*. Huntingdon: Centre for Ecology and Hydrology.
- HULTÉN, E. (1971). *Atlas över växternas utbredning i Norden*. Stockholm: Generalstabens Litografiska Anstalts Förlag.
- HULTÉN, E. & FRIES, M. (1986). *Atlas of north European vascular plants north of the Tropic of Cancer*. 3 vols. Königstein: Koeltz Scientific Books.
- INSTITUT FLORISTIQUE FRANCO-BELGE (1978–2001). *Documents floristiques 1–6*. Bailleul: Centre Regional de Phytosociologie.
- JALAS, J. & SUOMINEN, J., eds (1972–1994). *Atlas Florae Europaeae*. Volume 1 (1972), 2 (1973), 3 (1976), 4 (1979), 5 (1980), 6 (1983), 7 (1986), 8 (1989), 9 (1991), 10 (1994). Helsinki: Committee for Mapping the Flora of Europe and Societas Biologica Fennica Vanamo.

- JALAS, J., SUOMINEN, J. & LAMPINEN, R., eds (1996). *Atlas Florae Europaeae*. Volume 11. Helsinki: Committee for Mapping the Flora of Europe and Societas Biologica Fennica Vanamo.
- JALAS, J., SUOMINEN, J., LAMPINEN, R. & KURTTU, A., eds (1999). *Atlas Florae Europaeae*. Volume 12. Helsinki: Committee for Mapping the Flora of Europe and Societas Biologica Fennica Vanamo.
- JONSELL, B., ed. (2000–2001). *Flora Nordica*. Volume 1 (2000), 2 (2001). Stockholm: Bergius Foundation, Royal Swedish Academy of Sciences.
- KAY, Q. O. N., DAVIES, E. W. & RICH, T. C. G. (2001). Taxonomy of the western European endemic *Asparagus prostratus* (A. *officinalis* subsp. *prostratus*) (Asparagaceae). *Botanical Journal of the Linnean Society* **137**: 127–137.
- KURTTU, A., LAMPINEN, R. & JUNIKKA, L., eds (2004). *Atlas Florae Europaeae*. Volume 13. Helsinki: Committee for Mapping the Flora of Europe and Societas Biologica Fennica Vanamo.
- MEIJDEN, R. VAN DER, PLATE, C. L. & WEEDA, E. J., eds (1989). *Atlas van de Nederlandse Flora. 3 Minder zeldzame en algemene soorten*. Leiden: Onderzoekinstituut Rijksherbarium/Hortus Botanicus.
- MENNEMA, J., QUENÉ-BOTERENBROOD, A. J. & PLATE, C. L., eds (1980). *Atlas of the Netherlands Flora. 1 Extinct and very rare species*. The Hague: Dr. W. Junk.
- MENNEMA, J., QUENÉ-BOTERENBROOD, A. J. & PLATE, C. L., eds (1985). *Atlas van de Nederlandse Flora. 2 Zeldzame en vrij zeldzame planten*. Utrecht: Bohn, Scheltema & Holkema.
- MEUSEL, H. & JÄGER, E. J. (1992). *Vergleichende Chorologie der zentraleuropäischen Flora*. Volume 3. 2 vols. Jena: Gustav Fischer.
- MEUSEL, H., JÄGER, E., RAUSCHERT, S. & WEINERT, E. (1978). *Vergleichende Chorologie der zentraleuropäischen Flora*. Volume 2. 2 vols. Jena: Gustav Fischer.
- MEUSEL, H., JÄGER, E. & WEINERT, E. (1965). *Vergleichende Chorologie der zentraleuropäischen Flora*. Volume 1. 2 vols. Jena: Gustav Fischer.
- MOSSBERG, B. & STENBERG, L. (2003). *Die nya nordiska Floran*. Wahlström & Widstrand.
- MURPHY, R. J. & RUMSEY, F. (2005). *Cystopteris diaphana* (Bory) Blasdel (Woodsiaceae) – an overlooked native new to the British Isles? *Watsonia* **25**: 255–263.
- PEARMAN, D. A. & EDWARDS, B. (2002). *Valerianella eriocarpa* Desv. in Dorset, and a reassessment of its status as a presumed introduction in Britain. *Watsonia* **24**: 81–89.
- PRESTON, C. D. & HILL, M. O. (1997). The geographical relationships of British and Irish vascular plants. *Botanical Journal of the Linnean Society* **124**: 1–120.
- PRESTON, C. D. & HILL, M. O. (1999). The geographical relationships of the British and Irish flora: a comparison of pteridophytes, flowering plants, liverworts and mosses. *Journal of Biogeography* **26**: 629–642.
- PRESTON, C. D., PEARMAN, D. A. & DINES, T. D. (2002). *New atlas of the British and Irish flora*. Oxford: Oxford University Press.
- RUMSEY, F. (2003). Bladder-ferns *Cystopteris* of the British Isles. *British Wildlife* **15**: 93–96.
- SCOTT, W. & PALMER, R. (1987). *The flowering plants and ferns of the Shetland Islands*. Lerwick: Shetland Times.
- STACE, C. A. (1997). *New Flora of the British Isles*, edn 2. Cambridge: Cambridge University Press.
- SWAN, G. A. (1993). *Flora of Northumberland*. Newcastle upon Tyne: Natural History Society of Northumbria.
- TUTIN, T. G., BURGESS, N. A., CHATER, A. O., EDMONDSON, J. R., HEYWOOD, V. H., MOORE, D. M., VALENTINE, D. H., WALTERS, S. M. & WEBB, D. A., eds (1993). *Flora Europaea*. Volume 1, edn 2. Cambridge: Cambridge University Press.
- TUTIN, T. G., HEYWOOD, V. H., BURGESS, N. A., MOORE, D. M., VALENTINE, D. H., WALTERS, S. M. & WEBB, D. A., eds (1968–1980). *Flora Europaea*. Volume 2 (1968), 3 (1972), 4 (1976), 5 (1980). Cambridge: Cambridge University Press.
- WALTERS, S. M. (1953). The continental element in our flora, in *The changing flora of Britain* (ed. J. E. Lousley), pp. 124–129. Botanical Society of the British Isles, Oxford.
- WALTERS, S. M. (1975). Presidential address 1974: Botanical co-operation. *Watsonia* **10**: 325–330.

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APPENDIX 1. SPECIES AT OR NEAR THE NORTHERN EDGE OF THEIR NATIVE EUROPEAN RANGE IN THE BRITISH ISLES

Native British species which have their northern European limits in the latitudinal bands 45–50° N, 50–55° N and 55–60° N are listed in this section. Species are asterisked if the absolute limit is reached in the British Isles, but not if it they reach their northern limit at the same latitude in our area and in other European countries or if the precise northern limit is obscured by introductions.

The following additional annotations are used:

§ Doubtfully native

(1) Confined as a native in the British Isles to the Channel Islands

(2) Confined as a native in the British Isles to Ireland

(3) Limit(s) of native range particularly confused by introductions (this also applies to doubtfully native taxa)

SPECIES WITH NORTHERN EUROPEAN LIMITS

BETWEEN 45° N AND 50° N

*Anogramma leptophylla** (1)
Armeria arenaria (1)
*Exaculum pusillum** (1)
Festuca armoricana (1)
*Festuca huonii** (1)
*Limonium auriculae-ursifolium** (1)
*Limonium normannicum** (1)
*Myosotis sicula** (1)
*Ophioglossum lusitanicum**
*Ornithopus pinnatus**
Ranunculus paludosus (1)

SPECIES WITH NORTHERN EUROPEAN LIMITS

BETWEEN 50° N AND 55° N

*Aceras anthropophorum**
Aconitum napellus§*
*Adiantum capillus-veneris**
*Agrostis curtisii**
Ajuga chamaepitys§
Allium sphaerocephalon§
Alopecurus bulbosus
Anagallis arvensis (3)
*Arabis scabra**
*Arbutus unedo** (2)
*Arum italicum**
Asparagus prostratus
*Asperula cynanchica**
*Asplenium onopteris** (2)
*Atropa belladonna** (3)
Brassica oleracea§*
*Bromopsis erecta**
Bunium bulbocastanum
*Bupleurum baldense**
*Buxus sempervirens** (3)
*Callitriche truncata**
Carex humilis
*Centaureum scilloides**
*Centaureum tenuiflorum**
*Cirsium eriophorum**
Cirsium tuberosum

Clematis vitalba (3)
*Clinopodium ascendens**
*Clinopodium calamintha**
Clinopodium menthifolium
*Colchicum autumnale**
Corrigiola litoralis
*Crassula tillaea**
Cynodon dactylon§
*Cynoglossum germanicum**
*Cyperus longus**
*Cystopteris diaphana**
*Daboecia cantabrica** (2)
*Damasonium alisma**
*Daphne laureola**
Dianthus gratianopolitanus
*Draba aizoides**
*Epilobium lanceolatum** (3)
*Erica ciliaris**
*Erica erigena** (2)
*Erica vagans**
*Erodium maritimum**
*Euphorbia amygdaloides**
*Euphorbia peplis**
Euphorbia serrulata§
*Festuca longifolia**
*Frankenia laevis**
Gagea bohemica
*Galium constrictum**
Galium parisiense§*
Gastrium ventricosum§*
Gaudinia fragilis§*
Gentianella germanica
*Geranium purpureum**
*Geranium rotundifolium**
*Gladiolus illyricus**
Gnaphalium luteoalbum§
*Helianthemum apenninum**
*Helleborus foetidus**
Helleborus viridis§*
*Herniaria ciliolata**
*Himantoglossum hircinum**
*Hippocrepis comosa**

- Hypericum liniifolium**
*Hypericum undulatum**
*Iberis amara**
*Inula crithmoides**
*Iris foetidissima**
*Isoetes histrix**
*Juncus acutus**
*Koeleria vallesiana**
*Lactuca saligna**
Lathyrus aphaca§*
*Lathyrus nissolia**
*Leucojum aestivum**
*Limonium bellidifolium**
*Limonium binervosum**
*Linum bienne**
*Lithospermum purpureocaeruleum**
*Lobelia urens**
Lotus angustissimus
*Lotus subbiflorus**
Ludwigia palustris
*Luzula forsteri**
Matthiola sinuata§*
*Medicago arabica**
*Medicago polymorpha**
Melittis melissophyllum
*Mentha pulegium**
*Mentha suaveolens** (3)
*Mibora minima**
Milium vernale (1)
*Minuartia hybrida**
*Minuartia recurva** (2)
Muscari neglectum§*
*Neotinea maculata**
*Oenanthe pimpinelloides**
*Oenanthe silaifolia**
*Ononis reclinata**
Ophrys fuciflora
*Ophrys sphegodes**
*Orchis simia**
*Ornithogalum pyrenaicum**
*Otanthus maritimus**
*Petrorhagia nanteuillii**
*Petroselinum segetum**
Peucedanum officinale
Physospermum cornubiense
*Pinguicula grandiflora** (2)
*Poa infirma**
Polycarpon tetraphyllum§*
*Polygala calcarea**
*Polygonum maritimum**
*Polypogon monspeliensis**
Potamogeton nodosus
*Puccinellia fasciculata**
*Pulmonaria longifolia**
Pyrus cordata§*
*Ranunculus parviflorus**
Ranunculus tripartitus
*Romulea columnae**
*Rosa stylosa**
*Rubia peregrina**
*Rumex pulcher**
*Rumex rupestris**
*Ruscus aculeatus**
*Salicornia pusilla**
*Saxifraga hirsuta** (2)
Schoenoplectus pungens§
Schoenoplectus triqueter
*Scilla autumnalis**
Scirpoides holoschoenus
*Sedum forsterianum**
Serapias parviflora §*
*Sibthorpia europaea**
*Simethis planifolia** (2)
*Sison amomum**
*Sorbus aria**
*Sorbus domestica**
*Spartina maritima**
Spiranthes aestivalis
*Stachys germanica**
*Suaeda vera**
*Tamus communis**
*Thesium humifusum**
Thlaspi perfoliatum
*Trifolium bocconeii**
*Trifolium glomeratum**
*Trifolium incarnatum**
*Trifolium occidentale**
*Trifolium ochroleucon**
*Trifolium ornithopodioides**
*Trifolium squamosum**
*Trifolium strictum**
*Trifolium subterraneum**
*Trifolium suffocatum**
*Trinia glauca**
*Tuberaria guttata**
*Ulex minor**
Ulmus procera§*
Valerianella eriocarpa§*
Verbascum pulverulentum§*
*Viburnum lantana**
*Vicia bithynica**
*Vicia parviflora**
Viola kitaibeliana
*Viola lactea**
*Vulpia ciliata**

SPECIES WITH NORTHERN EUROPEAN LIMITS

BETWEEN 55° N AND 60° N

- Acer campestre**
Alisma gramineum
Alisma lanceolatum
Althaea officinalis
Anacamptis pyramidalis
Anthriscus caucalis
*Aphanes arvensis**
Apium graveolens
*Apium inundatum**
*Apium nodiflorum**
Apium repens
*Aquilegia vulgaris** (3)
Arum maculatum
*Asplenium obovatum**
Aster linosyris
*Atriplex laciniata**
Atriplex pedunculata
Atriplex portulacoides
Baldellia ranunculoides
Berberis vulgaris§
Beta vulgaris
*Blackstonia perfoliata**
Brassica nigra§*
*Bromus commutatus**
Bromus racemosus
*Bryonia dioica**
Bupleurum tenuissimum
*Callitriche obtusangula**
*Calystegia soldanella**
Carduus nutans
*Carduus tenuiflorus**
Carex davalliana
*Carex depauperata**
*Carex divisa**
Carex divulsa
*Carex laevigata**
*Carex pendula**
Carex punctata
Carex strigosa
Carex trinervis
Carpinus betulus
*Carum verticillatum**
*Catapodium marinum**
*Catapodium rigidum**
Cephalanthera damasonium
Cerastium glomeratum (3)
Ceratophyllum submersum
Ceterach officinarum
*Chaerophyllum temulum**
*Chamaemelum nobile**
Chenopodium chenopodioides
Cicendia filiformis
Cirsium acaule
*Cirsium dissectum**
Cochlearia anglica
*Cochlearia pyrenaica**
*Coincya monensis**
Corynephorus canescens
Crataegus laevigata
Crepis biennis
Crepis capillaris (3)
Crepis mollis
*Crithmum maritimum**
*Cruciata laevipes**
Cuscuta epithymum (3)
Cyperus fuscus
*Cytisus scoparius** (3)
Dactylorhiza praetermissa
Dianthus armeria
Dipsacus fullonum§*
Dipsacus pilosus
*Dryopteris aemula**
*Dryopteris oreades**
*Dryopteris remota**
*Dryopteris submontana**
Elytrigia atherica
Epilobium hirsutum
*Epipactis leptochila**
Epipactis phyllanthes
Epipactis purpurata
*Equisetum telmateia**
*Erica mackaiana**
*Erodium lebelii**
Euonymus europaeus
*Euphorbia hyberna**
*Euphorbia paralias**
*Euphorbia portlandica**
*Euphrasia tetraquetra**
Festuca filiformis
Festuca lemarii§*
Filago lutescens§
Filago minima
*Filago vulgaris**
Fritillaria meleagris§
*Fumaria bastardii**
*Fumaria capreolata**
*Genista anglica**
Genista pilosa
Genista tinctoria
Glaucium flavum
Groenlandia densa
Helianthemum oelandicum
Homogyne alpina§*
*Hordeum marinum**
Hordeum secalinum
Hornungia petraea
*Hyacinthoides non-scripta**
Hydrilla verticillata
*Hymenophyllum tunbrigense**
*Hypericum androsaemum**

<i>Hypericum elodes</i> *	<i>Oxytropis halleri</i> *
<i>Hypericum humifusum</i>	<i>Parapholis incurva</i> *
<i>Hypericum tetrapterum</i> *	<i>Parapholis strigosa</i>
<i>Hypochaeris glabra</i>	<i>Parentucellia viscosa</i> *
<i>Illecebrum verticillatum</i> *	<i>Parietaria judaica</i> *
<i>Inula conyzae</i> *	<i>Petasites hybridus</i> (3)
<i>Isolepis cernua</i> *	<i>Phleum arenarium</i>
<i>Juncus foliosus</i> *	<i>Phyteuma orbiculare</i>
<i>Juncus inflexus</i> *	<i>Pinguicula lusitanica</i> *
<i>Juncus maritimus</i> *	<i>Poa bulbosa</i>
<i>Juncus pygmaeus</i>	<i>Polypodium cambricum</i> *
<i>Juncus subnodulosus</i>	<i>Polypodium interjectum</i>
<i>Koeleria macrantha</i> *	<i>Polystichum setiferum</i> *
<i>Lactuca virosa</i> *	<i>Potamogeton acutifolius</i>
<i>Lamiastrum galeobdolon</i>	<i>Potamogeton coloratus</i>
<i>Lavatera arborea</i> *	<i>Potamogeton trichoides</i>
<i>Leontodon saxatilis</i> *	<i>Potentilla rupestris</i>
<i>Lepidium heterophyllum</i> *	<i>Potentilla sterilis</i> *
<i>Lepidium latifolium</i> (3)	<i>Primula elatior</i>
<i>Limonium humile</i>	<i>Puccinellia rupestris</i> *
<i>Limonium vulgare</i>	<i>Pulicaria dysenterica</i> *
<i>Lotus glaber</i>	<i>Pulicaria vulgaris</i>
<i>Lotus pedunculatus</i>	<i>Ranunculus fluitans</i> *
<i>Luronium natans</i>	<i>Ranunculus omiophyllus</i> *
<i>Lysimachia nummularia</i> (3)	<i>Ranunculus ophioglossifolius</i>
<i>Malva moschata</i> * (3)	<i>Ranunculus sardous</i> §
<i>Marrubium vulgare</i> (3)	<i>Raphanus raphanistrum</i> *
<i>Meconopsis cambrica</i> *	<i>Reseda lutea</i> §*
<i>Medicago minima</i>	<i>Rorippa microphylla</i> *
<i>Meum athamanticum</i> *	<i>Rorippa nasturtium-aquaticum</i> *
<i>Minuartia sedoides</i> *	<i>Rosa agrestis</i>
<i>Moenchia erecta</i> *	<i>Rosa arvensis</i> *
<i>Myosotis alpestris</i> *	<i>Rosa micrantha</i>
<i>Myosotis stolonifera</i> *	<i>Rosa rubiginosa</i>
<i>Myosotis sylvatica</i> (3)	<i>Rosa tomentosa</i>
<i>Narcissus pseudonarcissus</i> *	<i>Rumex conglomeratus</i> *
<i>Oenanthe crocata</i> *	<i>Rumex palustris</i>
<i>Oenanthe fistulosa</i>	<i>Sagina apetala</i> *
<i>Oenanthe fluviatilis</i>	<i>Salix purpurea</i> (3)
<i>Oenanthe lachenalii</i> *	<i>Salvia pratensis</i> §
<i>Ononis spinosa</i>	<i>Salvia verbenaca</i> *
<i>Ophrys apifera</i> *	<i>Sanguisorba minor</i> (3)
<i>Orchis laxiflora</i>	<i>Sarcocornia perennis</i> *
<i>Orchis morio</i>	<i>Saxifraga spathularis</i> *
<i>Orchis purpurea</i>	<i>Scabiosa columbaria</i>
<i>Orchis ustulata</i>	<i>Scrophularia auriculata</i> *
<i>Ornithopus perpusillus</i> *	<i>Scrophularia umbrosa</i>
<i>Orobancha alba</i>	<i>Scutellaria minor</i> *
<i>Orobancha artemisiae-campestris</i>	<i>Seriphidium maritimum</i>
<i>Orobancha caryophyllacea</i>	<i>Sherardia arvensis</i> (3)
<i>Orobancha elatior</i>	<i>Silaum silaus</i>
<i>Orobancha hederac</i> *	<i>Silene conica</i> *
<i>Orobancha minor</i> (3)	<i>Silene otites</i>
<i>Orobancha purpurea</i>	<i>Sonchus palustris</i>
<i>Orobancha rapum-genistae</i> *	<i>Sorbus torminalis</i>
<i>Orobancha reticulata</i>	<i>Spergularia rupicola</i> *

Spiranthes spiralis
*Stellaria neglecta**
Stellaria pallida
Symphytum tuberosum§*
Teesdalia nudicaulis
Teucrium scordium
*Teucrium scorodonia**
*Thlaspi caerulescens**
Tilia platyphyllos
*Torilis nodosa**
*Trichomanes speciosum**
Trifolium campestre
Trifolium micranthum
*Trifolium scabrum**
Trifolium striatum
Trisetum flavescens (3)
*Ulex europaeus**
*Ulex gallii**
Ulmus minor
*Umbilicus rupestris**
Valeriana dioica
Verbascum lychnitis
Veronica catenata
*Veronica montana**
*Vicia lutea**
*Viola lutea**

Vulpia bromoides (3)
*Vulpia fasciculata**
*Wahlenbergia hederacea**
Wolffia arrhiza

SPECIES WITH NORTHERN EUROPEAN LIMITS
 BETWEEN 60° N AND 65° N AND NORTHERNMOST
 OCCURRENCES IN THE BRITISH ISLES

These species reach their northern European limits north of 60° in Shetland, although *Aphanes australis* is only doubtfully native there (Scott & Palmer 1987). There are 257 other native British species that reach their northern limit in the 60–65° latitudinal band elsewhere in Europe.

*Aira caryophyllea**
*Aphanes australis**
*Deschampsia setacea**
*Eleogiton fluitans**
*Eryngium maritimum**
*Glyceria declinata**
*Isolepis setacea**
*Radiola linoides**
*Ranunculus hederaceus**
*Schoenus nigricans**

APPENDIX 2. SPECIES AT OR NEAR THE SOUTHERN EDGE OF THEIR NATIVE EUROPEAN RANGE IN THE BRITISH ISLES

Native British species which have their southern European limits in the latitudinal bands 55–60° N, 50–55° N and 45–50° N are listed in this section. Species are asterisked if the absolute limit is reached in the British Isles, but not if it they reach their southern limit at the same latitude in our area and in other European countries.

- § Doubtfully native
 (3) Limit(s) of native range particularly confused by introductions (this also applies to doubtfully native taxa)

SPECIES WITH SOUTHERN EUROPEAN LIMITS

BETWEEN 55° N AND 60° N

*Artemisia norvegica**
*Carex rariflora**
*Carex salina**
*Carex saxatilis**
*Diapensia lapponica**
*Erigeron borealis**
*Euphrasia foulaensis**
*Koenigia islandica**
*Luzula arcuata**
*Minuartia rubella**
*Sagina nivalis**
*Salix arbuscula**
*Salix lanata**
*Salix myrsinites**
*Saxifraga rivularis**

SPECIES WITH SOUTHERN EUROPEAN LIMITS

BETWEEN 50° N AND 55° N

Alchemilla wichurae
*Alopecurus borealis**
*Arenaria norvegica**
*Atriplex longipes**
*Atriplex praecox**
Blysmus rufus
*Carex aquatilis**
*Cerastium arcticum**
Cornus suecica
*Dactylorhiza purpurella**
*Euphrasia frigida**
*Euphrasia ostenfeldii**
*Euphrasia scottica**
*Festuca vivipara**
*Galium sternerii**

Hydrilla verticillata
Juncus balticus
*Ligusticum scoticum**
*Mertensia maritima**
*Polygonum boreale**
Rubus arcticus
*Salix phylicifolia**
*Saxifraga cespitosa**
*Saxifraga hypnoides**
Saxifraga nivalis
*Sorbus rupicola**

SPECIES WITH SOUTHERN EUROPEAN LIMITS

BETWEEN 45° N AND 50° N

As explained in the text, these species are not necessarily close to their southern limit in the British Isles, but as the list is so short it is included for completeness.

Arabis petraea
Atriplex glabriuscula
Calamagrostis purpurea
Calamagrostis stricta
Callitriche hermaphroditica
Carex magellanica
Carex maritima
Carex norvegica
Carex pauciflora
Centaurium littorale

Cochlearia officinalis
Crassula aquatica
Dactylorhiza praetermissa
Draba norvegica
Euphrasia arctica
*Euphrasia confusa**
Euphrasia tetraquetra
Festuca armoricana
Festuca huonii
Festuca longifolia
Gentianella uliginosa
Juncus biglumis
Juncus castaneus
Leymus arenarius
Limonium humile
Limonium normannicum
Luzula pallidula
Minuartia stricta
Najas flexilis
Oenanthe fluviatilis
Poa humilis
Potamogeton rutilus
Ribes spicatum
Rubus chamaemorus
Salicornia pusilla
Saxifraga hirculus
Saxifraga rosacea
Tephrosieris palustris
Thymus serpyllum

‘Far from any house’ – assessing the status of doubtfully native species in the flora of the British Isles

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ABSTRACT

The question of the native or alien status of British and Irish plants was a popular subject in Victorian times, but little serious work has been undertaken for a century; instead species have been looked at individually. A recent paper has dealt with archaeophytes; this deals with neophytes, those alien plants arriving after 1500. The advances in detailed distribution mapping (by grid squares) both in the British Isles and in much of N. Europe, the new research available in the fields of archaeobotany and in the interpretation of the nomenclature of early gardening works, both in medieval times and up to 1800, now allow a broader view to be taken. This can often be coupled with recent European work on alien and native status and on archaeophytes. It is suggested that a range of criteria are examined for each species, and although it is unlikely that any single one will give an answer, if several point in the same direction then a decision based on the probability is possible. The ten criteria used are: first date into cultivation; first date found in the wild; presence in semi-natural habitats; spatial distribution in Britain; trends in frequency; persistence; use; European range; archaeological evidence; genetic diversity. A range of species, all except one treated as alien or native or alien in the *New Atlas of the British & Irish Flora*, is examined illustrating the use of those criteria. Conservation considerations are discussed.

KEYWORDS: Alien species; neophytes; European work; archaeobotany; medieval gardening; criteria; conservation considerations.

INTRODUCTION

The question of the status of British plants, whether a species is native or alien in the country as a whole, or whether it is native in one area but not in another, is bedevilled with uncertainty and optimism, especially the latter. The position in Ireland is usually, but not always, clearer. A recurring theme in very many County Floras is the sentiment that distance from habitation over-rides all other considerations, including common sense. Whilst we were assembling the data from the recent *New Atlas of the British & Irish Flora*

(Preston, Pearman & Dines 2002) it became apparent that for many species there was considerable divergence over views on their nativeness, even within the last 50 years, and that there had been no rigorous investigation, covering the whole of the flora, for well over a century, let alone any attempt to apply the same criteria to all the species in question.

We therefore prepared a list of about 300 species (about 20% of the possibly native flora) where we felt there were questions to be raised over their origin, omitting many species whose status as aliens has never been questioned. We were inspired by the seminal paper by Webb (1985), where, briefly, he discussed eight criteria that could be used to produce a more objective assessment of native status than that currently used, and where he suggested examples of native species possibly requiring reconsideration. We subsequently used all those criteria except that on reproductive pattern, together with three others that we considered relevant.

We analysed our list of 300 against the assignment of “nativeness” in the post-war standard floras and checklists, none of whom gave other than the most cursory reasons for their decisions. In fact there has been no comprehensive study work since the earlier work on the origins of plants by Watson (1832, 1847–1859, 1870) and Dunn (1905), and none at all that takes into account recent developments that might be relevant in the world of horticulture and archaeology, or even of advances in mapping in Europe other than on a very few individual species.

Our work was stimulated by the need to provide sound assessments for a complication which researchers did not have to face until comparatively recently, namely the fixation of the conservation industry with “nativeness”; that is the unwillingness to conserve something that might be “alien”, and therefore the pressure on commentators to label as native those plants that conservationists want to conserve or for which they have established S.S.S.I.s.

We felt then that whilst it is difficult or even impossible to attain certainty in the field of origin, the issues were best served by setting out as many of the facts and dealing with as many of the facets as we could, and making a judgement based on all of those, and in repeating this same process, using the same criteria, for all the species in question. Obviously some criteria might be more important than others, not only as a generality, but for particular species, but that would only become clear in discussion.

On this basis about 150 of these 300 species qualified as archaeophytes (that is plants which were brought to Britain by man, intentionally or unintentionally, and became naturalized there between the start of the Neolithic period [c.4000 BC], and AD 1500), and these are dealt with in Preston, Pearman & Hall (2004), where we set out instances from as many archaeobotanical, horticultural and phytogeographical sources as we could.

Of the remaining 150 we decided, again using as many criteria as possible,

- I. that 74 were neophytes (that is, species brought by man after 1500) or almost certainly so
- II. that another 44 were probably neophytes, though there were enough uncertainties to categorize them as either native or alien, and
- III. that the rest, though we had doubts over many, were left as natives in the hope that further work would assist in forming a more definite view.

We are pleased that the conservation agencies have decided (Cheffings & Farrell 2005) that all the archaeophytes and all the species that we categorised as native or alien are to be treated as "honorary" natives for conservation purposes.

In this paper I attempt to show the criteria that we used in coming to these decisions, supplemented by other sources which we have become aware of since 2000, especially from studies in Europe on alien species (based on ecological work to predict invasiveness) which introduce views on status there which are very often at odds with those given in standard floras.

PREVIOUS TREATMENTS OF STATUS IN BRITAIN

The knowledge of the total number of species in the British and Irish native flora grew steadily from the 16th century and was almost

complete (over 90%, excluding critical species) by the mid 19th century. Interest in the origins of this "native" flora arose in a more piecemeal way, and is well covered in Preston (2002). There was certainly understanding of the difference between the wild and the cultivated flora in the works of Turner and some, but rather less, in Gerard, Goodyer, Tradescent, Parkinson and Ray, up to 1700, and in Martyn, Withering and Hudson in the eighteenth century. These authors reported a plant was in the wild with only rare comments on whether they thought it might be other than a native plant, together with some cases of deliberate or accidental introductions.

But Smith (1800–1804, 1828), both in his own works and in conjunction with Sowerby in their illustrated *English Botany* (Smith & Sowerby 1790–1814), complicated the study of nativeness by admitting into those works (possibly because they were suitable subjects for illustration) a host of species that were little more than garden escapes and even deliberate plantings or errors. Despite not putting forward any rigorous evidence he had a considerable and lasting influence on his contemporaries. For instance the distinguished Henry Aiton, in his first edition of the plants cultivated at Kew (Aiton 1789), gave the origin of many plants we now call alien as from overseas, with details of who had introduced them and often the date of this. But by the second edition (Aiton 1810–1813), that is after Smith's first works, he had altered the country of origin to "Britain", and this was followed by the all the subsequent enumerators of plants grown in Britain (Loudon, Sweet, Paxton *et al.*). In Druce's paper on the *Extinct and Dubious Plants of Britain* (1919) over 50 of the 147 species covered had their origin in Smith & Sowerby.

An example of the text in Smith & Sowerby is too apposite to omit in this paper. Having discussed *Leucojum aestivum*, which a lady from Suffolk described as a troublesome weed in old pastures that had never been broken up, he passes to *Fritillaria*, where he writes "If we can allow the *Leucojum* a place in a work on British plants we cannot hesitate about the *Fritillaria*, which although not noticed by Ray or Dillenius, is very common in parts of Middlesex, as well as Suffolk and other counties. Mrs Cobbald sent it from Little Stoneham (Suffolk) with *Leucojum aestivum*, *Ornithogalum umbellatum* and *Colchicum*". None of these is in a native site, other than possibly the *Colchicum*! Again and again the

species in question is described as “far from any house”, “not the slightest doubt of its being indigenous” or “the situation seems to preclude the idea of an escape from gardens” and the like.

It was not until Watson, in the second quarter of the nineteenth century, that there was any serious attempt to stand back and consider whether there was any evidence on the likely origin of particular species in the British flora. Only four years after the publication of Smith's *English Flora*, Watson began this process of more critically assessing the origin of species, in his *Outlines of the Geographical Distribution of British Plants* (Watson 1832), a process elaborated and refined in his major work, *Cybele Britannica* (Watson 1847–1859). Here he divided alien species into three categories, using the following names for them:

Alien: “now more or less established, but either presumed or certainly known to have been originally introduced from other countries”.

Denizen: “at present maintaining its habitats, as if a native, without the aid of man, yet liable to some suspicion of having been originally introduced”.

Colonist: “a weed of cultivated land or about houses, and seldom found except in places where the ground has been adapted for its production by the operations of man”.

In his *Compendium* (Watson 1870) he later added a fourth category,

Casual, for “chance stragglers such alien species as are uncertain in place or persistence”.

The subject, and its principle relevance to the treatment of archaeophytes, is discussed in more detail in Preston *et al.* (2004).

His treatment of neophytes was much simpler. Of the 74 species selected by us from our list as neophytes, Watson covered 48, and of these he categorised only four as native without any caveats. Of the 44 species we selected as native or alien, he covered 34, and called 17 native with no caveats.

Watson's work was followed in virtually every county flora and national check-list for the next 100 years, including Druce's check-lists (1908, 1928) and his *Comital Flora* (1932). Certainly there were local exceptions and special pleadings, but the general framework was either accepted or deferred to. The problem, which affects too many local

flora writers, is the lack of experience of the flora of Britain and Ireland as a whole, a problem we found still endemic when preparing the *New Atlas* (Preston *et al.* 2002) where adjacent counties assigned different statuses to the same species. Watson, and later Druce, by looking at the flora as a whole, was able to see the inconsistencies and comment on them.

Another work of that period was that of Dunn (1905) on the alien flora of Britain, where he covered in short accounts all the species that he considered alien. He dealt with 924 species, together with a further 170 that he had some doubts over, but accepted as probably native. In his book he described the habitat, mentioned the first date in the wild if he thought it relevant and discussed the wider distribution. His introduction covers many of the points covered in Preston *et al.* (2004) and is still relevant. He suggests that “it is a general experience, and one that is to be expected, that two areas inhabited by a given native species are seldom known to be separated by a large tract of similar, and apparently suitable ground, devoid of that species”. He qualifies this by agreeing that it was not impossible that such a gap might occur in the truly native range, for instance as a consequence of approaching extinction, but recounts the study of geographical distribution to shed light on these conundrums – an approach we tried to bring together in the *New Atlas* (Preston *et al.* 2002). Dunn's work, other than in the context of the general acceptance of Watson's works, received little attention at the time, though advances in the studies covered by my criteria have largely supported his conclusions.

Watson's position held sway until after World War II and Lousley (1953), in a review of the classification of alien plants, espoused his main points with only minor modifications. However, for reasons I cannot really pin down, Watson's system was falling out of favour by then, though a few local floras after 1960 have used it.

It would be difficult to say that Watson's tenets had been replaced by fresh reasoning in the post-war British floras and check-lists, because there is no discussion in any of them of the reasons behind their categorization of statuses, which are limited to “native” or “introduced” with qualifiers. In the *Flora of the British Isles* (Clapham *et al.* 1952) there is only a reference in the glossary, where “introduced” is defined (in the appendix, p. 1521) as plants

"known to have been, or strongly suspected of having been, brought into the British Is. accidentally or intentionally by man within historic times". Later editions (Clapham *et al.* 1962, 1987) modify the status of some of the treatments of individual species, but still shed no light on the reasons. Dandy (1958) gives no explanations, merely mentioning the difficulty of differentiating native and long-established aliens. I cannot find a rationale or explanation in Stace (1991, 1997), though I am fully aware that he not only has a huge personal experience but also many active correspondents. Kent (1992) gives no explanations at all; Clement & Foster (1994) and Ryves, Clement & Foster (1996) treat ancient introductions as native and for other species either deal with them as aliens, or, if in doubt, square bracket the species with the comment "accepted, with reservations, as native". So, whilst it is possible to see there, for instance, that *Pentaglottis sempervirens* is treated as a native or an ancient introduction, it is not possible to see why.

I have also consulted Reynolds (2002) for the treatment of Ireland. Every plant on our draft list of neophytes and of native or alien was treated by her as alien in Ireland other than three instances where, in following the Irish Census Catalogue, the status in Ireland was not further questioned by her.

It is not altogether surprising that the above dealt so summarily with aliens or doubtful aliens as their works were all fulfilling many other purposes and status was only one, and a mixed one at that. But the real point is that I cannot trace any attempt since Watson and Dunn to examine a range of species, using as many criteria as possible, and to present that information, and this is the purpose of this paper.

CRITERIA USED AND THEIR RELEVANCE

1. FIRST DATE IN CULTIVATION

The main sources of summarised information are Aiton (1810–1813) and Loudon (1855). The second is later but omits the invaluable details on sources contained in the former. Elucidation of early sources (Turner and his predecessors, Gerard *et al.*) usually but not always contained in Aiton and Loudon, has been made much clearer by the recent works of John Harvey and his colleagues, covering both interpretation of nomenclature and previously unknown or inaccessible works. More background is contained in the introductory chapter in Preston *et al.* (2002).

Work on species introduced since Loudon has been hampered by the fact that nothing comprehensive has been attempted since his last edition, possibly because there were so many, so information has had to have been assembled from a great variety of sources. The other most significant missing link in our researches is the history of grass seed and fodder crop introductions, together with the impurities that these might have brought with them (see Rich & Karran 2003) for a rare illustration).

I consider that a date in cultivation for a species that is considerably earlier than the first date for the wild is very relevant for garden species. (e.g. *Aconitum napellus*, *Allium sphaerocephalum*, *Daphne mezereum*, *Fritillaria meleagris*, *Galanthus nivalis*) but, of course, is less relevant for a species that might have been grown for curiosity but never entered mainstream gardening (e.g. *Linaria supina*, *Hypericum canadense*, *Serapias lingua*). Note, as discussed earlier, that once a species was shown, particularly by Smith & Sowerby, as native in Britain, then Aiton, Loudon and others no longer showed its source and introduction date.

2. FIRST DATE IN THE WILD

The information to support the first dates of discovery comes principally from Clarke (1900), Dunn (1905) and Druce (1932), and as we said in the *New Atlas*, we regard the first two as more reliable than the last. More background is contained in the introductory chapter in Preston *et al.* (2002). As with work on introductions into cultivation, so any research on first dates in the wild has similarly lapsed, with virtually no work taking place in the last 70 years, despite the increased interest in alien plants generally. Since the *New Atlas* further work has seen the emendation of about 15% of the dates given there, but little further herbarium work, which is potentially the main remaining source of better data, has been undertaken.

For species other than those that are critical or really insignificant, I consider the first date in the wild as of very great importance, in helping to assess possible arrival dates, particularly in well-worked areas of British Isles. Of the 74 species in our initial selection that we decided were probably neophytes, 44 had first dates in the wild in the 19th and 20th centuries, with a further 19 in the 18th century, mostly after 1750.

3. PRESENCE IN SEMI-NATURAL HABITATS AND IN PLANT COMMUNITIES

We collected information for these for the paper on archaeophytes (Preston *et al.* 2004), but because the species covered by this paper are such an eclectic mix compared with those we selected as archaeophytes their occurrence or not in semi-natural habitats is of less relevance, and probably of more importance for the non-garden and annual plants. Nonetheless, there must be a reasonable hypothesis to suggest how species have survived from their arrival in the British Isles (usually earlier in post-glacial times) and this is often very difficult for species in man-made habitats. Thus if a plant grows only in man-made habitats it is likely to be alien.

In each case Rodwell (1991–2000) has been consulted for the habitats of species, and has been supplemented by the information in Hill, Preston & Roy (2004), from county floras and by personal knowledge. It would be no surprise that many of the species illustrated in the following case studies did not appear in Rodwell, as almost all are rare.

4. SPATIAL COHERENCE IN BRITAIN AND IRELAND

This is an interpretation of the actual range in Britain and Ireland, compared with the available habitat. Thus *Stachys alpina*, restricted to two copses when it could occur anywhere, has no coherence whatsoever, and *Galanthus nivalis*, omnipresent, has. In itself, of course, a limited range, when there is plenty of other suitable habitat, is not conclusive to a decision on alien status or not, but it is indicative. Where a species, such as *Euphorbia serrulata*, has a core “native” range and other more scattered records elsewhere, only that alleged “native” range is taken into account.

5. TRENDS IN FREQUENCY (DYNAMISM)

In our original selection we looked also at dynamism in Britain (whether a species was increasing or decreasing, and if so, how fast). Rapid increase is frequently one of the hallmarks of a neophyte, whereas natives and archaeophytes, in general, show slow declines. Furthermore if the environment changes, then the range of natives tend to change too, whereas the range of aliens is changing even if the environment stays the same.

A further subject for research on which some progress has been made in Europe, but as yet little here, is the time-lag between the arrival of an alien plant in cultivation, and its appearance,

if it makes that transition, in the wild. Recent work in Germany (Kowarik 1995) (only one of a number of recent papers) gives a surprisingly long time-lag for woody plants, so we might only now be seeing the rapid spread of plants introduced 100 to 200 years ago.

6. PERSISTENCE

This covers whether the recorded sites were long-lasting or ephemeral. As a generalisation many aliens are ephemeral, their presence characterised by a number of different sites, each short-lived.

7. USE

This covers whether the species was grown in gardens, as an herbal or medicinal plant, or as a crop, and thus whether it is more likely that it has escaped into the wild. Of course a native plant may be used by man – there are very many medical and culinary examples – but if there is a use, then there is a better chance of it becoming established in the wild, and, again, this is just one of a range of criteria.

8. EUROPEAN RANGE

Most of our standard floras give distribution in Europe, or in the rest of the world, or both. The information will have been obtained from foreign national floras, and from regional and local floras, and more recently atlases such as Meusel *et al.* (1965, 1978, 1992) and Hultén & Fries (1986), Bolòs & Vigo (1984–2001), and others where the distribution maps have the range shaded could have been used. Whilst this last enables the total range to be seen, it often fails to differentiate between the core range and outliers. Webb (1965) recognised this as a problem, writing that “the elegant loops and curves which we see in so many maps conceal ambiguities and ignorance”!

However since Perring & Walters (1962), and the earlier work by Hultén (1950) a few countries have started to produce grid-based atlases which enable the real distribution to be seen much more clearly, and to better allow us (or more easily than a text can) to evaluate our flora with its distribution elsewhere.

As my survey of these works is new and perforce incomplete, in that either I am still unaware of the existence of data, or, more likely, the data that I consider necessary is not available, this must be considered work-in-progress, but it is of such major assistance to this paper that it will surely be used more and more.

There are recent grid-based Atlases, all at a scale of 10 × 10 km or larger, for Germany (one each for the former West and East) (Haupler & Schonfelder 1988; Benkert *et al.* 1996), for Holland (Mennema *et al.* 1980, 1985; Meijden *et al.* 1989) and an incomplete series (covering about 900 species) for N.E. France, covering an area from Cherbourg in Normandy to the German border, down to Paris, and including Luxemburg, most of Belgium and much of Holland (Institut Floristique Franco-Belge 1978–2001). There is also available a volume of maps for the Breton department of Finistère (Hardy 2002), useful for Atlantic species.

Atlas Florae Europaeae (Jalas *et al.* 1972–1994, 1996, 1999) covers all species in Vol. 1 in *Flora Europaea* (roughly, up to *Saxifragaceae*) and the latest (Kurtto *et al.* 2004) volume starts the *Rosaceae*. These are, of course, invaluable, but since they are at the scale of 50 × 50 km, show less detail than the country atlases listed above.

A further source of research, which is sometimes not available from the sources cited above, is information on how European national and regional floras describe the status of our flora in their countries. Often of course, their statements have been as vacillatory as ours, and though, again, I feel that I have barely explored this subject, I have been able to consult interesting lists for countries which, like ours, could well be at the edge of the range of Mediterranean species. In particular, I have used the recent checklists for Germany (FloraWeb – <http://ice.zadi.de/floraweb/>), for Poland (Mírèk *et al.* 1995) and the Czech Republic (Pyšek *et al.* 2002). This whole subject, linked to work exploring and predicting the ecology of plant invasions, is developing apace, and Pysak *et al.* (2002) make the interesting point of the “remarkable difference they found between the data drawn from the standard floras and (that from) checklists commenting on species immigration status and studies focussing specifically on alien plants”. In other words a study of work in other countries is often essential to a better understanding of the origin of our own flora, in the same way as a national Atlas might see a broader picture than a county Flora.

9. ARCHAEOLOGICAL EVIDENCE

Of major importance in the paper on archaeophytes (Preston *et al.* 2004) was the information available on archaeological

evidence, almost all of it gathered in the last 30 years. For neophytes the evidence is, not surprisingly, almost entirely absent. Of all the species investigated for this paper the only evidence found was for the currants, *Ribes nigrum* and *R. uva-crispa*, where post-Norman remains were identified.

10. GENETICS

There has been relatively little relevant work here. Nevertheless there has been research on *Draba aizoides* (John 1992) which seemed to support its claim to nativeness and for *Leucojum aestivum* where David Coombe was able to demonstrate differences between the native and alien subspecies (FitzGerald, in Gillam 1993).

CASE STUDIES

For our work for the *New Atlas* (Preston *et al.* 2002) we looked at all the criteria for each species before coming to a decision, using a “score” by which we decided the probable status of each. A spreadsheet, showing all the species we covered in the categories that I have described (neophyte, native or alien and others) and using the criteria outlined above, is available from the author. Rather than produce that very large table it seems more appropriate to try and give a selection of examples to illustrate the use of the criteria.

Each study is prefaced by a heading and condensed paragraph setting out the information available on the relevant criteria, though the information on the European distribution is dealt with in the main text that follows. In this paragraph “NVC” refers to the information in Rodwell (1991–2000); “Watson” to Watson (1847–1859, 1870), “Dunn” to Dunn (1905), “Stace” to Stace (1991), “Kent” to Kent (1992), “Clement & Foster” to Clement & Foster (1994), “*Fl. Europaea*” to Tutin *et al.* (1968–1980, 1993), and “VCCC” to Stace *et al.* (2003).

A garden plant, long cultivated here, but with late first records, and uncertain native range

EUPHORBIA CYPARISSIAS

In cultivation by 1640, first record in wild 1796 (Earl of Stamford’s woods at Enville, Staffs). It is not included in the NVC and is invariably a species of open ground. The records are very scattered; it is increasing, and it is persistent in its sites. It is grown as a garden plant. It was

treated by Watson as alien, and by Dunn as native. The treatment in recent floras has varied, with some showing as native, some alien, and *Fl Europaea* and the VCCC as alien.

This species is frequent in continental Europe, up to, but not within 20 miles of, the Channel coast, so a first glance at a world distribution map would not arouse many doubts on nativeness, though Mennema *et al.* (1980) say it has been extending northwards for some centuries. Yet a combination of all the above criteria points decisively against this. Even Dunn's decision is not what it appears. He says... "not, the only natural locality is on the downs near Dover" (Dunn 1905). Yet this is presumably based on the entry in the Flora of Kent (Hanbury & Marshall 1899) which actually says ... "perhaps native in one station.....chalky hill-slope near Dover. ...it may be indigenous here; the continental distribution of the species rather favours this view." Druce (1908) considered it an alien and Clement & Foster (1994) report, *inter alia*, that it was formerly brought in with racehorses.

It is a very persistent garden plant, spreading through its rhizomes on light soils.

Decision: alien (neophyte).

A garden plant, long cultivated here, but with late first records, and uncertain native range

FRITILLARIA MELEAGRIS

In cultivation at least by 1597, and possibly by 1578, with first record in wild 1736 (Middlesex, Harefield). NVC MG4, and widely naturalised elsewhere. Spatially it is fairly widespread, but in most sites it has declined though it can multiply quickly given appropriate conditions. A well-known garden plant, treated by Watson as a denizen and not covered in Dunn. All recent floras other than Kent and Stace (1997) have treated it as native, as has *Flora Europaea* and the VCCC.

More has been written about the nativeness or otherwise of this species than any other. The case for was recently summarised in Oswald (1992) and that against by Harvey, the expert on medieval plants (1996), and I refer readers to those papers for the case in full (and in Harvey's case for much more besides – endlessly provoking and utterly fascinating). A summary for nativeness (Oswald) might be:

1. Near-continental distribution makes extension into southern England possible.
2. Late discovery possibly due to very short early flowering time and restricted range.

3. Habitat often waterlogged in winter and not the sort of countryside a 17th century botanist might have felt exploring.
4. A reference in the 17th century naturalist John Aubrey to a plant called 'crow-bells' might represent a very much earlier record.

To these should be added, of course, the fact that many of the sites are first-rate examples of neutral grassland and that aliens are very rare in this habitat.

Harvey's points include:

1. Late date for such a colourful and obvious flower, and a dismissal of any connection with the plant described by Aubrey.
2. Unlikely to have been overlooked by Turner, Gerard, Parkinson, Johnson, Ray, Morison and Dillenius.

Since the publication of those two papers more has come to light regarding the continental distribution. Preston *et al.* (2004) point out that it is treated as native in Poland, but an archaeophyte in Germany, a neophyte in Finland and a casual in the Czech Republic. In Denmark, cited by Harvey, it is treated as a neophyte, arriving in 1647, and in Sweden (Zhang 1983) a neophyte, arriving in 1742 or 1743, having been grown in Uppsala Botanic Garden since at least 1658. Here it has spread into flower-rich meadows, behaving like a native if one did not know its source. Finally, it is absent from N.E. France (Institut Floristique Franco-Belge 1978–2001) and in Brittany is found only in the south (des Abbayes *et al.* 1971). So the European distribution militates strongly against it being a native here.

In England the first date in the wild is 1736, from a site where it had been known for "forty years". We have always ignored these feats of memory as being unreliable, but the next wild record I can trace is not until 1776 (Hind 1889), where it was described as abundant in meadows. Then, for the 29 counties where it was mapped as native in the New Atlas (and some of those are very recent discoveries indeed), it was found in another twelve in the next 30 years, ranging from Stafford to Suffolk and down to Dorset, and another nine in the next 25 years. It was not discovered until 1862 in the county possibly most celebrated for its display, Wiltshire, and the Herefordshire and Huntindon "native" sites are both twentieth century finds.

What happened either to account for collective myopia all over southern England, or

to explain why it was discovered in twelve out of 29 supposedly native counties within 30 years? I can offer no explanation. Its propensity to multiply very fast is well-recorded (e.g. Zhang 1983), and Kevin Walker (*in litt*) tells me of his experiences at Portholme in Hunts. At that site there was very little in the years 1925 to 1980, and then a vast increase in the period 1980 to date. It seemed to be helped by winter flooding (spreading the seeds) and by hay cuts (seeds dispersed).

How could it arrive within a very few years other than by repeated introductions?

Decision: alien (neophyte).

A garden plant, long cultivated here, but with late first records, and uncertain native range

RIBES UVA-CRISPA

In cultivation by 1275, first record in wild 1763 (Cambs, though both Babington (1860) and Perring *et al.* (1964) considered it doubtfully native there). In NVC (W8 (*Fraxinus-Acer campestre* woods) but only as a very incidental constituent and elsewhere a species of varied habitats. The records are widespread, increasing (possibly as a result of better recording of aliens), and persistent. It has been grown for centuries and was treated by Watson as a denizen, and by Dunn as a native. All recent floras treat as native, with some doubts in Stace, but the VCCC treats as alien.

There is archaeological evidence from medieval times (1225–1400) (Tomlinson & Hall 1996). Roach (1985) recorded a pale (i.e. green) form arriving from Flanders in 1509. Turner (1548) has it growing only in gardens, though he mentions that in Germany it grows in the fields amongst other bushes. Gerard (1597) describes it as well-established (in gardens) but said it had no name amongst old writers who either knew it not or esteemed it not. Smith & Sowerby (1790–1814) say “nothing can be more difficult than to say whether this plant can be truly a native of Britain. It is so far naturalised as to be common everywhere. Mr Robson finds it plentifully in woods and hedges around Darlington, which may be its native country”. Dunn (1905) describes it as common in damp woods in perfectly natural habitats, though undoubtedly alien in many places.

It seeds very easily and as with *R. rubrum*, it might always have existed in a wild and weedy form but if so it is odd that it was ignored by all the early botanists.

Decision: alien (neophyte, though possible archaeophyte).

A species once grown in gardens, and capable of being spread by seeds, long-established in one site seemingly as a component of semi-natural vegetation

LONICERA XYLOSTEUM

In cultivation 1596, first record in wild 1770 (Northumberland, but by 1801 in Sussex, nr Arundel). It is not included in the NVC, but occurs in ancient woodland and hedgerows at one site. Older records particularly were fairly widespread, but these were mainly casual records, and it is only locally persistent. It was formerly grown as a garden plant, but now rarely as more floriferous species have been introduced. Watson decided as probably alien, Dunn as a native. Recent floras and *Fl Europaea* have been equally divided between native and alien status.

It is widely distributed in Europe, principally in higher areas away from the coastal plains, as far north and west as just above Paris, and in Germany up to Hanover. Elsewhere, as in Brittany (des Abbayes *et al.*), it is as a casual or introduction. In Wigginton (1999) much is made of the habitat in species-rich woodland or hedgerows, often near to old trackways, and ancient woodland herbaceous associates are given. In particular the presence of stools of *Tilia platyphyllos* is stressed, and paralleled with similar woods in France.

Webb (1985) singles this species out for special attention under his criteria of “frequency of known naturalization”. After pointing out that if a plant claimed to be native in one locality is becoming more and more widely naturalised in similar habitats elsewhere then some reconsideration is called for, he points out that the claim for nativeness in one station near Arundel “can be traced back to a statement by Borrer, published by Smith in 1801, that it was “growing plentifully and certainly wild”. But Borrer was only 19 at the time.....Smith admitted at the time that it was frequent in gardens and that he had previously regarded it as an escape.....I cannot believe that the statement of the youthful Borrer, copied uncritically from one book to another, outweighs the mass of evidence in the opposite direction”.

It is still in the Arundel site, but the evidence (late discovery, use as garden plant and frequency of introduction elsewhere) sides with

Webb (and Watson before him, whom Webb used but did not acknowledge!).

Decision: alien (neophyte).

A well-known garden plant, with a very late discovery date, with an allegedly native endemic subspecies

ACONITUM NAPELLUS

In cultivation by 1596, first record in wild 1819 (Herefords, "in a truly wild state"). It is not included in the NVC but often forms an integral part of riparian vegetation. Spatially it is limited as a presumed native and its dynamism is confused by escapes; it is very persistent. It has been grown as a garden plant for centuries. Watson treated it as a probable denizen and Dunn as an alien. Recent floras all treat it as a native, possibly influenced by the suggestion of an endemic subspecies.

The taxonomy of this species is complicated. Jalas & Suominen (1972–1994) follow one taxonomist's recent work in showing the British species as a near endemic subspecies, subsp. *napellus*, restricted to western Britain with one outlier in S.W. France. Stace (1997) seems ambivalent. The Brittany flora (des Abbayes *et al.* 1971) shows all records there as adventive. It is clear there is no consensus and that more work is needed to establish whether there actually is any endemic subspecies here.

I have traced no map of the European range, other than a shaded map in Bolòs & Vigo (1984–2001) which shows the species occurring from central and southern France across to Switzerland and northern Spain.

It was grown in Elizabethan times, and it seems inconceivable that, as a native, it was not discovered in the wild until 1819. It has many strong advocates as a native – there is a notable passage in the excellent *Flora of Bristol* (White 1912). It has the appearance of being perfectly wild along shady streams, but all the sites, some long-standing, investigated by the author in Dorset and Somerset turn out to be below gardens, old or current, and pieces of the tuberous rhizomes, washed away by floods, readily establish on open ground downstream. Incidentally White was a strong optimist over plant status – he gave the benefit of doubt to almost every relevant species covered in this paper, including the following.

The very late discovery, coupled with the large gap in the potential native range, seem to outweigh the semi-natural niche that it is now found. The taxonomy still needs to be resolved.

Decision: alien (neophyte). Work needed to clarify the taxonomy.

A species, once grown as a garden plant, with a very late date of discovery and a very odd distribution

STACHYS ALPINA

In cultivation by 1597, first record in wild 1897 (Glos, Wootton-under-Edge). It occurs in woodland and on verges. As a presumed native its distribution is extremely limited, and its dynamism is uncertain, as it is obscured by conservation action; it is persistent given favourable conditions. It has been used as a garden plant, but probably not now, and was not covered by Watson or Dunn. All recent floras describe it as native.

The European distribution is interesting – primarily around the Alps, but with a band across central Germany, Belgium and mid France, with further outliers N.W. of Paris and in S Brittany, though the most recent Belgium flora (Lambinon *et al.* 2004) remarks it is sometimes introduced. It has been closely studied by Kay & John (1995), who report that all the populations are closely related and almost monomorphic, that all the sites have nothing out of the ordinary to explain such a refuge, that it sets seed easily and spreads by this and root division, and that following the discovery of the Gloucester site, where it considerably increased in range following discovery, many botanists grew it in their gardens. As such they feel that it is very unlikely indeed to be a native plant.

Though it does seem to be a garden plant of very little value, it seems totally unlikely that its British distribution should be only three localities, in habitats that are either secondary woodland or ruderal sites. I am amazed its nativeness has not been questioned before!

Decision: alien (neophyte).

A species found in semi-natural grassland, with a coherent European distribution, but a late discovery

PRUNELLA LACINIATA

This was cultivated in 1713, but not found in the wild until 1886 (Glos). It is found in semi-natural grassland. It has been recorded in over 60 10-km squares, mainly in a broad swathe of S England, but is declining. Watson did not cover it, but Dunn treated it as an alien, as have most recent floras, though Stace treats as possibly native.

Hultén & Fries (1986) show a wide swathe of distribution across Europe, reaching N.E. France and southern England, but in fact Institut Floristique Franco-Belge (1978–2001) shows only very scattered records away from Belgium.

There are records of the species being introduced with clover seed (Preston *et al.* 2002), and very many of the remaining sites in England have populations of the hybrid with *P. vulgaris*; in fact this seems to lead to the extinction of *P. laciniata*. (e.g. Morton 1973). This lack of a long-term survival mechanism, coupled with the classic curve of a frequent repeated introduction and almost terminal decline, together with the very late date of discovery, all points conclusively to an introduction.

Decision: alien (neophyte).

A late discovery with no contiguous European range and no real semi-natural habitat

EUPHORBIA SERRULATA

There are no historic details of cultivation, and first record in wild is 1773 (Tintern). It seems to be a species of open disturbed habitats, only growing in woodlands when there is little competition and plenty of light. Its area of presumed nativeness is very restricted indeed and it has little dynamism, decreasing other than as a casual. It is usually persistent in open habitats. It is certainly grown as a garden plant, but possibly only recently. It was treated by Watson as a native in the Wye Valley, it is not included in Dunn, and all recent floras all treat it as native, other than Kent.

Due to past confusion with *E. platycarpus* its history as a garden plant is not recorded. It is a weed species, responding very well to disturbance and light. In garden conditions, both in alkaline Dorset (pH 8.1) and acid Cornwall (pH 4.5) it seeds and spreads prolifically. But it is confined as a presumed native to around 20 historical sites in the Wye Valley, with an increasing number of escapes elsewhere.

I have not found any map of the world distribution, but map floras of West Germany (Haupler & Schonfelder 1988) and N.E. France (Institut Floristique Franco-Belge 1978–2001) show a central European distribution with no occurrences north the Cologne area in Germany and in France from Lorraine, where it is frequent, westwards, with very scattered records to southern Brittany (Mayenne).

It is supposed to be a calcicole, and its very limited range, absence from anywhere else in Britain and northern Europe, plus its late discovery, justifies the doubt over status.

Decision: alien (neophyte).

A weedy species of open habitats, though with a Mediterranean-Atlantic distribution, and some persistence

LAVATERA CRETICA

In cultivation 1723, with first record in wild 1859 (Surrey, as a grain impurity, but 1873 in Scilly). It is a species of open disturbed ground. Its distribution shows very little spread, little dynamism, but it is persistent in Scilly and the Channel Isles. It has no use, is not covered in Watson, and is treated by Dunn as a casual. All recent floras, other than the VCCC, show it as native.

Its European range is Mediterranean (Bolòs & Vigo 1984–2001), reaching Portugal, with the French records possibly (the map is unclear) confined to the far S.W. and the far N.W. It is rare, sporadic and non-persistent in mainland Cornwall; in Scilly persistent (first discovered in 1873) and restricted to disturbed ground ("waste ground, old quarries, roadsides and bulbfields"). In Jersey it was first recorded as a casual in 1879 (Le Sueur 1984), and was then rare over the next 80 years, and in Guernsey it was found before 1886 (McClintock 1975), and has spread only in the last 50 years.

Lousley (1971) argues that failure to spread in Scilly indicates nativeness but where did it grow before the modern landscape was formed? He further claims that it occurs up the west coast of France in habits similar to those in Scilly, but this is not born out by the Brittany flora (des Abbayes *et al.* 1971) where it is described as a naturalised adventive or occasional casual.

A common Mediterranean weed, but a most unlikely native plant.

Decision: alien (neophyte).

A weedy species of open habitats, though with a Mediterranean-Atlantic distribution

ANISANTHA MADRITENSIS

Not apparently cultivated and first record in wild 1716 (Kent, Sandown Castle, but known in Avon Gorge since 1773). It is a species of open disturbed ground. Fairly widespread, with some dynamism but these are mainly casual records and it is persistent only in two core

areas. Use, none, and treated by Watson as possibly native, with caveats, but by Dunn as an alien. Recent floras are completely contradictory.

A frequent weed in the Mediterranean, and occasional up the west coast of France to southern Brittany; absent from Germany and a casual elsewhere in northern Europe. Perring & Walters (1962) claim "native or long established" in Pembrokeshire and Glamorgan, together with the Avon Gorge, but Ellis (1983) regards it as colonist from England, with all the older records from there being from around ports or ancient buildings. The case for the Avon Gorge is certainly more convincing but is more likely to be an early introduction in view of the European distribution, the commercial importance of area and subsequent spread, a view endorsed by Lovatt (1982).

Decision: alien (neophyte).

A weedy species of open habitats

SPERGULARIA BOCCONEI

There is no record of cultivation; first record in wild 1901 (Cornwall, Par). It is a species of open disturbed ground. Spatially very limited as a presumed native, with little dynamism, declining and not persistent. Use, none, and not covered by Watson or by Dunn. Recent floras have treated it as native, with some doubts, notably in Stace, and the VCCC shows it as alien.

A predominately coastal species, found around the Mediterranean (and eastwards to Iran), and very rare in France (Jalas & Suominen 1972–1994). It is found in the Channel Isles (Guernsey 1912 and Jersey 1906), where it is considered a probable introduction (McClintock 1975; Le Sueur 1984). Its other British sites are mostly at or near ports, where its usual habitat seems to be car parks and in other weedy places; few (any?) of the populations are long-persistent.

Decision: alien (neophyte).

A weedy species of open habitats, with a coherent European distribution

PETRORHAGIA PROLIFERA

In cultivation, no record, first record in wild not known for sure due to confusion with *P. nanteuillii*, but at least by 1840 (Norfolk). It is a species of open disturbed ground. It is only currently recorded from two sites, is declining, though it has been known in its current areas for some time. There is no recorded use, and it was not covered by Watson or Dunn. Of recent

floras only Kent calls it native, the rest equivocate.

This species has a coherent European distribution (Jalas & Suominen 1972–1994), reaching the Channel coast, though Lambinon *et al.* (2004) describe it as only in southern Belgium and Lorraine, often introduced elsewhere. Mennema *et al.* (1980) show its habitat in Holland as in dry open sandy places along the great rivers. It is a weed in the southern Hemisphere.

In the area of Norfolk where one of its two British sites occur, it has been known for 160 years, the remaining site is next to a concrete roadway, and, although it is in the adjacent semi-natural grassland, Petch & Swann (1968) described it as a casual there. In its other site in Bedfordshire it is by a sand pit, adjacent to a railway. Akeroyd & Beckett (1995) argue for its native status at these sites, but its late date of discovery (even allowing for confusion with *P. nanteuillii*), its single site with any claim to continuity (out of only two that have even been suggested as native) and its habitat, all have greater weight than the continental distribution.

Decision: alien (neophyte).

A weedy species of open habitats, long-known in Britain, but probably never more than a casual other than in the last century at one site

TORDYLIUM MAXIMUM

There are no records of cultivation but the first record in wild is 1670 (Middlesex, but first in Essex 1875). It is a species of open disturbed ground. Spatially very rare and scattered and declining. It has some persistence, but this is now aided and obscured by conservation intervention. It has no uses, and Watson treated it as alien or denizen and Dunn as alien. All recent floras, including *Fl Europaea* treat it as alien except Clement & Foster, possibly native, and the VCCC, which treats it as native.

Its European range is Mediterranean, reaching across France to Brittany, but not in N.E. France, Belgium or Holland (Bolòs & Vigo (1984–2001). Adams (1999) seems incorrect in stating it is considered native in northern France. Institut Floristique Franco-Belge (1978–2001) show it as a rare casual, with only a very few records, all to the south of Paris. It is also a casual in Holland and Germany.

Smith & Sowerby (1790–1814) give only an old record near Oxford, adding "but having been observed there for above a century, it cannot but be considered as a native". Adams

(1999) postulates that it might be an overlooked native that firmly established itself during (or perhaps before) the climatic optimum of the sixteenth century, and points to its presence with other continental thermophiles such as *Lactuca saligna* and *Vicia bithynica*. However, in Britain this species has always been a rare casual and nothing more, other than in Essex where it has persisted in a number of open sites adjacent to forts and other disturbed areas, though the true position is hopelessly confused by planting and gardening.

Decision: alien (neophyte).

A weedy species with coherent European distribution, but late discovery and habitat suggest a recent arrival

CERASTIUM BRACHYPETALUM

There is no record of cultivation, with the first record in the wild 1947 (Beds). Abroad, it is a species of open disturbed ground. Its distribution is extremely limited as a presumed native, with no dynamism at all, and persistent only with conservation action. It was not covered by Watson or Dunn. Some recent floras, including the VCCC, treat it as native, some as possibly native or probably alien.

This species has a coherent European distribution (Jalas & Suominen 1972–1994), reaching the Channel coast wherever there are calcareous soils, though Lambinon *et al.* (2004) describe it as rare other than in northern Picardy and sometimes occurring as an adventive. In Kent, it occurs also in adjoining semi-natural grassland, albeit in open areas caused by rabbits, but since extensive conservation action has failed to preserve it in such a habitat (T. C. G. Rich, pers comm.), it seems more likely that it has spread from the railway to the grassland, rather than the other way around.

With a first date of discovery as late as 1947, its discovery in a railway cutting in Bedfordshire, its presence in a similar habitat in Kent, together with the fact that in Europe it is described as an annual of open ground, all point overwhelmingly to a recent arrival.

Decision: alien (neophyte).

An example of the distribution being consistent with its European range, with an early date of discovery, but alien status likely

SCROPHULARIA SCORODONIA

There is no record of cultivation, with the first record in the wild 1689 (Jersey, and 1712 in Cornwall, St Ives). It is a species of open

disturbed ground. Spatially fairly widespread and very dynamic, spreading fast; its persistence in any one site is not known. It has no recorded use, and Watson treated it as native, but it was not covered in Dunn. Recent floras have all treated it as native.

The distribution in Britain is a quite consistent extension of its Atlantic range (W France, Spain, Portugal, Madeira, Azores, and N.W. Morocco)

In 1950 (Clapham *et al.* 1952) it was confined to Cornwall, Devon and Jersey, and naturalised in Glamorgan. By the *New Atlas* (Preston *et al.* 2002) it had colonised the S Wales coast to Pembrokeshire, with an outlier in Cardigan, reached Dorset (3 sites) with further outliers further east. It is difficult to escape the conclusion that if one looked at its distribution now, in 2006, knowing nothing of the past, it would look like that of a native, spreading from west to east in a coherent pattern, and recent warm years may be playing a part in this spread.

Yet we know it has spread from a few sites, all ports. Davey (1909) gives many sites for Cornwall, though one has the feeling many of these are ruderal; certainly when I moved to Cornwall I was struck by the impression of a fast-colonising weed. The Cornish origin is clearly from a number of loci and even today is concentrated around four ports (see the map in French *et al.* 1999). In Devon it had, before being obscured by later records, an extraordinary clumped distribution around Kingsbridge (Ivemey-Cook 1984).

It is now spreading fast (as an alien might), and appears to have no semi-natural niche, that is, though it is a perennial, it does not occur in perennial closed communities.

Decision: alien (neophyte).

A species in every recent RDB (and protected under the Wildlife and Countryside Act), which is in fact a recent arrival

GNAPHALIUM LUTEOALBUM

In cultivation 1633, first record in wild 1690 (Jersey, but first British 1802, Cambs and first coastal in Norfolk 1882). It is a species of open disturbed ground. Spatially very rare and scattered, previously declining, but now spreading (Clement 2004); it shows little persistence unless it has continual disturbance. Watson treats it as a casual, but Dunn as a native, with caveats. All recent floras treat it as native.

It is found throughout Europe (Hultén & Fries 1986), though the few more detailed maps that I have seen show a very scattered and local distribution (e.g. Haeupler & Schonfelder 1988). In Holland it is colonising new sand-flats on the coast (Mennema *et al.* 1980). It is a widely naturalised in the world, especially in warmer climes (Clement 2004), and its true range is difficult to decide. Britten (1899) sets out the early English records, giving the first as from Cambs, reported by the finder as “indubitably wild [that is, by the conventions of the time, native], in the road, far from any house”!! He covers the now vanished Breckland sites, but does not mention the Norfolk coastal populations, which also were reported as “native, remote from houses, uninfluenced by agricultural operations and out of the track of the ordinary tourist” (Saunders 1899).

There seems little doubt that it is spread by winds and by birds (Clement 2004), and that the seed is persistent, for the current Norfolk sites are in the historic locality, but grow in pits dug in the 1970s and 1980s for natterjacks. There are even more recent records since the *New Atlas*. The fact that this “serious pest” (Clement 2004) might be arriving by means other than by man clouds the issue of native or alien status, though there is no doubt it is a recent and repeated arrival, and is categorically unworthy of special protection.

Decision: alien (neophyte), with some reservations over the mode of arrival.

A cornfield weed, potentially an archaeophyte, but with no evidence yet to support a long sojourn here

MELAMPYRUM ARVENSE

Never in cultivation, first record in wild 1716 (Norfolk, Norwich) It is a weed of arable habitats. Its distribution is rare and scattered, and it is declining dramatically, though this now masked by conservation actions. It is persistent only where it has spread out of its arable habitat into adjoining bare ground. Watson treats it as a casual or a colonist and Dunn as an alien. Recent floras treat it as native, with some reservations in Stace and Clement & Foster.

It is absent from much of western Europe, being frequent in central and southern Germany (Haeupler & Schonfelder 1988), and widespread east and south of Paris, with outliers in the lower Seine (Institut Floristique

Franco-Belge 1978–2001), but rare further west (des Abbayes 1971). Therefore England stands away from the main range.

For such a showy plant its first date in the wild is late, especially as it was locally reviled for tainting the wheat. Yet elsewhere in England, in Dorset, it was found as a constituent of smoke-blackened thatch dated to the mid-eighteenth century, suggesting a wider distribution. It is treated as an archaeophyte in the Czech Republic, Poland and Finland, and possibly so in Germany.

So there is no question, it seems, as to its status, merely whether it is an archaeophyte or a neophyte, and in the absence of any archaeological evidence and mention in the literature, it seems safer to leave as a neophyte for now.

Decision: alien (neophyte, though possible archaeophyte).

A late discovery of weedy habitats that has been espoused as a native, possibly to justify retrospectively conservation action

FUMARIA REUTERI

Never cultivated, first record in wild 1904 (Cornwall, Penryn). It is a species of open disturbed ground. No coherent range, declining, with persistence only in allotments, where it is aided by conservation action. Not covered by Watson or Dunn, but treated by all recent floras as native.

This species is almost confined to Spain and Portugal, with only one or two records for France, and an historical total of 14 widely scattered sites in England. There is a taxonomic problem here, in that some authorities attribute the English records to the almost endemic subsp. *martinii*, although Lidén (1986), in *Flora Iberica*, treats them as synonyms. It seems to be extinct in Cornwall, and as far as is known it is now found only in the Isle of Wight, but at both of these sites it occurs only in allotments.

Although it is part of a critical and inconspicuous genus, because of this totally artificial habitat and its lack of contiguous distribution, a late arrival is strongly suggested. This may be contrasted with *F. muralis* subsp. *boraiei*, one of the group of species that includes *F. bastardii*, *F. capreolata*, *F. occidentalis* and *F. purpurea*. That species also has a late first date in the wild (1860, presumably reflecting the critical nature of the genus), but, like its congeners, has a niche not

only in arable fields, but also in scrub-edge, hedges and vegetated cliffs. In addition it has a coherent distribution from Spain and Portugal, up the west coast of France to Britain and Ireland. This contrasts with the strongly arable habitat of *F. officinalis* and others that we treated as archaeophytes.

Decision: alien (neophyte).

An extinct species, of uncertain status, with a possible very early first record

EUPHORBIA VILLOSA

The only record of cultivation found is 1758, and the first certain record is 1834 (see below), though both Clarke (1900) and Druce (1932) cite a record from 1576 "in sylva D. Ioannis Coates prope Batthonium". It is a species of woods in Europe, but Bath is the only place in Britain that it was ever recorded from. Watson treated it as an alien or denizen, Dunn did not cover it, and all recent floras treated it as alien.

The European range is easterly and southerly, reaching N.W. France (Clapham *et al.* 1987), and indeed des Abbayes (1971) gives a few records from the far south of Brittany. Meusel (1965–1992) shows the records reaching the Loire in France, and these French records as isolated from the main centre, with no records in Germany or the Low Countries. The British record therefore is far divorced from any others.

I have no idea at all if the species described by Lobel in 1578 was this, though others have so claimed it. Murray (1896) cites a Mr Foster who records that the plant recorded by Lobel was gathered by Thomas Johnson in July 1634. It does not seem to have been recorded or cited by any other author in the next two centuries. However the (re)discovery by Babington, described by him in Smith & Sowerby (1790–1814) is worth citing. He describes it as "in great plenty and luxuriance in a little frequented lane to the west of Prior Park, and also in a coppice wood, far from any house, to the east. I have not the slightest doubt of it being indigenous in both of the above as there is not the least appearance of it having escaped from any garden". It was recorded, gradually diminishing, by many others, until the last record in 1941 (Roe 1981).

The answer must be academic, other than to those who tabulate the extinctions of native plants, but the evidence for native status seems extraordinarily sketchy.

Decision: alien (neophyte).

A species treated as native, though we had reservations which now look more sustainable

SYMPHYTUM TUBEROSUM

In cultivation in 1596, with the first record in wild 1777 (Edinburgh, Water of Leith). It is not included in the NVC but it seems to be a part of woodland vegetation. It is widely distributed, dynamic, increasing fast, and persistent. It is occasionally grown in gardens. Watson treats it as a native, but with caveats re England and part of Scotland; it is not covered in Dunn. Recent floras all treat it as native.

The European picture is very interesting. Meusel (1965–1992) shows its range from northern Spain, across southern France to the Black Sea. The German Atlas (Haeupler & Schonfelder 1988) shows it as present only in the farthest south. It is absent from the Low Countries, and present in France only in the centre and south – elsewhere it occurs as an adventive (e.g. des Abbayes 1971).

Perring & Walters (1962) treated this probably native only in Scotland, and we have followed this, although the recent Atlas (Preston *et al.* 2002) contains so many more records, including many more in Scotland too, though some of these may be due to past under-recording. None of the Scottish floras cover this species in any depth, and I have traced only a reference in Watson (1847–1859) citing Gordon (1839) who doubted its native status. Interestingly a later Flora of Moray (Burgess 1935) also calls it alien there. For Cumbria, Halliday (1997) mapped it as native, but mentioned doubts over native status. For Northumberland Swan (1993) also mapped it as native, with a first date of 1820, but his predecessor (Baker & Tate 1867) did not show any records, nor does Swan list any other records between 1820 and 1893.

In view of this and its rapid and recent spread in England and Wales, the hallmark of an alien species, together with its continued spread in Scotland, it seems very likely to have been an introduction in the mid-seventeenth century, a conclusion echoed in Braithwaite *et al.* (2006).

Decision: alien (neophyte).

A species treated as a native, but about which I now have strong reservations

LIMOSELLA AUSTRALIS

Never cultivated, with a first record in the wild 1897 (Glamorgan, Kenfig). It seems to have a particular niche in upper salt-marshes. Its

distribution is very limited as a presumed native, but it is stable and persistent. It was not covered in Watson or Dunn, and recent floras have all treated it as native.

This species is one of the small group of British species that is not found elsewhere in Europe, though it is widespread elsewhere, particularly in the southern Hemisphere and there is a possibility that its arrival is a recent natural dispersal, or that its presence was overlooked before. It has a very late discovery date, but is very inconspicuous, and appears, in Britain, to be in a finite ecological niche. However Jones (1999) has written persuasively of the possibility of its arrival as a contaminant of ballast, and this seems to me the most likely explanation of its origin, though it does grow with *Eleocharis parvula*, looking just as native, and that species has only been known in Wales since 1980.

Decision: native or alien.

A plant previously considered alien where recent work has indicated a niche in semi-natural vegetation

VALERIANELLA ERIOCARPA

In cultivation 1821, first record in wild 1845 (Worcs, but first in Dorset 1874). Not included in the NVC, but see Pearman & Edwards (2002). Rare, scattered and declining as a casual but stable and confined to chalk and limestone as a presumed native, where it is persistent in open semi-natural vegetation. Use, it is meant to have been one of the species used as "Italian" cornsalad. Watson treated it as a colonist and Dunn as an alien, together with all recent floras.

It has no real continuous distribution away from the Mediterranean, or indeed a home even there. On the other hand we suspect nobody has thought about it, and it has always been a critical species! Watson and Dunn, and indeed the twentieth century floras, would probably have thought of it as another weedy species of open habitats, and not known of its cliff-top sites.

The work by Pearman & Edwards (2002) seems to show that it is a coherent part of the early-flowering cliff-verge calcareous coastal community (as is *Gastroidium ventricosum*), occurring in communities CG4a, MC5d and MC11a (Rodwell 1991–2000), and work subsequent to that paper (Pearman & Edwards 2007) adds sites on the limestone in Devon and Caernarvon, in addition to those already described in Dorset and the Isle of Wight.

Decision: native or alien.

DISCUSSION

THE ROLE OF THE NATURE CONSERVATION MOVEMENT

The twentieth century growth of the nature conservation movement has brought developments that would have surprised our earlier botanists, notably the concentration of resources on species perceived to be native. Again this is dealt with in more depth in Preston *et al.* (2004), but the result has been that only species regarded as native or archaeophyte have been included in the current *Red Data List* (Cheffings & Farrell 2005), the recent *Red Data Book* (Wigginton 1999), or designated as nationally scarce (Stewart *et al.* 1994). The BAP list similarly is comprised exclusively of perceived natives, and though the country conservation organisations have now treated archaeophytes as "honorary natives" for conservation purposes, and similarly those species designated as "native or alien" in the new Atlas, this treatment has not been extended to those we designated, often for the first time in a century or more, as neophytes.

Of course resources themselves are scarce, but this, if I may describe it, obsession with native status, which extends in the opposite direction to blaming aliens for many of the ills facing our native flora, is surely misplaced and simplistic. I would like to extend the parameters of species worthy of protection to those species which are an integral part of the mosaic which is being valued and conserved – thus, amongst others, one might preserve *Fritillaria meleagris*, *Lonicera xylosteum*, *Salvia pratensis* and perhaps *Teucrium chamaedrys* as being part of a valued semi-natural habitat; *Althaea hirsuta*, *Anisantha madritensis*, *Galium parisiense*, *Holosteum umbellatum*, *Teucrium botrys* and possibly *Petrorhagia prolifera* as species very persistent in open, species-rich, therophyte communities; *Melampyrum arvense* and *Rhinanthus angustifolius* as part of the cornfield weed mosaic we now value (and possibly potential archaeophytes too). I appreciate this is more subjective than the natives "good", aliens "bad" approach, but I do feel that species that have that cultural resonance, act in harmony with other species that we value in their habitats and have a long association in those sites, could well be included in conservation efforts. This would be all the more possible since almost all conservation efforts are perforce concentrated on the management of the habitat rather than the individual species therein. Furthermore the list would not be long.

Conversely there must be some effort by the conservation movement to absorb new evidence, to review S.S.S.I.s notified for their botanical interest, and amend them if necessary. I see no need, for instance, for S.S.S.I.s for *Equisetum ramosissimum* or *Cerastium brachypetalum* on old railway sites, unless they fit the suggested guidelines above.

A PLEA FOR A MORE HOLISTIC APPROACH

There has, then, been relatively little discussion in the round on the possible status of plants in Britain in the century or more since Watson and Dunn; in fact, other than in Lousley (1953) and Webb (1985), I have been unable to find any substantial work in that period, and neither appears to have had any influence on later writers, though the latter is often cited! National floras since 1950 have tended to take a much more simple approach than Watson, for reasons I cannot pin down, though Preston *et al.* (2004) detect the influence of Godwin's work on the history of the British flora (Godwin 1956); this influence would of course extend to the treatment of archaeophytes rather to neophytes. A further interesting point might be that in Clapham *et al.* (1952 etc), there was, for the first time in well over a century, one acknowledged national flora, which was followed by all of their generation.

Local Floras have often continued to look at the position in their area, rather than stand back and look at the national or even European picture (Halliday (1997) is a notable exception). In these local floras and other papers the role of the optimist was able to flourish. In addition to White (1912) mentioned above, the illustrious names of Marshall (Hanbury & Marshall 1899), and the late Francis Rose head a list of consistent pleaders for native status for favoured species, along with a host of Flora writers. An extreme illustration of optimism comes from Cambridgeshire (Anon 1960), where the finding of a patch of *Aster salignus* [actually *A. novi-belgii*], previously under suspicion as a garden escape at Wicken Fen, at Fowlmere "many yards from the nearest house means that its status must be carefully reconsidered".

As in the concept of Archaeophytes it does not seem, in the main, that British writers have used the slowly-growing corpus of grid-based map floras from Europe and their supporting literature, and have not obviously been aware of both the developments in the world of archaeobotanical research and of interpretation

of the names used in medieval gardening (or even that of the 16th, 17th and early 18th centuries), and even of the existence of European works on alien floras that are becoming available.

What case studies there have been have tended to have been restricted to individual species, which may then have been examined not only in isolation to others, but all too often to a limited range of criteria. Inevitable though this might be, it does not seem a fruitful way forward, and that is why, for the *New Atlas*, and therefore as the basis of this paper, we chose to examine a large number of species and to try and apply the same criteria to all.

Of course I appreciate that for many species there can never be certainty, though for neophytes the imponderables must usually be less than for archaeophytes. However an awareness of the sources outlined in this paper must still have more to contribute – witness the case of *Fritillaria*, fairly clear already (to those who were prepared to look), that has become clearer through examination of Scandinavian work and our own county floras.

There must be more work to do in unravelling the history both of species treated here (and in the available spreadsheet) as neophytes and of others not yet fully considered. In alphabetical order I would like to investigate, for instance, *Allium scorodoprasum*, *Crepis foetida*, *Ericas* in Ireland, *Lepidium latifolium* (at least away from the east coast), *Scrophularia umbrosa*, *Sorbus domestica* and *Stachys germanica*. Other species covered in our initial list might well turn out to be archaeophytes if more historical evidence becomes available.

Webb (1985) has the magisterial status that I am sure I lack. I was reading British Wildlife last month, and came across a comment that *Sisyrinchium bermudiana* might well be native in the Wye valley, "remote from any houses" (Peterken & Tyler 2006). It reminded me of Webb's closing comments "The various arguments must be weighed against each another as fairly as possible, and the conclusion adopted which, even if rather improbable, seems less improbable than the alternatives. Who is best qualified to do this weighing?Detailed local knowledge is often invaluable, but all too often its value is eroded by local patriotism. There is a curious emotional bias, which I have found very widespread (and from which I may not entirely be free myself) which favours native status for

an attractive plant or for the botanist's home county. For this reason a cool assessment by an outsider may be more reliable." I hope this paper sets the scene of that re-appraisal; what is really needed is a series of case studies on all these contentious species, to enable the criteria for each to be aired and placed in context.

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REFERENCES

- ADAMS, K. J. (1999). *Tordylium maximum*, in M. J. WIGGINTON, comp. & ed. *British Red Data Books 1 Vascular plants*, 3rd edition, p. 373. Joint Nature Conservation Committee, Peterborough.
- AITON, W. (1789). *Hortus Kewensis*. London.
- AITON, W. (1810–1813). *Hortus Kewensis*, 2nd ed. Longman, Hurst, Rees, Orme & Brown, London.
- AKERROYD, J. R. & BECKETT, G. (1995). *Petrorhagia prolifera* (L.) P.W. Ball & Heywood (Caryophyllaceae), an overlooked native species in eastern England. *Watsonia* **20**: 405–407.
- ANON. (1960). Field meetings, 1959. *Nature in Cambridgeshire* **3**: 15–18.
- BABINGTON, C. C. (1860). *Flora of Cambridgeshire*. John van Voorst, London.
- BAKER, J. G. & TATE, G. R. (1868). *A new flora of Northumberland and Durham*. Williams & Norgate, London.
- BENKERT, D., FUKAREK, F. & KORSCH, H., eds (1996). *Verbreitungsatlas der Farn- und Blütenpflanzen Ostdeutschlands*. Gustav Fischer, Jena.
- BOLÒS, O. DE & VIGO, J. (1984–2001). *Flora dels Països Catalans*. 4 vols. Editorial Barcino, Barcelona.
- BRAITHWAITE, M. E., ELLIS, R. W. & PRESTON, C. D. (2006). *Change in the British flora, 1987–2004*. Botanical Society of the British Isles, London.
- BRITTEN, J. (1899). *Gnaphalium luteo-album* in East Anglia. *Journal of Botany* **37**: 520–521.
- BURGESS, J. J. (1935). *Flora of Moray*. Elgin.
- CHEFFINGS, C. M. & FARRELL, L. (2005). The Vascular Plant Red Data List for Great Britain. *Species Status* **7**: 1–116. Joint Nature Conservation Committee, Peterborough.
- CLAPHAM, A. R., TUTIN, T. G. & MOORE, D. M. (1987). *Flora of the British Isles*, 3rd edition. Cambridge University Press, Cambridge.
- CLAPHAM, A. R., TUTIN, T. G. & WARBURG, E. F. (1952). *Flora of the British Isles*. Cambridge University Press, Cambridge.
- CLAPHAM, A. R., TUTIN, T. G. & WARBURG, E. F. (1962). *Flora of the British Isles*, 2nd edition. Cambridge University Press, Cambridge.
- CLARKE, W. A. comp. (1900). *First records of British flowering plants*, 2nd edition. West, Newman & Co., London.
- CLEMENT, E. J. (2004). *Gnaphalium luteoalbum* needs no special protection. *BSBI News* **95**: 43–44.
- CLEMENT, E. J. & FOSTER, M. C. (1994). *Alien plants of the British Isles*. Botanical Society of the British Isles, London.
- DANDY, J. E. (1958). *List of British vascular plants*. British Museum (Natural History), London.
- DAVEY, F. H. (1909). *Flora of Cornwall*. F. Chegwiddden, Penryn.
- des ABBAYES, H., CLAUSTRES, G., CORILLION, R. & DUPONT, P. (1971). *Flora et Végétation du Massif Armoricain; 1 Flore Vasculaire*. Presses Universitaires de Bretagne, Saint Briec.
- DRUCE, G. C. (1908). *List of British plants*. Oxford University Press, Oxford.
- DRUCE, G. C. (1919). The extinct and dubious plants of Britain. *Botanical Exchange Club* **5**: 731–799.
- DRUCE, G. C. (1928). *British plant list*, 2nd edition. T. Buncle & Co., Abroath.
- DRUCE, G. C. (1932). *The comital flora of the British Isles*. T. Buncle & Co., Abroath.
- DUNN, S. T. (1905). *Alien flora of Britain*. West, Newman & Co., London.
- ELLIS, R. G. (1983). *Flowering plants of Wales*. National Museum of Wales, Cardiff.
- FITZGERALD, R. (1993). *Leucojum aestivum*, in B. GILLAM (ed.). *The Wiltshire Flora*. Pisces Publications, Newbury.
- FRENCH, C. N., MURPHY, R. J. & ATKINSON, M. G. C. (1999). *Flora of Cornwall*. Wheal Seton Press, Camborne.

- GERARD, J. (1597). *The herbal or generall historie of plantes*. J. Norton, London.
- GODWIN, H. (1956). *The history of the British flora*. Cambridge University Press, Cambridge.
- GORDON, G. (1839). *Collectanea for a flora of Moray*.
- HALLIDAY, G. (1997). *A Flora of Cumbria*. Centre for North-West Regional Studies, University of Lancaster, Lancaster.
- HANBURY, F. J. & MARSHALL, E. S. (1899). *Flora of Kent*. Frederick J. Hanbury, London.
- HARDY, F., ed. (2002). *Atlas préliminaire de la flore vasculaire du Finistère -1er Bilan (1990–2000)*. Conservatoire Botanique National de Brest, Brest.
- HARVEY, J. H. (1996). Fritillary and martagon – wild or garden? *Garden History* **24**: 30–38.
- HAUPLER, H. & SCHONFELDER, P., eds (1988). *Atlas der Farn- und Blütenpflanzen der Bundesrepublik Deutschland*. Eugen Ulmer, Stuttgart.
- HILL, M. O., PRESTON, C. D. & ROY, D. B. (2004). *Plantatt*. Centre for Ecology & Hydrology, Abbot's Ripton.
- HIND, W. M. (1889). *Flora of Suffolk*. Gurney & Jackson, London.
- HULTÉN, E. (1950). *Atlas of the distribution of vascular plants in N.W. Europe*. Generalstabens Litografiska Anstalts Förlag, Stockholm.
- HULTÉN, E. & FRIES, M. (1986). *Atlas of north European vascular plants north of the Tropic of Cancer*. 3 vols. Koeltz Scientific Books, Königstein.
- INSTITUT FLORISTIQUE FRANCO-BELGE (1978–2001). *Documents floristiques 1–6*. Centre Regional de Phytosociologie, Bailleul.
- IVIMEY-COOK, R. B. (1984). *Atlas of the Devon Flora*. Devonshire Association, Exeter.
- JALAS, J. & SUOMINEN, J., eds (1972–1994). *Atlas Florae Europaeae*. Volume 1 (1972), 2 (1973), 3 (1976), 4 (1979), 5 (1980), 6 (1983), 7 (1986), 8 (1989), 9 (1991), 10 (1994). Committee for Mapping the Flora of Europe and Societas Biologica Fennica Vanamo, Helsinki.
- JALAS, J., SUOMINEN, J. & LAMPINEN, R., eds (1996). *Atlas Florae Europaeae*. Volume 11. Committee for Mapping the Flora of Europe and Societas Biologica Fennica Vanamo, Helsinki.
- JALAS, J., SUOMINEN, J., LAMPINEN, R. & KURTTO, A., eds (1999). *Atlas Florae Europaeae*. Volume 12. Committee for Mapping the Flora of Europe and Societas Biologica Fennica Vanamo, Helsinki.
- JOHN, R. F. (1992). *Genetic variation, reproductive biology and conservation in isolated populations of rare plant species*. Ph.D. thesis, University of Wales, Swansea.
- JONES, A. (1999). *Limosella australis*, in M. J. WIGGINTON, comp. & ed. *British Red Data Books 1 Vascular plants*, 3rd edition, p. 224. Joint Nature Conservation Committee, Peterborough.
- KAY, Q. O. N. & JOHN, R. (1995). *The conservation of scarce and declining plant species in lowland Wales: population genetics, demographic ecology and recommendations for future conservation in 32 species of lowland grassland and related habitats*. Countryside Council for Wales. (Science Report No.110), Bangor.
- KENT, D. H. (1992). *List of vascular plants of the British Isles*. Botanical Society of the British Isles, London.
- KOWARIK, I. (1995). Time lags in biological invasions with regard to the success and failure of alien species., in P. PYŠEK, K. PRACH, M. REJMANEK & M. WADE eds., *Plant invasions – general aspects and special problems*, pp. 15–38. SPB Academic Publishing, Amsterdam.
- KURTTO, A., LAMPINEN, R. & JUNIKKA, L., eds. (2004). *Atlas Florae Europaeae*, 13. Committee for Mapping the Flora of Europe & Societas Biologica Fennica Vanamo, Helsinki.
- LAMBINON, J., DELVOSALLE, L., & DUVIGNEAUD, J. (2004). *Nouvelle Flore de la Belgique, du Grand-Duché de Luxembourg, du Nord de la France et des régions Voisines*. 5th ed. Jardin Botanique national de Belgique, Meise.
- LE SUEUR, F. (1984). *Flora of Jersey*. Société Jersiaise, Jersey.
- LIDÉN, M. (1986). *Fumaria* in Castroviejo et al. *Flora Iberica* Vol 1. Real Jardín Botánico, C.S.I.C., Madrid.
- LOUDON, MRS, ed. (1855). *Loudon's encyclopaedia of plants*, edn 2. Longman, Brown, Green & Longman, London.
- LOUSLEY, J. E. (1953). The recent influx of aliens into the British flora, in J. E. LOUSLEY, ed., *The changing flora of Britain*, pp. 140–159. Botanical Society of the British Isles, Oxford.
- LOUSLEY, J. E. (1971). *Flora of the Isles of Scilly*. David & Charles, Newton Abbot.
- LOVATT, C. M. (1982). *The history, ecology and status of the rare plants and the vegetation of the Avon Gorge, Bristol*. Ph.D. thesis, University of Bristol.
- MCCLEINTOCK, D. (1975). *The wildflowers of Guernsey*. Collins, London.
- MEIJDEN, R. VAN DER, PLATE, C. L. & WEEDA, E. J. eds. (1989). *Atlas van de Nederlandse Flora. 3 Minder zeldzame en algemene soorten*. Onderzoeksinstituut Rijksherbarium/Hortus Botanicus, Leiden.
- MENNEMA, J., QUENÉ-BOTERENBROOD, A. J. & PLATE, C. L., eds. (1980). *Atlas of the Netherlands Flora. 1 Extinct and very rare species*. Dr. W. Junk, The Hague.
- MENNEMA, J., QUENÉ-BOTERENBROOD, A. J. & PLATE, C. L., eds. (1985). *Atlas van de Nederlandse Flora. 2 Zeldzame en vrij zeldzame planten*. Bohn, Scheltema & Holkema, Utrecht.

- MEUSEL, H. & JAGER, E. J. (1992). *Vergleichende Chorologie der zentraleuropäischen Flora. Volume 3*, 2 vols. Gustav Fischer, Jena.
- MEUSEL, H., JAGER, E., RAUSCHERT, S. & WEINERT, E. (1978). *Vergleichende Chorologie der zentraleuropäischen Flora. Volume 2*, 2 vols. Gustav Fischer, Jena.
- MEUSEL, H., JAGER, E., & WEINERT, E. (1965). *Vergleichende Chorologie der zentraleuropäischen Flora. Volume 1*, 2 vols. Gustav Fischer, Jena.
- MIREK, Z., PIEKOŚ-MIRKOWA, H., ZAJĄC, A. & ZAJĄC, M. (1995). *Vascular plants of Poland: a checklist*. W. Szafer Institute of Botany, Polish Academy of Sciences, Kraków.
- MORTON, J. K. (1973). A cytological study of the British Labiatae (excluding *Mentha*). *Watsonia* **9**: 239–246.
- MURRAY, R. P. (1896). *The Flora of Somerset*. Barnicott & Pearce, Taunton.
- OSWALD, P. (H). (1992). The Trifoliary in Britain – a historical perspective. *British Wildlife* **3**: 200–210.
- PEARMAN, D. A. & EDWARDS, B. (2002). *Valerianella eriocarpa* Desv. in Dorset, and a reassessment of its status as a presumed introduction in Britain. *Watsonia* **24**: 81–89.
- PEARMAN, D. A. & EDWARDS, B. (2007). *Valerianella eriocarpa* Desv. as a presumed native in Britain – an update. *Watsonia* **26**: 387.
- PERRING, F. H., SELL, P. D., WALTERS, S. M. & WHITEHOUSE, H. L. K. (1964). *A flora of Cambridgeshire*. Cambridgeshire University Press, Cambridge.
- PERRING, F. H. & WALTERS, S. M., eds. (1962). *Atlas of the British flora*. Thomas Nelson & Sons, London.
- PETCH, C. P. & SWANN, E. L. (1968). *Flora of Norfolk*. Jarrold & Sons, Norwich.
- PETERKEN, G. & TYLER, S. J. (2006). Flowers in the fields: community conservation in the Lower Wye Valley. *British Wildlife* **17**: 313–321.
- PRESTON, C. D. (2002). Approaches to native and alien species. *Transactions of the Suffolk Naturalists' Society* **38**: 37–48.
- PRESTON, C. D., PEARMAN, D. A. & DINES, T. D., eds (2002). *New Atlas of the British and Irish flora*. Oxford University Press, Oxford.
- PRESTON, C. D., PEARMAN, D. A. & HALL, A. R. (2004). Archaeophytes in Britain. *Bot. J. Linn Soc.* **145**: 257–294.
- PYŠEK, P., SÁDLO, S. & MANDÁK, B. (2002). Catalogue of alien plants of the Czech Republic. *Preslia* **74**: 97–186.
- REYNOLDS, S. C. P. (2002). *A catalogue of alien plants in Ireland*. National Botanic Gardens, Glasnevin.
- RICH, T. C. G. & KARRAN, A. B. (2003). Geographical and temporal distributions of *Alyssum alyssoides* and *Berteroa incana* (Brassicaceae) in the British Isles and the relationship to their modes of introduction. *Watsonia* **24**: 499–506.
- ROACH, F. A. (1985). *Cultivated fruits of Britain: their origin and history*. Basil Blackwell, Oxford.
- RODWELL, J. S., ed. (1991–2000). *British plant communities*, vols 1–5. Cambridge University Press, Cambridge.
- ROE, R. G. B. (1981). *The flora of Somerset*. Somerset Archaeological and Natural History Society, Taunton.
- RYVES, T. B., CLEMENT, E. J. & FOSTER, M. C. (1996). *Alien grasses of the British Isles*. Botanical Society of the British Isles, London.
- SAUNDERS, J. (1899). Notes on North Norfolk Plants. *Journal of Botany* **37**: 519–520.
- SMITH, J. E. (1800–1804). *Flora Britannica*. 3 vols. London.
- SMITH, J. E. (1828). *The English flora*, 4 vols. Longman, Rees, Orme, Brown, & Green, London.
- SMITH, J. E. & SOWERBY, J. (1790–1814). *English Botany*. London.
- STACE, C. A. (1991). *New flora of the British Isles*. Cambridge University Press, Cambridge.
- STACE, C. A. (1997). *New flora of the British Isles*, 2nd edition. Cambridge University Press, Cambridge.
- STACE, C. A., ELLIS, R. G., KENT, D. H. & MCCOSH, D. J., eds. (2003). *Vice County Census Catalogue of the Vascular Plants of Great Britain*. Botanical Society of the British Isles, London.
- STEWART, A., PEARMAN, D. A. & PRESTON, C. D., comps & eds. (1994). *Scarce plants in Britain*. Joint Nature Conservation Committee, Peterborough.
- SWAN, G. A. (1993). *Flora of Northumberland*. Natural History Society of Northumbria, Newcastle upon Tyne.
- TOMLINSON, P. & HALL, A. (1996). A review of the archaeological evidence for food plants from the British Isles: an example of the use of the Archaeobotanical Computer Database (ABCD). *Internet Archaeology* **1** (http://intarch.ac.uk/journal/issue1/tomlinson_index.html).
- TURNER, W. (1548). *The names of herbes*. London.
- TUTIN, T. G., BURGESS, N. A., CHATER, A. O., EDMONDSON, J. R., HEYWOOD, V. H., MOORE, D. M., VALENTINE, D. H., WALTERS, S. M. & WEBB, D. A., eds. (1993). *Flora Europaea*, 1, 2nd edition. Cambridge University Press, Cambridge.
- TUTIN, T. G., HEYWOOD, V. H., BURGESS, N. A., MOORE, D. M., VALENTINE, D. H., WALTERS, S. M. & WEBB, D. A., eds. (1968–1980). *Flora Europaea*, 2–5. Cambridge University Press, Cambridge.
- WATSON, H. C. (1832). *Outlines of the geographical distribution of British plants*. privately published, Edinburgh.

- WATSON, H. C. (1847–1859). *Cybele Britannica*. 4 vols. Longman & Co., London.
- WATSON, H. C. (1870). *A compendium to the Cybele Britannica*. Longmans, Green, Reader & Dyer, London.
- WEBB, D. A. (1965). Some difficulties in the establishment of phytogeographical divisions. *Revue Roumaine de Biologie, Série de Botanique* **10**: 33–41.
- WEBB, D. A. (1985). What are the criteria for presuming native status? *Watsonia* **15**: 231–236.
- WHITE, J. W. (1912). *The flora of Bristol*. John Wright & Sons, Bristol.
- WIGGINTON, M. J., comp. & ed. (1999). *British Red Data Books 1 Vascular plants*, 3rd edition. Joint Nature Conservation Committee, Peterborough.
- ZHANG, L. (1983). *Vegetation ecology and Population biology of Fritillaria meleagris L. at the Kungsängen Nature Reserve, Eastern Sweden*. Acta Phytogeographica Suecica 73. Uppsala.

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The last thirty five years: recent changes in the flora of the British Isles

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ABSTRACT

In 1970 Max Walters predicted a number of changes that have taken place in the British and Irish flora over the last 35 years. Although few species became nationally extinct during this period, losses at the local scale were dramatic, particularly in S.E. England where land use pressures were greatest. Despite these losses the British flora has become increasingly diverse due to the introduction, naturalisation and spread of alien species. Research into their habitats, modes of dispersal, and competitive inter-actions with native species has provided valuable ecological insights. Hybridisation events have produced some of the best studied examples of hybrid speciation. In the future, such naturalisation events may also provide important evidence for major environmental perturbations such as climate change.

KEYWORDS: aliens, diversity, extinction, hybridisation, naturalisation, neophytes, urban habitats.

INTRODUCTION

In 1970 Max Walters concluded *The flora of a changing Britain* conference by predicting a number of changes that were likely to take place in the British flora over the subsequent twenty-five years (Walters 1970). Although brief, his paper dealt with floristic richness, aliens, extinctions, plant conservation and land abandonment. The aim of this paper is to review three of these predictions in view of the major changes which have taken place: (1) floristic richness has increased as a result of man's activities; (2) the number of national and regional extinctions has continued to increase; and (3) much has been learnt from the naturalisation of alien species. In addressing these three predictions I have intentionally drawn heavily (but not exclusively) on research published within this journal, especially the review by Brenan (1982) which deals with many of the same topics. Wherever possible, I have also referred to changes in Max's home

county of Cambridgeshire (v.c. 29). I do not deal with changes in plant conservation, land use, or the ten activities he proposed for the society as these now form the basis of much of the society's current work (e.g. monitoring common species, research on rare species, publication of handbooks).

1. FLORISTIC RICHNESS WILL CONTINUE TO INCREASE AS A RESULT OF MAN'S ACTIVITIES

As Max predicted species invasions have exceeded extinctions by an order of magnitude leading to a dramatic net increase in the number of plant species recorded in the British Isles (Fig. 1). Despite localised losses only 21 native species have gone extinct nationally since records began in the sixteenth century (Stace 2002). Nine of these species have been lost in the last 35 years, although some are either dubiously native (e.g. *Galeopsis segetum*) or are likely to have been over-looked (e.g. *Epipogium aphyllum*) (Table 1). During the same period an equal number of species have been discovered or newly described of which only two are of questionable origin (*Cystopteris diaphana*, *Serapias parviflora*) and one (*Epipactis youngiana*) may be a recently evolved ecotype (Hollingsworth *et al.* 2006). In comparison to these rather modest changes to the native flora, there has been a dramatic increase in the number of naturalised aliens and casuals (Fig. 1): by the middle of the 1950s the number of recorded casuals exceeded the number of natives whereas there were around 600 naturalised aliens (30% of the native flora). By 2000 the number of casuals and naturalised aliens had increased to make up 45% and 18% of the entire British flora respectively.

Historically alien plants have arrived unintentionally as escapes from botanic gardens or as contaminants in the ballast of ships, grain, animal fodder and waste products of

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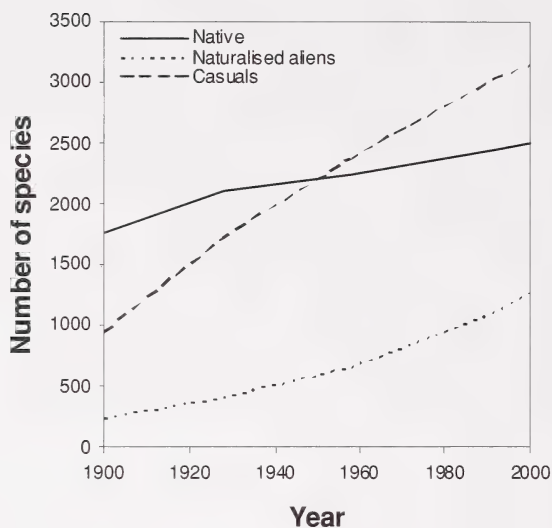


FIGURE 1. The number of native taxa, naturalised aliens and casuals in the flora of Great Britain according to various sources (Druce 1908; Druce 1928; Dandy 1958; Kent 1992; Kent & Stace 2000). 'Native' includes agamospecies such as *Hieracium*, *Rubus* and *Taraxacum*. Adapted from Stace (2002).

TABLE 1. NATIVE SPECIES DISCOVERED OR KNOWN TO HAVE BECOME EXTINCT IN BRITAIN (INCLUDING ISLE OF MAN) SINCE 1970. UPDATED FROM STACE (2002). SPECIES IN THE CRITICAL GENERA *ALCHEMILLA*, *EUPHRASIA*, *HIERACIUM*, *LIMONIUM*, *RUBUS*, *SORBUS* AND *TARAXACUM* ARE OMITTED

Species	First/last record	V.C.	Comment
(a) Discovered			
<i>Epipactis youngiana</i>	1976	67	Probably only an ecotype of <i>E. helleborine</i>
<i>Senecio eboracensis</i>	1979	63	Derived from spontaneous hybrid
<i>Crepis praemorsa</i>	1988	69	
<i>Utricularia stygia</i>	1988	97	
<i>Serapias parviflora</i>	1989	2	Native status uncertain
<i>Callitriche palustris</i>	2000	99	
<i>Cystopteris diaphana</i>	2000	2	Native status uncertain
<i>Carex salina</i>	2004	105	
(b) Extinct			
<i>Arnoseris minima</i>	1971	24	Probable archaeophyte. Re-introduced
<i>Bromus interruptus</i>	1972	29	Probable neophyte. Re-introduced
<i>Schoenoplectus pungens</i>	1972	59	Only native on Jersey. Re-introduced
<i>Galeopsis segetum</i>	1975	49	Probable archaeophyte
<i>Saxifraga rosacea</i> subsp. <i>rosacea</i>	1978	49	Still occurs in Ireland
<i>Crepis foetida</i>	1980	15	Probable archaeophyte. Re-introduced
<i>Epipogium aphyllum</i>	1986	22	Unconfirmed records since 1990
<i>Neotinea maculata</i>	1986	71	Occurs in Ireland. Formerly Isle of Man
<i>Senecio eboracensis</i>	2000	61	Possibly extinct?

Luzula pallidula is included as extinct by Stace (2002) but there are a number of confirmed records from Holme Fen in Huntingdonshire (v.c. 31).

TABLE 2. CHANGE IN THE NUMBER OF TAXA RECORDED IN BERKSHIRE (V.C. 22). ADAPTED FROM CRAWLEY (2005)

	Druce (1897)	Bowen (1968)	Crawley (2005)	% change	
				1897–1968	1968–2005
Native & archaeophyte	820	883	955	+8	+8
Neophyte	300	629	710	+110	+13
Apomictic	63	84	184	+33	+119
Subspecies & varieties	400	38	41	-91	+8
Hybrids	70	99	181	+41	+83

clothing manufacture (skins, wool, tan-bark) (Lousley 1953). Although introductions via these agencies declined during the second half of the twentieth century (Shimwell 2006), the numbers originating from horticulture, either as escapes or outcasts from gardens, have increased dramatically. For example, the *New Atlas* showed that eight of the 10 most rapidly spreading species since the 1960s are neophytes which were originally introduced as garden plants (*Buddleja davidii*, *Cotoneaster simonsii*, *Laburnum anagyroides*, *Linaria purpurea*, *Lysimachia punctata*, *Prunus cerasus*, *P. laurocerasus*, *Syringa vulgaris*) (Preston *et al.* 2002).

Changes at the vice-county level show a similar pattern. Berkshire (v.c. 22) has one of the best studied floras in the country, particularly with regard to alien species, and this

has allowed an assessment of changes in floristic richness over the past 100 years (Table 2; Crawley 2005). Whereas the number of native and archaeophyte additions has been rather modest there has been a dramatic increase in the number of recorded neophytes (Bowen 1968). Similarly, critical and hybrid taxa have been much better studied since 1968 whereas the vast majority of infraspecific taxa formerly recognised by Druce (1897) are not included in the modern floras of Bowen and Crawley.

Based on his experiences in Cambridgeshire Max Walters predicted that urban areas would accrue more alien species than rural areas and therefore, that urbanised 10-km squares would be the richest. However, unlike continental Europe, British urbanised tetrads are not significantly richer overall than their rural

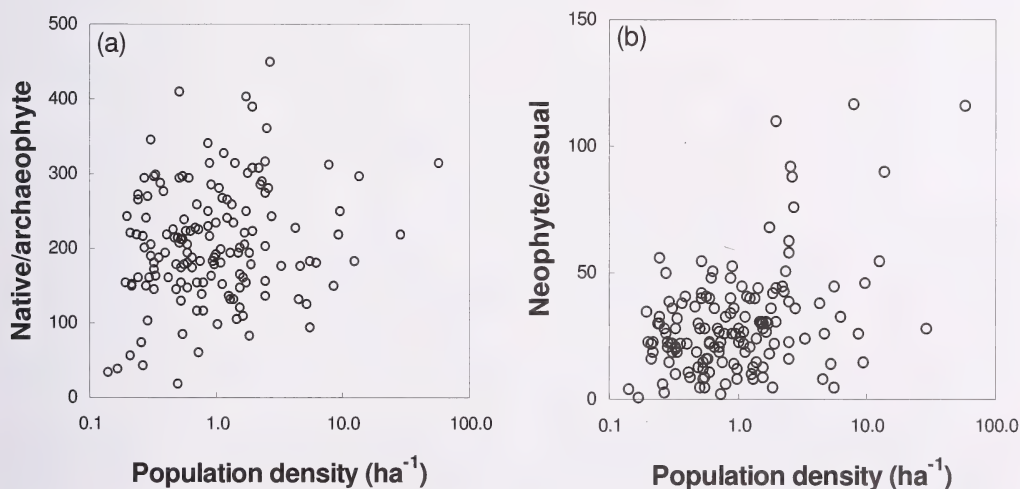


FIGURE 2. The relationship between human population density (displayed on a log scale) and (a) the number of natives and archaeophytes and (b) neophytes and casuals recorded in Cambridgeshire parishes (v.c. 29) between 1987–2000 ($n=151$). Human population densities were calculated from Population Census Returns for 2001.

counterparts, although they do support a greater number (and proportion) of introduced alien species (Roy *et al.* 1999). The results for agriculturally ravaged Cambridgeshire were as predicted by Max with more densely populated (and therefore urbanised) parishes tending to be marginally more species-rich ($R^2=4.2\%$, $F=6.5$, $p<0.05$) whereas differences in the number of natives and archaeophytes were not significant due to large variation in numbers of species between parishes ($R^2=1.9\%$, $F=2.9$, $p=0.09$; Fig. 2a). In contrast, urbanised parishes have significantly more neophytes and casuals with several of the ten richest parishes being almost entirely urban ($R^2=16.9\%$, $F=30.3$, $p<0.001$; Fig. 2b). The slight discrepancy between Cambridgeshire and the national picture (i.e. more species in urban areas) may be due to local factors. Some urban parishes in the county have been extraordinarily well recorded by resident botanists (e.g. Cambridge, Chesterton, Ely, Whittlesey) whereas the majority of rural parishes are relatively species-poor due to the intensity of arable farming in the county.

2. NATIONAL AND REGIONAL EXTINCTIONS WILL CONTINUE AT AN ALARMING RATE

As discussed above relatively few species have gone extinct at the national level and, with the possible exceptions of *Bromus interruptus*, which may be a recently evolved neo-endemic (Rich & Lockton 2002), and *Senecio eboracensis*, none have become globally extinct. Of the nine species that have disappeared since 1970 (Table 1) five were probably originally introduced (*Arnoseris minima*, *Bromus interruptus*, *Crepis foetida*, *Galeopsis segetum*, *Schoenoplectus pungens*; but see Rich & Lockton (2002) and Rich & Pryor (2003) for alternative views), *Saxifraga rosacea* and *Neotinea maculata* still occur in Ireland and there are unconfirmed records for *Epipogium aphyllum* in the last decade. In contrast, *Senecio eboracensis* is probably the shortest-lived addition to the British flora, having possibly gone extinct within 17 years of its discovery in 1979 (Abbott *et al.* 2005).

In contrast to these rather modest changes at the national level, there has been a dramatic loss of species at the regional and county level since the nineteenth century. Twenty-three native species have gone extinct in the most intensively populated region of lowland England which includes all vice-counties to the

east of a line running from Poole in Dorset to Goole in S.W. Yorkshire ('the Poole to Goole line'; Table 3). The vast majority are Northern (Boreal) species at the southern edge of their range in lowland England that disappeared following the widespread loss of lowland heaths and bogs (e.g. *Diphasiastrum* spp., *Huperzia selago*, *Gymnocarpium dryopteris*, *Listera cordata*, *Pseudorchis albida*, *Pyrola media*, *Scheuchzeria palustris*, *Selaginella selaginoides*, *Trientalis europaeus*, *Vaccinium vitis-idaea*). Others have been lost due to drainage of fenland (*Tephrosieris palustris*), hybridisation (*Schoenoplectus triquetus*), ploughing of calcareous grassland (*Cirsium tuberosum*) and changes to aquatic habitats (*Elatine hydropiper*, *Luronium natans*) or simply because their extreme rarity in S.E. England has made them highly susceptible to other factors (*Asplenium obovatum*, *A. viride*, *Genista pilosa*, *Mertensia maritima*, *Orobancha alba*, *Vicia orobus*). Species which still occur in S.E. England but have suffered dramatic declines are also listed in Table 3. These show a similar pattern to extinctions with the majority of species associated with rivers and wetlands (*Damasonium alisma*, *Leersia oryzoides*, *Potamogeton praelongus*, *Teucrium scordium*), infertile grasslands and heaths (*Antennaria dioica*, *Gentianella campestris*, *Orchis militaris*, *Potentilla neumanniana*) and lowland bogs and mires (*Carex limosa*, *Liparis loeselii*, *Viola persicifolia*, *Utricularia intermedia*).

The loss of species at the county level has been much greater than at the national or regional scale (Walker 2003). Fig. 3 shows the average decadal rate of extinction (actually the number of last records) using the most recent information for eighteen vice-counties in England (data available from the author on request). This shows a gradual increase in the number of extinctions from less than one species per decade at the start of the nineteenth century to 3 species per decade by 1850 and 4 species per decade by 1900. Numbers were more variable during the first half of the twentieth century, but were probably around 5 species per decade up to 1950 increasing to 6 species per decade in the 1960s and 1970s. The apparent decline in the 1980s is undoubtedly an underestimate as more time is usually needed to declare a species as extinct. Although the figures for the nineteenth century are less reliable due to lower recording intensities, they

TABLE 3. EXTINCT AND DECLINING SPECIES IN SOUTH EAST ENGLAND¹

(a) Extinct in S.E. England	Loss	(b) Marked decline in S.E. England ²	Extant	Loss
<i>Tephrosia palustris</i>	26	<i>Gastroidium ventricosum</i>	5	71
<i>Huperzia selago</i>	24	<i>Potamogeton praelongus</i>	5	55
<i>Gymnocarpium dryopteris</i>	13	<i>Damasonium alisma</i>	3	46
<i>Genista pilosa</i>	7	<i>Gentianella campestris</i>	5	46
<i>Pseudorchis albida</i>	7	<i>Antennaria dioica</i>	1	34
<i>Schoenoplectus triquetus</i>	6	<i>Lactuca saligna</i>	3	33
<i>Elatine hydropiper</i>	5	<i>Cynoglossum germanicum</i>	3	30
<i>Listera cordata</i>	4	<i>Teucrium scordium</i>	1	20
<i>Epipogium aphyllum</i>	3	<i>Atriplex pedunculata</i>	1	17
<i>Selaginella selaginoides</i>	3	<i>Utricularia intermedia</i> s.l.	1	17
<i>Asplenium viride</i>	2	<i>Liparis loeselii</i>	2	16
<i>Luronium natans</i>	2	<i>Orchis militaris</i>	3	16
<i>Orobancha alba</i>	2	<i>Alchemilla glabra</i>	4	14
<i>Scheuchzeria palustris</i>	2	<i>Leersia oryzoides</i>	3	14
<i>Asplenium obovatum</i>	1	<i>Viola persicifolia</i>	3	14
<i>Cirsium tuberosum</i>	1	<i>Campanula patula</i>	3	13
<i>Diphysastrum alpinum</i>	1	<i>Vicia bithynica</i>	5	13
<i>Diphysastrum complanatum</i>	1	<i>Carex limosa</i>	3	12
<i>Mertensia maritima</i>	1	<i>Erodium maritimum</i>	3	10
<i>Pyrola media</i>	1	<i>Potentilla neumanniana</i>	5	10
<i>Trientalis europaea</i>	1	<i>Lotus angustissimus</i>	5	9
<i>Vaccinium vitis-idaea</i>	1	<i>Salicornia nitens</i>	3	9
<i>Vicia orobus</i>	1	<i>Hypochaeris maculata</i>	5	8

¹ Includes vice-counties 10–32 & 53–56. ² Species recorded in ≤ 5 10-km squares between 1987 and 2000 (Preston *et al.* 2002). ‘Loss’ is the number of 10-km squares in which a species was recorded prior to 1987. A further 65 species occur in ≤ 5 10-km squares in S.E. England but have been excluded because they are either (a) very rare ($n=21$), (b) rare but showing only localised declines ($n=23$) or (c) northern/western species at the extreme edge of their range in S.E. England ($n=21$):

(a) *Apium repens*, *Artemisia campestris*, *Calamagrostis stricta*, *Cephalanthera rubra*, *Cyperus fuscus*, *Eriophorum gracile*, *Gnaphalium luteoalbum*, *Goodyera repens*, *Ludwigia palustris*, *Orchis simia*, *Orobancha artemisiae-campestris*, *Petrorhagia nanteuilii*, *Phyteuma spicatum*, *Polygala amarella*, *Potamogeton nodosus*, *Salicornia obscura*, *Scleranthus perennis*, *Scilla autumnalis*, *Senecio paludosus*, *Stachys germanica*, *Thymus serpyllum*, *Veronica spicata*, *Veronica verna*.

(b) *Alisma gramineum*, *Atriplex longipes*, *Bupleurum baldense*, *Carex depauperata*, *Carex filiformis*, *Clinopodium menthifolium*, *Eleocharis parvula*, *Gentianella ciliata*, *Lobelia urens*, *Luzula pallidula*, *Maianthemum bifolium*, *Najas marina*, *Ophioglossum azoricum*, *Ophrys fuciflora*, *Orobancha caryophylla*, *Pilosella peleteriana*, *Polygonum maritimum*, *Pulmonaria obscura*, *Selinum carvifolia*, *Seseli libanotis*, *Thlaspi perfoliatum*.

(c) *Allium scorodoprasum*, *Asplenium marinum*, *Blysmus rufus*, *Carum verticillatum*, *Dactylorhiza purpurella*, *Equisetum variegatum*, *Euphorbia portlandica*, *Festuca altissima*, *Fumaria purpurea*, *Gymnocarpium robertianum*, *Hymenophyllum tunbrigense*, *Juncus acutus*, *Juncus filiformis*, *Lavatera arborea*, *Melica nutans*, *Phegopteris connectilis*, *Rosa mollis*, *Rubus saxatilis*, *Salix myrsinifolia*, *Sibthorpia europaea*, *Sparganium angustifolium*, *Stellaria nemorum*.

suggest an overall increase in the rate of extinction during the twentieth century, especially since the 1960s. As can be seen from Fig. 3, rates in Cambridgeshire were generally higher than average throughout this period, particularly during the first half of the nineteenth century when many infertile grassland and bog species (e.g. *Drosera*

intermedia, *D. anglica*, *Herminium monorchis*, *Narthecium ossifragum*, *Ophrys sphegodes*) were lost as a result of parliamentary enclosure (Preston 2000). Rates approached one species a year (10 species per decade) for the majority of the twentieth century, particularly after the 1950s, when species of infertile semi-natural habitats continued to decline at an alarming

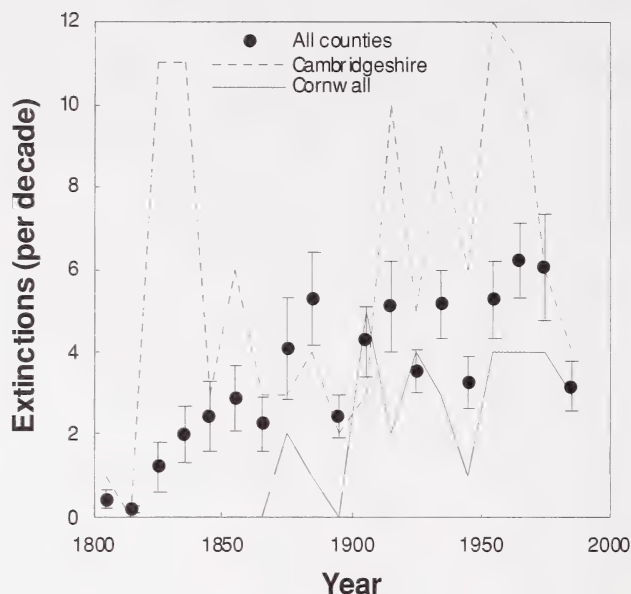


FIGURE 3. The average decadal 'extinction' rate (± 1 SE) based on figures for 18 lowland vice-counties in England for which recent (post-2000) data were available (v.c. 1/2, 9–10, 13/14, 21–22, 24, 27/28, 29–32, 39–40, 59–60, 81, Bristol Region). Values for Cambridgeshire (v.c. 29) and Cornwall (v.c. 1 & 2) are displayed for comparison.

rate, presumably due to the conversion of semi-natural grasslands to arable production (e.g. *Cirsium tuberosum*) but also as a result of more gradual changes brought about by eutrophication (e.g. *Alisma gramineum*, *Eleogiton fluitans*) and falling water tables (e.g. *Eriophorum angustifolium*, *Parnassia palustris*, *Pinguicula vulgaris*, *Utricularia minor*). At the other extreme, losses in Cornwall have been much lower than average since 1800, particularly during the nineteenth century when only three species were reported to have gone extinct (*Clinopodium acinos*, *Lathraea squamaria*, *Hypochaeris glabra*). Rates were more variable at just under 4 species per decade during the twentieth century with no obvious increase following the 1939–1945 war.

3. WE CAN LEARN MUCH FROM RECENT NATURALISATION EVENTS

Of the 8,000 or so plant species which have been deliberately or accidentally introduced into the British Isles, less than 100 have become widely naturalised (Preston *et al.* 2002) and of these vanishingly few (<0.1%) are

regarded as problem plants (Crawley *et al.* 1996). On the contrary, their introduction, spread and interactions with the native flora (e.g. competition, hybridisation) have provided fascinating ecological and evolutionary insights. To use Max Walters' own words: "Most of them are unplanned experiments, but if we watch we can learn a great deal from them" (Walters 1970, p.136). Table 4 lists some of the most successful invaders discussed in this paper.

SUCCESSFUL INVADERS

Clear ecological differences appear to exist between the British native and alien floras. British aliens tend to be larger, have larger seeds and occur in more fertile conditions than their native counterparts (Crawley *et al.* 1996; Williamson & Fitter 1996). They are also more likely to flower earlier or later in the year, have longer-lived seed banks and be pollinated by insects (Crawley *et al.* 1996). Although some of these differences are due to the predilections of gardeners and horticulturalists (e.g. woody species, attractive flowers) they also appear to reflect real ecological differences. The most

TABLE 4. ALIENS SHOWING THE MOST DRAMATIC INCREASES IN RANGE AND ABUNDANCE IN BRITAIN DURING THE TWENTIETH CENTURY

Species	Origin	First record	Main spread	Change Index
<i>Senecio squalidus</i> ¹	Italy	1794	1870-	+0.77
<i>Impatiens glandulifera</i>	Himalayas	1855	1940-	+1.85
<i>Matricaria discoidea</i>	N & S Asia	1871	1900-	-0.49
<i>Fallopia japonica</i>	E Asia	1886	1920-	+1.83
<i>Epilobium ciliatum</i>	N America	1891 ²	1930-	+3.88
<i>Epilobium brunnescens</i>	New Zealand	1904	1930-	+1.42
<i>Galinsoga quadriradiata</i>	C & S America	1909	1960-	+1.07
<i>Buddleja davidii</i>	C & W China	1922	1945-	+3.73
<i>Veronica filiformis</i>	N Turkey/Caucasus	1927 ³	1930-	+2.69
<i>Crassula helmsii</i>	Australia/New Zealand	1956	1970-	No data
<i>Conyza sumatrensis</i>	S America	1961 ⁴	1980-	No data
<i>Hyacinthoides xmassartiana</i>	Cultivation	1963	1960-	No data
<i>Elodea nuttallii</i>	N America	1966	1970-	No data
<i>Lemna minuta</i>	N & S America	1977	1989-	No data

¹ Possibly arose spontaneously as a result of hybridisation at Oxford Botanic garden in the 1890s. ² Known from a single site in Leicestershire up till 1934. ³ There is an earlier record for 1838. ⁴ The first record was from Guernsey. The first record in England was from S Essex in 1974.

widely naturalised species are either highly competitive woody or thicket-forming species capable of excluding native vegetation (e.g. *Fallopia japonica*) or rapidly maturing species that succumb to competition during secondary succession but spread rapidly via disturbed niches (e.g. *Epilobium ciliatum*, *Senecio squalidus*). Some of these invaders display higher growth rates than their native or introduced congeners. For example, stems of *Elodea nuttallii* elongate faster than those of *E. canadensis*, and this has been shown to cause displacement of the latter, formerly invasive species, in some sites (Simpson 1984, 1990). Similarly, the rapid development of leaves in *Lemna minuta* can exclude other native floating aquatics (Leslie & Walters 1983). In ruderal habitats, the dramatic spread of *Epilobium ciliatum* may be due, in part, to a faster growth rate and longer flower period than native willowherbs (Preston 1988). The lack of natural pests and pathogens within the introduced range may also provide exotic species with a competitive advantage thereby making them more invasive (the 'enemy release hypothesis'; Keane & Crawley 2002). Perhaps the most notoriously invasive plant in the British flora, *Fallopia japonica* var. *japonica*, provides a good example. Plants in Japan suffer damage from a range of invertebrate pests which attack rhizomes, stems

and leaves. No such pests have been found on British plants and no doubt this has aided its dramatic spread following its escape from cultivation in 1886 (Bailey & Connolly 2000).

HABITAT

The habitats occupied by naturalised species can provide fascinating ecological insights as well as providing novel conditions in which to study interactions with native congeners (e.g. competition, hybridisation). The vast majority of alien plants occur in man-made habitats (e.g. waste ground, railway lines, walls, urban sites) close to habitation ('the 100 m rule'; Crawley *et al.* 1996). These habitats provide disturbed, and often drought-stressed niches (e.g. cinder tips, clinker of railway lines, asphalt, quarries, rubble, wasteland) similar to conditions occupied in the native range. Some of the best examples are primary colonists of volcanic rocks (e.g. *Senecio squalidus*, *Fallopia japonica* var. *japonica*) and river shingles and gravels (e.g. *Epilobium brunnescens*). *Buddleja davidii* is a perennial shrub native to central and western China where it typically occurs as dense thickets on shingle beaches adjacent to rivers (Owen & Whiteway 1980). Its spread in southern Britain was one of the most dramatic of the twentieth century and

followed the sudden availability of lime-rich rubble created by bombing during the 1939–1945 war. Its ability to thrive on compacted, drought-prone soils combined with prolific seed production (>1 million seeds per plant) has allowed it to colonise a wide variety of ruderal niches (e.g. railway sidings, quarries, stone structures) and as a result it is now one of the most familiar weeds of urban and waste areas (Clay & Drinkall 2001). Similarly, *Epilobium brunnescent* has spread throughout much of northern and western Britain where it is now common on moist, gravely substrates similar to its native riverbed habitat in New Zealand (Kitchener & McKean 1998). Urban niches also provide suitable conditions for more southerly species such as the subtropical plant *Conyza sumatrensis* which is confined to arid, sun-baked niches such as pavement cracks (Wurzell 1988). In contrast, its more temperate cousin *Conyza canadensis* has spread further and more rapidly along railway-lines since the 1939–1945 war (Salisbury 1961).

INTRODUCTION AND SPREAD

Although some naturalised aliens were introduced unintentionally the vast majority, including many pernicious plant invaders, were brought in as garden ornamentals (Crawley *et al.* 1996). Their subsequent spread has long fascinated botanists and as a result many have been studied in great detail (e.g. *Elodea* spp., *Fallopia* spp., *Senecio* spp.). The time lag between escape into the wild and invasion can be surprisingly long given how widespread some species eventually become. For example, *Epilobium ciliatum* was known for over 40 years from a single site in Leicestershire before it began its dramatic spread throughout southern England in the 1930s (Preston 1988). However, most plant invasions have been shown to follow a rather generalised pattern with a pioneer phase of scattered primary occurrences followed by a rapid expansion from primary foci ('infection' *sensu* Salisbury 1961) and a final era of consolidation. The naturalisation of *Fallopia japonica* var. *japonica* in the British Isles provides the classic example. Its spread began in the early 1900s with initial foci in industrial areas in South Wales but also private gardens, estates, nurseries and botanic gardens from which dispersal by escape, exchange, gift, sale or disposal took place (Bailey & Connolly 2000).

Indeed today clusters of hybrids with *F. sachalinensis* (*F. xbohemica*) often indicate proximity to gardens where it was originally planted (Bailey & Connolly 2000). It spread modestly up till the 1939–1945 war but rapidly thereafter, especially around urban areas, before consolidating its range in the 1970s (Connolly 1977). In contrast, wind dispersed aliens have shown a much more continuous pattern of spread, particularly where colonisation took place along transport corridors (e.g. railway sidings). For example, *Epilobium ciliatum* showed a more or less even spread after the 1930s reflecting a more natural expansion of an established population rather than introduction by man at different sites (Preston 1988).

Although most aliens consolidate their distributions, a small number have subsequently declined. One of the best examples is *Elodea canadensis*: between 1850 and 1880 this North American species spread vigorously in the east of England, where it blocked drains, sluices and watercourses much to the chagrin of college rowers and swimmers in Cambridge (Simpson 1984). However, it quite inexplicably declined in abundance and invasiveness, more latterly due to displacement by *E. nuttallii* which was first recorded near Oxford in 1966 (Simpson 1990). *Spartina anglica*, the allopolyploid derivative of *S. maritima* and the North American *S. alterniflora*, has suffered a similar 'die-back' in some areas due to successional changes (Ainouche *et al.* 2004).

DISPERSAL MODE

Research on the dispersal modes of aliens has identified two distinct groups of successful invaders: tall, competitors that spread largely by vegetative fragments in garden waste and small, short-lived species with high reproductive outputs which are dispersed in soil or as airborne propagules (Hodkinson & Thompson 1997). The most extreme example of the former group is *Fallopia japonica* var. *japonica*. British populations are male-sterile and so spread is entirely by vegetative fragments from a single extraordinarily vigorous clone (Connolly 1977; Hollingsworth & Bailey 2000). Plants can establish from tiny root fragments dispersed in topsoil or garden waste, making it almost impossible to eradicate or control. The spread of the diminutive rockery plant *Veronica filiformis* has received less attention but is no less dramatic. Despite

setting virtually no seed, it has colonised almost every lowland hectad in less than 70 years, presumably by vegetative fragments transported on mowing machinery. Likewise, the astonishing spread of *Spartina anglica* along the Western seaboard of Europe has occurred as a result of dispersal of rhizome fragments by sea currents.

The spread of *Epilobium ciliatum* and *Senecio squalidus* are relatively easier to understand as both produce copious amounts of plumed seed capable of dispersal over large distances. For example, Druce (1927, p.241) famously observed the dispersal of seeds *S. squalidus* during a railway journey between Oxford and Reading (c. 40 miles): "...the vortex of air following the express train carries the fruits in its wake. I have seen them enter a railway-carriage window near Oxford and remain suspended in the air in the compartment until they found an exit at Tilehurst". No doubt many other 'railway yard' aliens have been spread in a similar fashion (e.g. *Buddleja davidii*, *Conyza canadensis*, *Senecio viscosus*). Invasion of riparian habitats via waterborne dispersal of seeds, fruits and vegetative propagules have been no less dramatic. Since the 1940s *Impatiens glandulifera* (incidentally Britain's tallest annual plant) has spread rapidly along riverbanks throughout the British Isles and now occurs in dense mono-specific stands where it can suppress native perennials such as *Urtica dioica* (Tickner *et al.* 2001). Less invasive examples include the dispersal of seeds of *Lathraea clandestina*, bulbils of *Cardamine bulbifera* and vegetative fragments of *Arenaria balearica* along watercourses (Atkinson 1996; Corner 1996; Wallace 2005). The transport of seeds in soils or waste manures (e.g. wool shoddy) has also led to the spread of many species, although relatively few aliens have become widely naturalised via this agency. Possibly the most successful example is *Matricaria discoidea* which was originally introduced, into Ireland at least, with American corn fed to poultry (Reynolds 1996) but has since spread rapidly in soil attached to animals, shoes and motor vehicles (Hodkinson & Thompson 1997). A more recent invasion has been the spread of *Galinsoga quadriradiata* in urban areas, initially due to the effects of bombing during the 1939–1945 war, but more latterly in soil amongst horticultural produce (Lacey 1957).

HYBRIDISATION AND SPECIATION

Occasionally naturalised species hybridise with native congeners or other introduced species. Of the estimated 800 or so angiosperm hybrids known to occur in the UK 87 combinations involve at least one non-native taxon and 26 are hybrids between two or more alien species (Preston *et al.* 2002). Many originated allopatrically and are therefore unique to the British Isles most notably hybrids between *Fallopia* and *Epilobium* taxa. As British populations of *Fallopia japonica* var. *japonica* are entirely male sterile all seed produced is inevitably of hybrid origin. The most frequent pollen donor appears to be the common garden plant, *F. baldschuanica* although instances of the hybrid *F. ×conollyana* establishing in the wild have been astonishingly rare given the amount of seed produced annually (Bailey 2001; but see Bailey & Spencer 2003). In contrast, the hybrid with *F. sachalinensis* (= *F. ×bohemica*) displays many of the invasive tendencies of *F. japonica* var. *japonica* and is currently colonising roadsides, waste ground, riversides and railway banks throughout the British Isles (Bailey *et al.* 1996).

Harsh, man-made environments often create novel abiotic conditions in which evolutionary changes can take place (e.g. heavy metal tolerance on colliery waste tips). They can also stimulate allopatric speciation events and new hybrid combinations. Good examples are hybrids between the naturalised willowherb *Epilobium brunnescens* and native *E. lanceolatum*, *E. montanum*, *E. obscurum*, *E. palustre* and *E. parviflorum*. All have arisen relatively recently on damp, acid substrates associated with former mining activities (e.g. quarry slopes, granite aggregates, mine wastes, china clay gravels) in Cornwall (Kitchener & McKean 1998; Kitchener 2003a). Native plants are very slow to colonise these habitats and as a consequence primary colonists, such as willowherbs, have ample time to establish and hybridise (Kitchener 2003b). In addition, the relatively sunny and warm Cornish climate may encourage hybridisation by allowing flowers to remain open longer thereby increasing chances of cross-pollination by insects (Kitchener 2003b).

The evolutionary implications of such novel hybridisation events are well documented and provide some of the clearest examples of

speciation by allopolyploidy. Possibly the best studied is the neoallopolyploid *Spartina anglica* which originated from hybridisation between the native species *S. maritima* and East American *S. alterniflora* following its introduction to Southampton Water in the 1820s. The sterile first generation hybrid, *S. ×townsendii*, was first observed in 1870 and within twenty years gave rise to the fertile allopolyploid *S. anglica* following genome duplication (Ainouche *et al.* 2004). More recent examples have involved *Senecio squalidus*, a diploid ragwort introduced from Mount Etna, Sicily, at the beginning of the eighteenth century (Harris 2002). This species may have originated in Oxford as a stabilised diploid hybrid between two Sicilian species, *S. aethnensis* and *S. chrysanthemifolius* (Abbott *et al.* 2000, 2002; although Sell & Murrell (2006) treat both as subspecies of *S. squalidus*). Hybridisation between *S. squalidus* and *S. vulgaris* is relatively rare in the wild yielding highly sterile triploid (= *S. ×baxteri*) or partially fertile tetraploid hybrids. Segregation from either of these hybrids, or following backcrossing to *S. vulgaris*, has been shown to produce the 'York radiate groundsel' *S. eboracensis* (Lowe & Abbott 2003) in England and the allohexaploid 'Welsh groundsel' *Senecio cambrensis* in Wales and Scotland (Abbott *et al.* 1983; Ashton & Abbott 1992). Although reproductively isolated from their parents due to self-compatibility mechanisms and flowering times (Lowe & Abbott 2004) both are currently threatened: the Edinburgh lineage of *S. cambrensis* was recently destroyed by redevelopment (Abbott & Forbes 2002) and York populations of *S. eboracensis* have declined as a result of over-zealous street cleansing and may be extinct (Abbott *et al.* 2005). Introgression of *S. squalidus* into *S. vulgaris* subsp. *vulgaris* has also been implicated in the origin of radiate forms of groundsel, *S. vulgaris* var. *hibernicus*, which is now a common variety of town and wasteland floras in many parts of the British Isles (Abbott *et al.* 1992). *Senecio squalidus* also hybridises with the introduced *S. viscosus* to form the sterile hybrid *S. ×subnebrodensis* and it has been suggested that subsequent introgression may have led to the spread of *S. viscosus* during the twentieth century (Crisp & Jones 1978).

CONCLUSION

The rather depauperate nature of the British flora has meant that, with the possibility of *Bromus interruptus*, *Senecio eboracensis* and a few critical taxa, no species have become globally extinct, and relatively few have been lost in the UK as a whole. However, as Max Walters (1970) predicted this belies real losses at the local scale over the last 35 years, particularly in the intensively managed lowlands of southern England, where land use pressures have been greatest. Here the extinction of species of infertile habitats shows now sign of abating, and it seems likely that many of the species listed in Table 3 could well go extinct within the next 35 years. However, these localised losses have been more than compensated by the discovery of new species, mainly within critical genera, and, even more so by the introduction and spread of casuals and neophytes. Although Max's prediction that urban areas will be the most diverse is not strictly true, they are certainly the centres of alien plant diversity in the UK and, as the results from Cambridgeshire show, they may well become the richest areas if we continue to lose native species from the countryside at the same alarming rate. In recent decades many non-native species have been treated as unwelcome additions which will threaten our native flora. However, British botanists have learnt a great deal from their means of arrival, dispersal, habitats and competitive interactions with the native flora. In addition, the naturalisation of species from all over the globe has provided evolutionary biologists with unique opportunities to study the intricacies of diploid hybrid speciation. Future naturalisation events may also provide evidence of major environmental changes, such as climate change, as conditions become more suitable for Mediterranean and subtropical species.

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REFERENCES

- ABBOTT, R. J. & FORBES, D. G. (2002). Extinction of the Edinburgh lineage of the allopolyploid neospecies, *Senecio cambrensis* Rosser (Asteraceae). *Heredity* **88**: 267–269.
- ABBOTT, R. J., INGRAM, R. & NOLTIE, H. J. (1983). Discovery of *Senecio cambrensis* Rosser in Edinburgh. *Watsonia* **14**: 407–408.
- ABBOTT, R. J., ASHTON, P. A. & FORBES, D. G. (1992). Introgressive origin of the radiate groundsel, *Senecio vulgaris* L. var. *hibernicus* Syme: Aat-3 evidence. *Heredity* **68**: 425–435.
- ABBOTT, R. J., JAMES, J. K., IRWIN, J. A. & COMES, H. P. (2000). Hybrid origin of the Oxford ragwort, *Senecio squalidus* L. *Watsonia* **23**: 123–138.
- ABBOTT, R. J., JAMES, J. K., FORBES, D. G. & COMES, H. P. (2002). Hybrid origin of the Oxford ragwort, *Senecio squalidus* L: morphological and allozyme differences between *S. squalidus* and *S. rupestris* Waldst. and Kit. *Watsonia* **24**: 17–29.
- ABBOTT, R. J., IRELAND, H. E., JOSEPH, L., DAVIES, M. S. & ROGERS, H. J. (2005). Recent plant speciation in Britain and Ireland: origins, establishment and evolution of four new hybrid species. *Proceedings of the Royal Irish Academy* **105B**: 173–183.
- AINOUCHE, M. L., BAUMEL, A. & SALMON, A. (2004). *Spartina anglica* C.E. Hubbard: a natural model system for analysing early evolutionary changes that effect allopolyploid genomes. *Biological Journal of the Linnean Society* **82**: 475–484.
- ASHTON, P. A. & ABBOTT, R. J. (1992). Multiple origins and genetic diversity in the newly arisen allopolyploid species, *Senecio cambrensis* Rosser (Compositae). *Heredity* **68**: 25–32.
- ATKINSON, M. D. (1996). The distribution and naturalisation of *Lathraea clandestina* L. (Orobanchaceae) in the British Isles. *Watsonia* **21**: 119–128.
- BAILEY, J. P. (2001). *Fallopia connollyana* The Railway-yard Knotweed. *Watsonia* **23**: 539–541.
- BAILEY, J. P. & CONNOLLY, A. P. (2000). Prize-winners to pariahs – A history of Japanese Knotweed *s.l.* (Polygonaceae) in the British Isles. *Watsonia* **23**: 93–110.
- BAILEY, J. P. & SPENCER, M. (2003). New records for *Fallopia connollyana*: is it truly such a rarity? *Watsonia* **24**: 452–453.
- BAILEY, J. P., CHILD, L. E. & CONNOLLY, A. P. (1996). A survey of the distribution of *Fallopia xbohemica* (Chrtek & Chrtková) J. Bailey (Polygonaceae) in the British Isles. *Watsonia* **21**: 187–198.
- BOWEN, H. J. M. (1968). *The flora of Berkshire*. Holywell Press, Oxford.
- BRENAN, J. P. M. (1982). Presidential address, 1982. The British flora – a changing picture. *Watsonia* **14**: 237–242.
- CLAY, D. V. & DRINKALL, M. J. (2001). The occurrence, ecology and control of *Buddleja davidii* in the UK. *The Brighton Crop Protection Council conference – Weeds 2001* **3B-4**: 155–160.
- CONOLLY, A. P. (1977). The distribution and history in the British Isles of some alien species of *Polygonum* and *Reynoutria*. *Watsonia* **11**: 291–311.
- CORNER, R. W. M. (1996). *Arenaria balearica* L. (Mossy Sandwort): observations on water-borne spread in Perthshire. *Watsonia* **21**: 200–202.
- CRAWLEY, M. J. (2005). *The flora of Berkshire*. Brambleby Books, Harpenden.
- CRAWLEY, M. J., HARVEY, P. H. & PURVIS, A. (1996). Comparative ecology of the native and alien floras of the British Isles. *Philosophical Transactions of the Royal Society of London* **B351**: 1251–1259.
- CRISP, P. C. & JONES, D. A. (1978). The hybridisation of *Senecio squalidus* and *S. viscosus* and the introgression of genes from diploid into tetraploid species. *Annals of Botany* **42**: 937–944.
- DANDY, J. E. (1958). *List of British vascular plants*. British Museum & Botanical Society of the British Isles, London.
- DRUCE, G. C. (1897). *The flora of Berkshire*. Clarendon Press, Oxford.
- DRUCE, G. C. (1908). *List of British plants*. T. Buncle, Arbroath.
- DRUCE, G. C. (1927). *The flora of Oxfordshire*, second edition. Clarendon Press, Oxford.
- DRUCE, G. C. (1928). *British plant list*, second edition. T. Buncle, Arbroath.
- HARRIS, S. A. (2002). Introduction of Oxford Ragwort, *Senecio squalidus* L. (Asteraceae), to the United Kingdom. *Watsonia* **24**: 31–43.
- HODKINSON, D. J. & THOMPSON, K. (1997). Plant dispersal: the role of man. *Journal of Applied Ecology* **34**: 1484–1496.
- HOLLINGSWORTH, M. L. & BAILEY, J. P. (2000). Hybridisation and clonal diversity in some introduced *Fallopia* species (Polygonaceae). *Watsonia* **23**: 111–121.
- HOLLINGSWORTH, P. M., SQUIRELL, J., HOLLINGSWORTH, M. L., RICHARDS, A. J. & BATEMAN, R. M. (2006). Taxonomic complexity, conservation and recurrent origins of self-pollination in *Epipactis* (Orchidaceae), in J. BAILEY, & R. G. ELLIS eds *Current taxonomic research on the British and European flora*, pp. 27–44. Botanical Society of the British Isles, London.
- KEANE, R. M. & CRAWLEY, M. J. (2002). Exotic plant invasions and the enemy release hypothesis. *Trends in Ecology and Evolution* **17**: 164–170.

- KENT, D. H. (1992). *List of vascular plants of the British Isles*. Botanical Society of the British Isles, London.
- KENT, D. H. & STACE, C. A. (2000). *List of vascular plants of the British Isles. Supplement 2*. Botanical Society of the British Isles, London.
- KITCHENER, G. D. (2003a). The relationship between hybridisation in *Epilobium* and Cornish China Clay and other mining waste. *Botanical Cornwall* **12**: 20–32.
- KITCHENER, G. D. (2003b). A new *Epilobium* (Onagraceae) hybrid: *Epilobium brunnescens* (Cockayne) Raven & Engelhorn $\times$ *Epilobium parviflorum* Schreber (*E. \times argillaceum*). *Watsonia* **24**: 519–523.
- KITCHENER, G. D. & MCKEAN, D. R. (1998). Hybrids of *Epilobium brunnescens* (Cockayne) Raven & Engelhorn (Onagraceae) and their occurrence in the British Isles. *Watsonia* **22**: 49–60.
- LACEY, W. S. (1957). A comparison of the spread of *Galinsoga parviflora* and *G. ciliata* in Britain, in J. E. LOUSLEY ed. (1957). *Progress in the study of the British flora*, pp. 109–115. Botanical Society of the British Isles, London.
- LESIE, A. C. & WALTERS, S. M. (1983). The occurrence of *Lemna minuscula* Herter in the British Isles. *Watsonia* **14**: 243–248.
- LOWE, A. J. & ABBOTT, R. J. (2003). A new British species, *Senecio eboracensis* (Asteraceae), another hybrid derivative of *S. vulgaris* L. and *S. squalidus* L. *Watsonia* **24**: 375–388.
- LOWE, A. J. & ABBOTT, R. J. (2004). Reproductive isolation of a new hybrid species *Senecio eboracensis* Abbott & Lowe (Asteraceae). *Heredity* **92**: 386–395.
- LOUSLEY, J. E. (1953). The recent influx of aliens into the British flora, in J. E. LOUSLEY ed. *The changing flora of Britain*, pp. 140–159. Botanical Society of the British Isles, London.
- OWEN, D. F. & WHITEWAY, W. R. (1980). *Buddleia davidii* in Britain: history and development of an associated fauna. *Biological Conservation* **17**: 149–155.
- PRESTON, C. D. (1988). The spread of *Epilobium ciliatum* Raf. in the British Isles. *Watsonia* **17**: 279–288.
- PRESTON, C. D. (2000). Engulfed by suburbia or destroyed by the plough: the ecology of extinction in Middlesex and Cambridgeshire. *Watsonia* **23**: 59–81.
- PRESTON, C. D., PEARMAN, D. A. & DINES, T. D., comps & eds (2002). *New atlas of the British and Irish Flora*. Cambridge University Press, Cambridge.
- REYNOLDS, S. C. (1996). Alien plants at ports and in coastal habitats on the east coast of Ireland. *Watsonia* **21**: 53–61.
- RICH, T. C. G. & LOCKTON, A. (2002). *Bromus interruptus* (Hack.) Druce (Poaceae) – an extinct English endemic. *Watsonia* **24**: 69–80.
- RICH, T. C. G. & PRYOR, K. V. (2003). *Galeopsis segetum* Neck. (Lamiaceae), Downy Hemp-nettle: native or introduced in Britain? *Watsonia* **24**: 401–411.
- ROY, D. B., HILL, M. O. & ROTHERY, P. (1999). Effects of urban land cover on the local species pool in Britain. *Ecography* **22**: 507–515.
- SALISBURY, E. J. (1961). *Weeds and Aliens*. London.
- SELL, P. D. & MURRELL, G. (2006). *Flora of Great Britain and Ireland. Volume 4. Asteraceae*. Cambridge University Press, Cambridge.
- 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.
- SIMPSON, D. A. (1984). A short history of the introduction and spread of *Elodea Michx* in the British Isles. *Watsonia* **15**: 1–9.
- SIMPSON, D. A. (1990). Displacement of *Elodea canadensis* Michx by *Elodea nuttallii* (Planch.) H. St John in the British Isles. *Watsonia* **18**: 173–177.
- STACE, C. A. (2002). Knowing what we have: the ever-changing inventory. *Suffolk Natural History* **38**: 23–36.
- TICKNER, D. P., ANGOLD, P. G., GURNELL, A. M., MOUNTFORD, J. O. & SPARKS, T. (2001). Hydrology as an influence on invasion: experimental investigations into competition between the alien *Impatiens glandulifera* and the native *Urtica dioica* in the UK, in G. BURUNDU, J. BROCK, I. CAMARDA, L. CHILD & M. WADE eds. *Plant invasions: species ecology and ecosystem management*, pp. 159–168. Blackhuys Publishers, Leiden.
- WALLACE, I. (2005). *Cardamine bulbifera* (Coralroot) in Harrogate. *BSBI News* **98**: 35.
- WALKER, K. J. (2003). One species lost every year? An evaluation of plant extinctions in selected British vice-counties since 1900. *Watsonia* **24**: 359–374.
- WALTERS, S. M. (1970). The next twenty five years, in F. PERRING ed. *The flora of a changing Britain*, pp. 136–141. Botanical Society of the British Isles, London.
- WILLIAMSON, M. H. & FITTER, A. (1996). The characters of successful invaders. *Biological Conservation* **78**: 163–170.
- WURZELL, B. (1988). *Conyza sumatrensis* (Retz.) E. Walker established in England. *Watsonia* **17**: 145–148.

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Water Germander *Teucrium scordium* L. in Cambridgeshire: back from the brink of extinction

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ABSTRACT

The indigenous distribution of Water Germander *Teucrium scordium*, an endangered Red Data species in Britain, has contracted to just three sites: two in dune slacks in North Devon and one in a disused flooded limestone quarry in Cambridgeshire. In at least two of these, it has been suffering a decline. At Kingfishers Bridge near Wicken in Cambridgeshire what appears to be a highly successful attempt to boost an ailing indigenous population has been undertaken by transplanting plants propagated vegetatively from the original site onto a nearby wetland created since 1995 on what was intensively farmed arable. The population has increased explosively from 1522 shoots on plants introduced in 1997–2000 to over 180,000 shoots in September 2004. The spread appears to be largely by fragile stolon fragments, sometimes broken from the parent plants by grazing geese, being distributed by water in winter and early spring. Optimal conditions for establishment are sparsely vegetated water margins exposed by summer draw-down. The water at Kingfishers Bridge is base-rich and generally of good quality. Water Germander does not thrive in the shade of dense reed, scrub and other tall vegetation, but can tolerate inundation by water and ice cover in winter. Reintroduction also seems to have been successfully achieved at Bassenhally, an indigenous Cambridgeshire site from which Water Germander disappeared soon after its discovery in 1967. Nearly 1700 shoots were counted there in 2004.

INTRODUCTION

Water Germander *Teucrium scordium* is a British Red Data plant, classed as endangered in the recently revised Red Data List (Cheffings & Farrell 2005). It is currently restricted as an indigenous species to three

sites, though it does occur in Western Ireland. The British populations have not been flourishing in recent years. This paper describes what appears to be a successful attempt to increase the Cambridgeshire population of Water Germander at a wetland recently created from intensive arable farmland at Kingfishers Bridge, close to the only remaining indigenous site in East Anglia and at another Cambridgeshire location from which the species had recently become extinct. This species recovery project is part of a wider ecological restoration campaign in the Fenland basin to rehabilitate degraded wetlands and to create new wetlands where they have been destroyed (Colston 2003; Hughes *et al.* 2005; Mountford & Wadsworth 2002). New and rehabilitated wetlands should support, in a sustainable way, as full a range of taxa as possible that were present in Fenland prior to the era of intensive drainage. In the 21st century context of climate change and fragmented landscapes, such restoration cannot hope to create individual perfect facsimiles of previous habitats and species assemblages. However, restoration programmes such as that at Kingfishers Bridge seek to restore natural ecological processes rather than make constructed copies of past habitats and are the antithesis of the “gardening” that has occurred in some nature management (Tomkins 1998). The programme at Kingfishers Bridge has also led to various observations on the ecology of *Teucrium scordium* which help to confirm the causes of the demise of the species in Britain and also offer ways of boosting existing populations by management and restoring this attractive plant to other sites.

PAST DISTRIBUTION – BRITAIN AND IRELAND

Teucrium scordium has never been known to have other than a very localised distribution in Britain. Pre-1970 it had been recorded from 24 10km squares extending from North Devon (v.c. 4), Berkshire (v.c. 22), Oxfordshire (v.c. 23) to South Lincolnshire (v.c. 53), North Lincolnshire (v.c. 54), Southwest Yorkshire (v.c. 63) and Northwest Yorkshire (v.c. 65). The centre of distribution was the East Anglian Fens: Cambridgeshire (v.c. 29) and Huntingdonshire (v.c. 31). By 1960 it had become extinct in all but North Devon, Cambridgeshire and West Suffolk (Perring & Walters 1962, Wigginton 1999, Preston *et al.* 2002). It was last recorded in South Lincolnshire in 1952 (Gibbons 1975). There is a record from Lakenheath, West Suffolk in 1860 (Hind 1889). It was 'rediscovered' in Stallode Wash (Botany Bay), Lakenheath in 1976 by M. G. and S. Rutterford (Rutterford 1977), but had disappeared by 1979 (Simpson 1982) – see Figure 1. In 2004, *T. scordium* was discovered on Anglesey (v.c. 52) by Richard Birch, where a small patch was found in 2004 in the draw-down zone of a balancing pond. The provenance and status of this population is unknown (Ian Bonner, pers. comm.), and there are no historical records from Anglesey or from Wales.

In Cambridgeshire, pre-1860, *T. scordium* was known from several sites in the fens, including from what is now within the northern boundary of Cambridge City (King's Hedges and Histon Road), 'abundantly on the road to Ely', Roswell Pits, Ely and at Mepal. There were earlier records from Waterbeach and Cottenham which could not be confirmed (Babington 1860). By the publication of the last full Cambridgeshire flora (Perring *et al.* 1964), it had long become extinct at all these sites, evidently due to its intolerance of competition from tall vegetation. A population does persist in the North Pit, (TL544733) 2.5 km north of Upware on the River Cam and the same distance northwest of Wicken Fen. Moreover, in 1967, Water Germander was discovered by Frank Perring and Ian Hepburn at Bassenhally Pit (TL286986) 1 km northeast of Whittlesey and close to the Nene Washes. By 1970, it had disappeared from this site (Langton 1970), though material from Bassenhally was grown on in the University Botanic Garden, Cambridge.

In North Devon, Water Germander has been known since the end of the 18th century from Branton Burrows (Polwhele 1797). It was locally abundant in the winter-flooded dune slacks well into the 20th century (Martin & Fraser 1939, Palmer 1946). In 1982 a survey by J. Vause, J. Breeds, J. Hope-Simpson and M. Tulloh recorded 18,874 shoots at six sites on the Burrows (Vause 1982). In 1998 only 3951 shoots at two of these sites were found. However, four 'new' sub-populations containing about 6881 shoots were located, including one of 6604 shoots previously unknown. Excluding the latter, but taking into account all colonies known up to 1997, the 1998 survey revealed 4228 shoots, a 78% decline on the 1982 count (Holyoak 1998). In an attempt to reverse this decline, from 1998 the site managers began to mechanically surface-scape dune slacks that had formerly supported *T. scordium*, leading to a substantial population recovery by 2005 (J. Diamond, pers. comm.).

A second North Devon location was discovered by Mr W. Tucker in 1976 at Northam Burrows on the opposite side of the Taw Estuary from Branton, growing in a similar habitat (Ivimey-Cook 1984; Tucker 1978). A survey of Northam made by one of the authors of the present paper (JOM) with Mr Tucker (then North Devon B.S.B.I. recorder) in 1997 showed a small population of <500 shoots, having declined from the few thousand stems of the 1970s, probably due to vegetation succession within the dune slack (W. Tucker, pers. comm.).

The North Pit near Upware, Cambridgeshire Branton Burrows and Northam Burrows currently all have SSSI status. The plant in Devon differs from that in Cambridgeshire in being very hairy and has been described as var. *dunense* Druce (P. Sell in press).

Teucrium scordium has been recorded from twelve 10 km squares in western Ireland since 1970 and since 1987 is known from 10 of these (Preston *et al.* 2002). It extended along the Shannon from Roosky (Leitrim v.c. H29) to Doonass (Limerick v.c. H8). It is still locally abundant on the calcareous shores of Lough Derg (Clare v.c. H9; and SE Galway v.c. H15) and Lough Ree (southeast Galway). There are isolated stations in North Tipperary, v.c. H10 and elsewhere in Clare (Praeger 1934, Webb 1977).

Water Germander occurred on Guernsey in the Channel Islands where it was last seen in

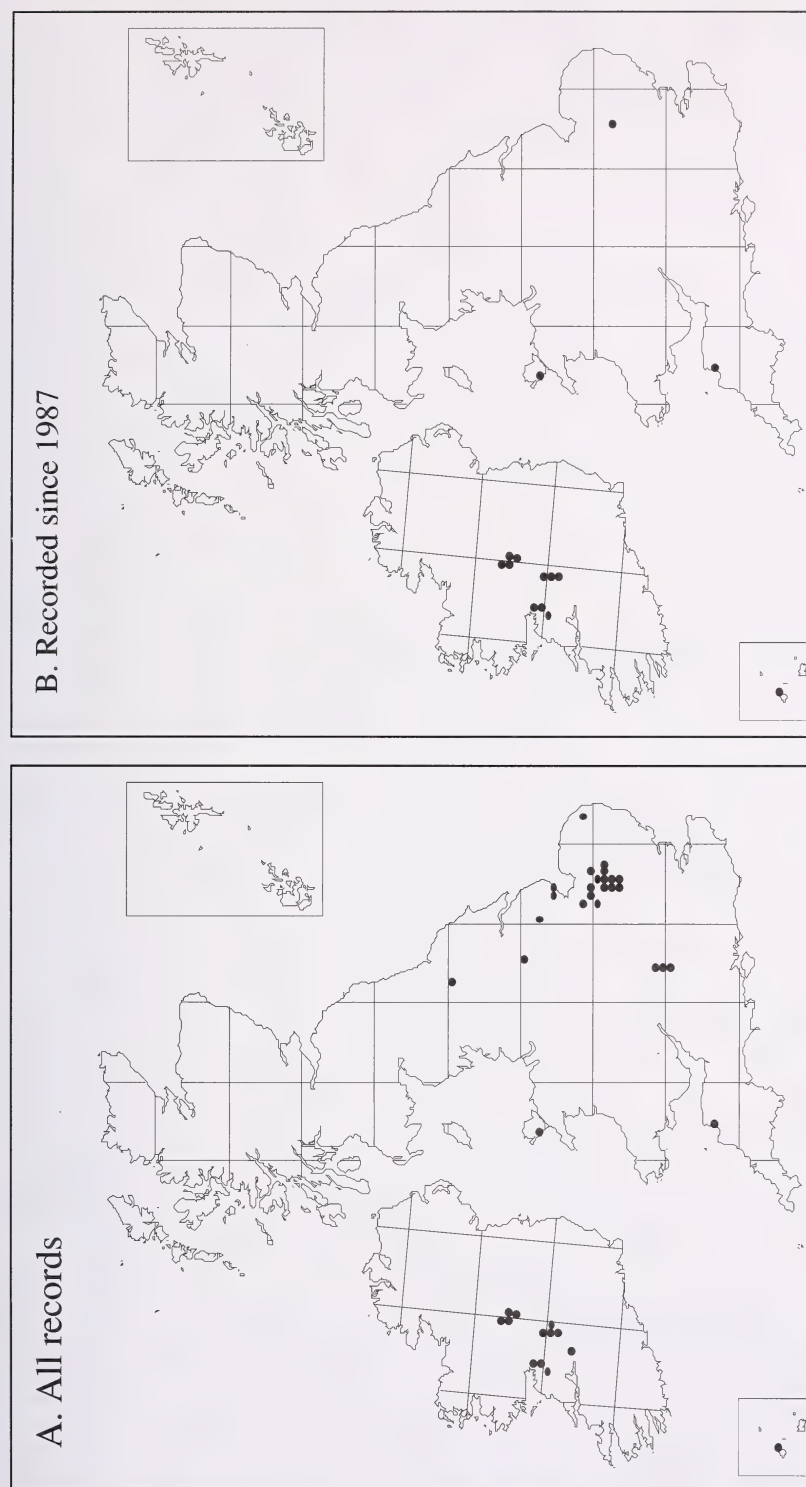


FIGURE 1. Distribution of *Teucrium scordium* L. in Britain and Ireland, showing:
 A. All 10 km squares with which *T. scordium* has been recorded
 B. 10 km squares where *T. scordium* has been recorded since 1987

TABLE 1. *TEUCRIUM SCORDIUM* SHOOT COUNTS CAMBRIDGESHIRE SITES 1997–2004

	1997	1998	1999	2000	2001	2002	2004	Total
North Pit (original, indigenous)	330	578	700	1200	558	600	214	
(introduced)		18*	2	8	4	3	0	
Cam Washes SSSI				599*	1294	156	0	
Wetland Creation Project (WCP)								
Kingfishers Bridge								
Fen (sites 1,2 & 10)		96*	72+110*	196+260*	1000	1500	338	
Reedbed (sites 3 & 4)		43*	72	69+800*	0+2330	2761	1125	
Lake (sites 7 & 8)		50*	86	423	520	3088	41,014	
Winter Flood (site 9)		24*	41+114*	165	1970	10,820	134,686	
Contour Ditch (site 5)		25*	39	119	130	2409	3595	
Big Ditch						323*	436	
Total shoots WCP			310	972	5950	20,578	181,194	
Total plants introduced		238*	224*	1060*	0	323*		1845
Bassenhally Pit (Whittlesey)			41*		96	30	1683	

(*Planted introductions)

TABLE 2. WATER GERMANDER *TEUCRIUM SCORDIUM* SHOOT DENSITY AND ASSOCIATED VEGETATION AT KINGFISHERS BRIDGE

	<i>Teucrium</i> shoot density	Associated vegetation height
	Mean/m ²	Mean cm
Kingfishers Bridge		
North Pit – indigenous (n = 2)	19	177.0 ± 30.9
Winter Flood N (n = 5)	457 ± 540	26.2 ± 13.3
(n = 4)	564 ± 557	21.9 ± 10.6
Winter Flood S (n = 5)	52 ± 95	24.1 ± 12.2
Lake shore draw down (n = 5)	45 ± 95	3.4 ± 3.3
Lake shore drift line (n = 5)	149 ± 99	30.8 ± 12.0
Reedbed/lagoon margin (n = 2)	368 ± 240	25.6 ± 12.5
Reedbed – tall & dense (n = 3)	192 ± 116	231.3 ± 26.7
Ditches (n = 6)	313 ± 230	37.5 ± 25.0
Bassenhally Pit		
Herb-rich fen		49.4 ± 29.2

1925 (McClintock 1975). The Guernsey plant was said to be referable to subsp. *scordioides* Rouy, which is the commonest form in coastal sites in southern Europe, including the Atlantic fringe and Mediterranean. A recent biometric study of *T. scordium* populations in northwest France and Brittany suggests that one population in dune slacks in Pas-de-Calais may be referable to subsp. *scordioides*, with other populations at the site appearing intermediate between subsp. *scordioides* and subsp. *scordium* (Toussaint *et al.* 2005).

BACKGROUND TO THE KINGFISHERS BRIDGE WETLAND CREATION PROJECT

Since 1970, attempts have been made to arrest the catastrophic decline of *T. scordium* through management of its remaining sites. By 1998, these attempts have met with some local success, but the area of remaining suitable habitat at North Pit (Upware) was tiny, both the Bassenhally and Stallode Wash populations had disappeared and in Devon, *T. scordium* was either declining (Northam Burrows) or with an

uncertain future due to changes in the site's conservation status (Braunton Burrows). At a regional, national and international scale, it was becoming increasingly clear that nature conservation of small discrete sites through intensive management ("gardening") was becoming non-viable (Colston 2003) and that effective protection of nature had to not only conserve that which survived but pursue "creative conservation" i.e. ecological restoration (Sheail *et al.* 1997). The underlying philosophy behind the Kingfishers Bridge project is precisely this type of creative conservation and seeks to achieve a viable population of *T. scordium* in a large wetland site that itself forms part of a network of major restored wetlands around the southern margin of the Fenland basin.

The project is a private venture to restore a variety of semi-natural fenland habitats on land that was intensively farmed up to 1995. It lies close to the River Cam and is only 2.5 km from Wicken Fen, one of the oldest nature reserves, which is owned and managed by the National Trust. The project is the inspiration of Andrew Green who has dedicated 65 ha of his and his family's low-lying arable farmland to creating a nature reserve. Roger Beecroft (one of the authors of this paper) has provided major advisory and management input from the start of the project. The construction of the site has been described by Tomkins (1998).

Three types of soil are represented on the site: neutral fenland peat, Gault clay of marine origin and Corallian limestone. Most of the water originates as run-off from the land supplemented by some that is pumped from a neighbouring limestone quarry. It is both highly calcareous and of good quality. A small indigenous population of *Teucrium scordium* grows in a flooded long-abandoned limestone quarry close to the created wetland.

Five created habitats suitable for *T. scordium* at Kingfishers Bridge were well established by 2004:

- A 7.0 ha shallow lake of permanent water with eleven islands. In the summer there is considerable draw-down which exposes a sparsely vegetated shoreline;
- A 9.4 ha reed-swamp with pools of shallow water and stands of other marsh vegetation (the pools are subject to draw-down in summer);
- Seasonally flooded wet grassland in three areas which have shallow pools that remain well into the spring and which are grazed by sheep and wildfowl;

- Highly calcareous margins of two water-filled ditches;
- Two quarries specially excavated in Corallian limestone to provide nest-sites for Sand Martins (*Riparia riparia*) and Common Kingfishers (*Alcedo atthis*). Each quarry has a pool of clear water at the base of the excavated face.

RECORDING METHODS FOR *TEUCRIUM SCORDIUM*

As the species is a stoloniferous perennial, counting plants is impracticable, except for young ones occurring at a low density on bare ground. Following Holyoak (1998), counts of basal shoots made in late August or September were found to be a repeatable methodology allowing comparison of populations at different sites (Table 1). Mean shoot density per square metre was calculated by counting shoots in five 20 × 20 cm quadrats (sub-samples) nested within a 2 × 2 m quadrat. (Table 2). In all but the North Pit (indigenous population) and the Big Ditch (introduced) five 2 × 2 m quadrat samples were taken. The total shoot count was calculated either by counting shoots over the entire habitat (as in most instances) or where densities were particularly high over a sizeable area (as on the Winter Flood) by extrapolation from the mean density /m² × measured area.

The quadrat samples were also used to obtain cover/abundance estimates on a Domin scale for *Teucrium scordium* and associated plant species. Those species occurring in four or more of the sample quadrats in a habitat were treated as constants. One measurement of vegetation height was taken in each of the nested 20 × 20 cm sub-samples within the quadrats (Table 2). Distance from the nearest surface water was also measured as was the depth of 'soft' substrate (*i.e.* penetrable by a narrow pole). Each quadrat was located to a 10 figure grid reference by GPS.

POPULATION AND DISTRIBUTION OF WATER GERMANDER AT KINGFISHERS BRIDGE

A) INDIGENOUS POPULATION

T. scordium has long been known in the North Pit (often referred to as being at Upware though 2.5 km north of the village) at TL54367333. The population has been monitored irregularly in terms of percentage cover, but systematic recording (shoot counts) began in 1997 when R. Beecroft recorded 330 shoots. Cutting the Reed and other vegetation

over all the area occupied by *T. scordium* resulted in an increase to 1200 shoots in 2000. Since then, vegetation cover has increased once more and water levels in the pit have risen. The shoot count diminished to 214 in 2004 and just 35 in 2006. The introduction in 1998 of a few propagated plants to a slightly different area within the pit had failed by 2004 (Table 1).

B) PROPAGATION

Cuttings from growing shoots were initially taken from the North Pit SSSI in 1997. Cuttings rooted easily with a success rate of almost 100%. The first batch of propagated plants was used as stock to provide more cuttings. Since there was no evident advantage from rooting in water first, subsequent cuttings were placed in compost from the outset. Propagation appeared to be a straightforward process and, once rooted, plants were kept in pots for about a year before being planted out.

C) PLANTING OUT

Initially 238 propagated plants were introduced to nine sites within the Kingfishers Bridge Wetland Creation Project area on 4th August 1998. Further introductions of propagated plants were made in 1999 (224 plants), 2000 (1060 plants) and 2003 (323 plants) – Table 1. The locations were chosen to give a range of hydrological conditions in an attempt to compare survival under different water regimes. Since it was difficult to identify individual plants once established, progress was measured by counting shoots in August and September.

D) INTRODUCTIONS

The propagated plants from North Pit stock were introduced to the Kingfishers Bridge Wetland Creation Project area as follows: the Fen, TL545738 (three sites); the Reedbed TL545739 (two sites); the south shore of the Lake TL540737 (two sites); the Winter Flood, TL541737 (one site) and two ditch banks, TL544736 and TL547733. A total of 1845 plants were introduced between 1998 and 2003. From 310 shoots on plants introduced in 1998, the count rose to 5950 by 2001, 20,578 by 2002 and in 2004 the number of shoots had soared to an estimated 181,000. The most marked increases were on the Winter Flood (from 165 shoots in 2000 to an estimated 135,000 in 2004) and the Lake, where plants had spread to all the shores and the seven islands (86 shoots in 2000 to 41,014 in 2004 including 11,060 on the islands). *T. scordium* has flourished and spread to a lesser degree on the banks of the two ditches (at one of them, 119 shoots in 2000 to 3595 in 2004). In the Fen

and Reedbed, however, there was an increase up to 2002 but a subsequent marked decrease associated with development of a tall and dense reedbed that has invaded the Fen (Table 1).

An introduction was made in 2000 to the adjacent winter-flooded Dimmock's Cote Washes TL541727 (Cam Washes S.S.S.I.) following slubbing out of the channel and creation of open ground, in order to test establishment under a differing water-regime. The shoot count increased from 599 that year to 1294 in 2001, but by the following year few plants had survived and none was seen in 2004 (Table 1). It appears that the plants had failed to compete with robust Reed Sweet-grass *Glyceria maxima*. This site also lacks the summer draw-down present in Kingfishers Bridge.

HISTORY OF THE POPULATION AT BASSENHALLY PIT (WHITTLESEY)

In 1967 a small population (ca 20 plants) of *T. scordium* was found at Bassenhally Pit on bare mud by a path across a ditch (Crompton 2006). Following its disappearance by 1970, propagated plants from Bassenhally stock were reintroduced to the same location in 1973 by S. M. Walters, R. M. Payne and JOM. The population survived until at least 1975 but became increasingly etiolated and rarely if ever flowered (Crompton 2006; JOM records) it was not subsequently observed. This failure appeared to be due to the particular path having been abandoned and Hawthorn (*Crataegus monogyna*) scrub having grown up to shade the pit margin. By 1980 the original location appeared entirely unfavourable to Water Germander. A second introduction, this time from North Pit stock, was made in 1999 to a nearby herb-rich largely scrub-free fen, TL286987, known as the Central Depression (Langton 1970). Here where there are patches of relatively short vegetation, Water Germander had done well, and the count of 41 shoots introduced in 1999 had increased to 1683 by 2004 (Table 1).

HABITAT

I. KINGFISHERS BRIDGE AND UPWARE NORTH PIT

a) North Pit

The flooded North Pit, a long abandoned Corallian limestone quarry, supports the indigenous *T. scordium* population, which has been declining since 2000, possibly as a result of shading by taller vegetation and scrub that has invaded the pit, and variation in water quality and depth.

The vegetation of two 2 × 2 m quadrats in which *T. scordium* grows has been surveyed annually 1997–2004 with the exception of 2003. The NVC community of the site is Reed swamp (S4: Rodwell 1991–2000), and specifically the Marsh Bedstraw (*Galium palustre*) sub-community (S4b). Constants throughout the period have been *Phragmites australis*, *Galium palustre*, Great Pond Sedge (*Carex riparia*), Great Reedmace (*Typha latifolia*), Lesser Duckweed (*Lemna minor*) and the moss *Drepanocladus aduncus*. Lesser Water-parsnip (*Berula erecta*) and Great Water Dock (*Rumex hydrolapathum*) were constants in most years. Comparison with a survey made in 1989 (JOM and G. Crompton) suggests that Ivy-leaved Duckweed (*Lemna trisulca*) and Bittersweet (*Solanum dulcamara*) have both declined, the former markedly so. The overhanging scrub is composed mainly of Grey Sallow (*Salix cinerea*), Hawthorn (*Crataegus monogyna*) and Guelder-Rose (*Viburnum opulus*). In 2004 the reed stems were ‘spindly’ and growing at a rather low density, with a mean height of 177.0 ± 30.9 cm. The Reed swamp was floating and at the site where *T. scordium* was growing the water depth at the surface was 5–10 cm with 30–40 cm of silt below. *T. scordium* did not extend into the wetter and increasingly quaking swamp in the centre of the pit.

b) Reedbed and Fen

The Reedbed was established from what had been peaty arable land in 1997. *T. scordium* was introduced into the young reedbed first in 1998 and again in 2000. By 2004, a dense S4 reed-swamp had developed with *Phragmites* of an average height (in September 2004) of 231.3 cm ($n = 15$). There was little other vegetation in the reedbed apart from *T. scordium*, which struggled to compete. Etiolated plants of *T. scordium* reached 180 cm in height, but had few if any flowers.

The Reedbed bordered a shallow lagoon, which by the end of the summer had an extensive draw-down zone of peaty mud colonised by Water Mint (*Mentha aquatica*), Amphibious Bistort (*Persicaria amphibia*), Creeping Bent (*Agrostis stolonifera*) and the moss *Drepanocladus aduncus* as well as sparse *Phragmites*. In 2004 *T. scordium* was flourishing in this open draw-down area between the reedbed and lagoon. The mean density there was 308 ± 240 shoots/m² compared with 192 ± 116 shoots/m² in the

dense reedbed. Virtually all the Reedbed apart from embankments is submerged in shallow water over the winter. The Fen, on somewhat higher ground, had a vegetation community that was probably best described as S26 tall herb fen *Phragmites australis*–*Urtica dioica* (Rodwell 1991–2000). Much of it has however converted to reed-swamp.

c) Winter Flood

This is an area of grassland bordering the Lake. Its depressions are shallowly flooded for much of the winter and spring. With a depth of only 5 cm of peat above the clay substrate, drainage was poor. In the northeast sector where *T. scordium* was particularly abundant, the constant plant species (forming over 50% cover in each sample) were *Persicaria amphibia*, *Mentha aquatica*, Whorled Mint (*Mentha x verticillata*), Gypsywort (*Lycopus europaeus*), Scentless Mayweed (*Tripleurospermum inodorum*), Great Plantain (*Plantago major*) and *Agrostis stolonifera*. Over an area of 0.13 ha *T. scordium* was one of the dominant species with an average density of 564 ± 557 shoots/m². However, where *Mentha aquatica* formed the predominant vegetation, *T. scordium* was sparse.

Further from the Lake, 150 m south of the main population, *T. scordium* was growing around depressions in the grassland that were permanently inundated between November and April/May, but only intermittently flooded by rain water at other times. Here the constants were *Agrostis stolonifera*, Common Spike-rush (*Eleocharis palustris*), Jointed Rush (*Juncus articulatus*) and *Plantago major*. The density of *T. scordium* was 52 ± 95 shoots/m², less than a tenth of that of the main population.

Such vegetation is not unequivocally classified in the NVC, but shows some allegiance to various kinds of regularly inundated grasslands within the alliance *Elymo-Rumicion crispis* e.g. MG11 *Festuca rubra*–*Agrostis stolonifera*–*Potentilla anserina* grassland, MG13 *Agrostis stolonifera*–*Alopecurus geniculatus* grassland and OV28 *Agrostis stolonifera*–*Ranunculus repens* community (Rodwell 1991–2000).

d) The Lake

At its full extent there are 7 ha of water with eleven islands, some of which are submerged in winter. In summer a considerable area of peat and clay is exposed on the Lake shore and around the islands by draw-down. Such areas,

including all the islands, have been extensively colonised by *T. scordium*. The main constants in the draw-down zone on the south shore were *Mentha aquatica*, Redshank (*Persicaria maculosa*), Hemp Agrimony (*Eupatorium cannabinum*), Brookweed (*Samolus valerandi*), Toad Rush (*Juncus bufonius*) and *Lycopus europaeus*. A number of annuals such as Red Goosefoot (*Chenopodium rubrum*) and Golden Dock (*Rumex maritimus*) were frequent. The average density of *T. scordium* was 45 ± 95 shoots/m² ($n = 25$), with 50–90% of the draw-down zone still bare peat. Many of the plants had only become established for a year or two.

At the winter/spring high water mark on the southern shore of the lake there was a 2 m wide drift line. This was totally vegetated, predominantly by *Lycopus europaeus*, *Mentha aquatica*, *Eupatorium cannabinum*, *Agrostis stolonifera*, *Persicaria amphibia*, *Samolus valerandi* and such annuals as *Persicaria maculosa* and Trifid Bur-marigold (*Bidens tripartita*). *T. scordium* here attained a mean density of 149 ± 99 shoots/m² ($n = 25$).

e) Ditches

T. scordium was introduced at two sites on the margins of ditches (Big Ditch and Contour Ditch). Here the substrate was highly calcareous clay. Where *Teucrium* was growing, the constants were *Agrostis stolonifera*, *Samolus valerandi*, *Plantago major* and *Eleocharis palustris*. The vegetation height in the sample plots varied between 11.4 cm and 78.8 cm ($n = 7$). The *T. scordium* density was highly variable ranging from 35 to 520 shoots/m² ($n = 7$).

II. BASSENHALLY PIT

Here the *T. scordium* occupied two distinct vegetation communities when surveyed in 2004. Where it had been reintroduced in 1999, *Agrostis stolonifera*, Brown Sedge (*Carex disticha*), Slender Spike-rush (*Eleocharis uniglumis*), *Galium palustre* and the moss *Drepanocladus aduncus* were dominant and the community was again best placed within the *Elymo-Rumicion crispis*. The presence in the site of *Eleocharis uniglumis*, *Juncus gerardii* and, in the second vegetation community, *Schoenoplectus tabernaemontani* suggested some brackish influence, and relationship to **SM20** *Eleocharis uniglumis* saltmarsh (Rodwell 1991–2000). The physiognomy of the vegetation has some resemblance to a dune-slack, and some areas resembled **SD17**

Potentilla anserina-*Carex nigra* dune-slack, another component of the *Elymo-Rumicion crispis* alliance that is normally coastal in the UK (Rodwell 1991–2000). 329 shoots of *T. scordium* were counted in this zone.

T. scordium had also spread into taller vegetation in which Slender Tufted-sedge (*Carex acuta*) was predominant and included such species as Marsh Pennywort (*Hydrocotyle vulgaris*) and Grey Club-rush (*Schoenoplectus tabernaemontani*). Eighty percent of the population of *T. scordium* (1683 shoots) occupied this community which may prove to be a variant of **S6** *Carex riparia* swamp (Rodwell 1991–2000). The mean shoot height of *T. scordium* at Bassenhally was 38.7 ± 19.4 cm, while that of the surrounding vegetation was 49.4 ± 29.2 cm. The Central Depression at Bassenhally Pit is the most important part of a site with many species typical of herb-rich fen, including some locally scarce plants such as Great Water-parsnip (*Sium latifolium*), Marsh Speedwell (*Veronica scutellata*), Lesser Waterplantain (*Baldellia ranunculoides*), as well as *Eleocharis uniglumis*.

REPRODUCTION AND SPREAD: KINGFISHERS BRIDGE

T. scordium flowered prolifically in the more open areas at Kingfishers Bridge (Lake Shore, Winter Flood, the draw-down zone at the edge of the Reedbed and ditch margins). In the dense reedbed and in the North Pit where plants were shaded, flowering was largely suppressed. Many plants that had flowered on the Winter Flood were examined on 12 October 2004 – though abundant seed had been set with two to four nutlets per calyx, very few seeds had ripened by that date. At the time of the survey in mid-September 2004, there was little evidence of reproduction from seed, even on the bare peat of the Lake shore.

Most reproduction, at least at Kingfishers Bridge, appears to be vegetative from stolons that are produced in late summer and autumn. They differ from the erect flowering shoots in extending horizontally from the plant and are thickened, suggesting a storage function. In winter, stolon segments get detached from the parent plants e.g. by trampling and grazing by wildfowl – particularly Greylag Geese (*Anser anser*) and Canada Geese (*Branta canadensis*). Though sheep may trample and fragment *T. scordium* by trampling, they appear not to eat it, possibly because of its garlic-like odour¹.

¹Both German vernacular names (Knoblauch-Gamaner and Lauch-Gamander) and the specific epithet *scordium* itself refer to garlic or leek.

Stolon fragments have been seen floating in flood water, even under ice. *T. scordium* had spread naturally from the original planting of 50 plants on the south central shore of the lake in 1998 right round the margin and to all eleven islands by 2004. In addition, a new colony appeared naturally on the east side of the Big Ditch opposite a planting on the west bank, 15 m across the water. On the Winter Flood even low raised banks 20–30 cm high have withheld the flow of winter flood water across the area and this has apparently limited the spread of *T. scordium* westward and southward. However, by 2005, plants had become established on a nearby, but discrete, winter-spring flooded area, in the Wader Meadow. This colonisation probably originated as a result of water being pumped onto the site from the Lake. By September 2006, there had been a further massive increase in the *T. scordium* cover, both around the Lake and on the sheep – and goose-grazed Winter Flood, where over an area of 0.58 ha it was dominant almost to the exclusion of other plants.

PRELIMINARY CONCLUSIONS ON THE ECOLOGY OF WATER GERMANDER IN CAMBRIDGESHIRE

The introduction of *T. scordium* has revealed or confirmed certain aspects in the ecology of the species (Hill *et al.* 1999):

- it flourishes in calcareous substrate – clays and peat (and calcareous sand in North Devon dunes) – the Ellenberg **R** indicator value is 8 i.e. moderately basic;
- it requires damp conditions and tolerates long periods of submergence in winter but quaking swamp conditions through the summer are detrimental – the Ellenberg **F** indicator value is 8 i.e. sites that are damp to seasonally wet;
- flowering is suppressed by shading, and though shoots become etiolated it appears that perennial plants are eventually out-competed by tall dense vegetation (such as Reed and scrub) and fail to reproduce vegetatively – the Ellenberg **L** indicator value is 7 i.e. preferring well-lit places, but will survive for a while in partial shade;
- the main form of reproduction in the studied sites is vegetative by stolons, which when detached can be dispersed widely by water;
- low banks that inhibit the flow of water can act as barriers to vegetative dispersal;
- optimal conditions for colonisation are the sparsely vegetated sites that are exposed on the margins of water bodies by summer draw-down.

ECOLOGY OF *TEUCRIUM SCORDIUM* IN NORTH DEVON

Most of the colonies of Water Germander in North Devon are in dune slacks that have, at least until recently, been regularly inundated by a water-table rise in winter. Inundation may continue well into the spring. Two of the sites were margins of artificial ponds. The large colonies were on predominantly level ground. The substrate on which *Teucrium* was growing was calcareous sand that was fairly humic (Holyoak 1998). Holyoak emphasised that Water Germander on the Burrows was associated with short vegetation, much of it less than 5 cm, and grew sparsely where vegetation exceeded 15 cm. It colonised temporarily disturbed ground after the excavation of ponds, and could tolerate some vehicle pressure leading to ruts. The short vegetation was being maintained by rabbit grazing and the poor nutrient status of the soil, together with winter flooding and near-drought conditions in summer.

A large number of plant species were associated with Water Germander in the Devon dune slacks. Most constant associates were *Agrostis stolonifera*, Bog Pimpernel (*Anagallis tenella*), Marsh Helleborine (*Epipactis palustris*), *Hydrocotyle vulgaris*, Sharp Rush (*Juncus acutus*), Sea Rush (*Juncus maritimus*), *Mentha aquatica*, Silverweed (*Potentilla anserina*), Common Fleabane (*Pulicaria dysenterica*) Creeping Willow (*Salix repens*) and the moss *Drepanocladus aduncus* (Holyoak 1998; unpublished data JOM). Such vegetation again approaches NVC communities of the *Elymo-Rumicion crispi* such as **MG11** and **SD17**, as well as other dune-slack types that are either more fenney *e.g.* **SD15** *Salix repens*–*Calliargon cuspidatum* or more scrub-dominated *e.g.* **SD16** *Salix repens*–*Holcus lanatus* (Rodwell 1991–2000).

Features similar to the Kingfishers Bridge site were:

- winter-spring flooding and tolerance of inundation;
- calcareous substrate with some shallow humic soil;
- short vegetation;

- colonisation of temporary disturbed ground; and
- frequent associated plants in all the Devon and Cambridgeshire sites were *Agrostis stolonifera*, *Mentha aquatica* and *Drepanocladus aduncus*. *Hydrocotyle vulgaris* occurred at Bassenhally and in the Devon slacks.

Major differences were:

- Braunton Burrows and, to a lesser extent, Northam Burrows are essentially natural; the Kingfishers Bridge wetland is recently created, even where the indigenous population of *T. scordium* still occurs is a disused quarry. Bassenhally Pit also is artificial, though like the North Pit, it has been abandoned for many decades;
- in Devon the main habitat is dune slack (to which the Bassenhally site bears some resemblance); at Kingfishers Bridge the species has flourished in the draw-down zone around a lake, reedbed lagoons and seasonally flooded grassland resulting from lowering water-table in summer;
- the substrate in Devon is humic sand; at the Fenland sites it is clay with some peat;
- on the Burrows species frequently associated with *T. scordium* included *Epipactis palustris*, *Potentilla anserina*, *Pulicaria dysenterica* and *Salix repens*, all of which were absent from sites where Water Germander occurred at Kingfishers Bridge. There *Persicaria amphibia*, *Lycopus europaeus*, *Plantago major* and *Samolus valerandi* were among the most frequent associates. A mixture of *Carex* species and subarctic *Cyperaceae* were especially common at Bassenhally;
- the areas where *T. scordium* still flourished at Braunton and Northam were heavily grazed by rabbits, which also browsed the margins of the Bassenhally site, while those at Kingfishers Bridge were grazed by sheep and feral geese.

REASONS FOR THE DECLINE IN THE UK

It should be acknowledged that, as a species of early successional habitats, *T. scordium* may always have been transient in individual sites, but able to maintain itself in a complex of sites within a region since, as one site became overgrown, suitable conditions developed elsewhere nearby. Insofar as the available literature

can be used to reconstruct its distribution through the past 250 years, there is evidence that *T. scordium* indeed survived for many decades in particular regions, though "monitoring data" for particular populations were only gathered from the latter part of the 20th century onward.

The main reasons for the disappearance of Water Germander from most of its British sites were probably drainage and land claim. However, within those sites that survived into the modern era, it appears that competition and shading from tall wetland vegetation are the main factors in its decline (Perring *et al.* 1964). Thus at Stallode Wash at Lakenheath, its demise was almost certainly as a result of being unable to compete with tall vigorous *Phragmites australis* (Wigginton 1999). Indeed surveys made of the former Lakenheath site in the 1990s showed almost 100% cover of dense Reed, with canes reaching >2.5 m tall (JOM unpublished data). Its decline and lack of vigour at North Pit, Upware appears to be due to shading by scrub, though higher water levels may have contributed leading to extensive quaking swamp. Poorer water quality may also be a factor, with turbid water during winter floods preventing growth – witness the contemporary decline of *Lemna trisulca* at Upware. The fact that the indigenous population at Bassenhally Pit died out and that the first reintroduction was unsuccessful was almost certainly also due to scrub encroachment and the end of light trampling at that particular location within the pit. Both in Britain and Ireland, the most vigorous *T. scordium* populations have occurred where there is light disturbance, through trampling, peat cutting or regular draw-down. In the Reedbed at Kingfishers Bridge *T. scordium* still survives, but is unlikely to persist for long in the dense vegetation. The failure of the introduction at Dimmock's Cote is also linked to a highly competitive grass (*Glyceria maxima*).

At Braunton Burrows the decline is attributable to a falling water table and scrub encroachment in the dune slacks. Holyoak (1998) states that the vegetation had grown markedly taller between the 1982 and 1998 surveys. At a few sites where Water Germander was still flourishing the vegetation was kept short by rabbit grazing. Remedial conservation action at Braunton in 1998 has met with early success, and by 2004 *T. scordium* had re-appeared in seven of the eight dune-slacks where the surface has been

mechanically scraped (J. Diamond, pers. comm.). This recovery appears to be due both to reduced competition from *Salix repens*, *Juncus acutus* etc., and also to bringing the sand surface where *T. scordium* is rooted closer to the underlying water-table.

Attention must also focus on the regeneration niche for *T. scordium*, and whether the species reproduces primarily from seed, or vegetatively. Data on seed productivity and viability come from collections of *T. scordium* held in the Royal Botanic Gardens Kew's Millennium Seed Bank at Wakehurst Place. From this source it is clear that *T. scordium* may produce very little viable seed in the wild, with collections from British populations varying from a maximum of 40 viable seeds per plant (i.e. 40 plants producing around 1600 seeds) to as little as 1 viable seed per plant (i.e. 12 plants producing an overall total of just 12 viable seeds). When wild material is grown on in horticultural conditions, productivity may be much higher, with the total seed-output of 40 plants varying from 1350 to ca 51000 seeds. A very small trial conducted within the present study is consistent with these results. Seeds collected from North Pit were sown to check viability, and only one seed germinated from twelve sown in March onto saturated compost and kept in a poly-tunnel. Taken together these observations strongly suggest that vegetative reproduction will be more important than establishment from seed in wild British populations; and may provide further explanation of why *T. scordium* has not re-established when previous sites have been subject to apparently suitable restoration management.

THE CAMBRIDGESHIRE SITES IN A EUROPEAN CONTEXT

According to Clapham *et al.* (1987), *T. scordium* is confined to a) Europe from Sweden, notably Öland and Gotland (Hultén 1950) and Estonia southwards and b) to West Siberia and the Aral-Caspian region. Hultén and Fries (1986) essentially confirm this distribution, showing it to be uncommon throughout its range but with concentrations locally in Germany, the Caucasus and former Yugoslavia. Hultén and Fries also suggest that *T. scordium* subsp. *scordioides* is largely confined to the Mediterranean zone, the Black Sea and Caucasus and the Aral-Caspian, although other sources (e.g. McClintock 1975) indicate that this subspecies is found as far

north as the English Channel. The southern limits of its native distribution appear to be in Morocco (seemingly absent elsewhere in Africa), Malta (where it is endangered) Lebanon, Israel, northern Iran and Uzbekistan. Recent national distribution maps for countries in Central Europe indicate that *T. scordium* is most commonly associated with the floodplains of major rivers, and there is a suggestion that it has declined sharply in the former Federal Republic of Germany and Switzerland, whilst remaining locally frequent in the former Democratic Republic (Haeupler & Schönfelder 1989; Lauber & Wagner 2002; Benkert *et al.* 1998). Elsewhere in central and northern Europe, *T. scordium* is threatened in the Czech Republic, and endangered in both Latvia and Lithuania.

Though in Britain, *T. scordium* is at the edge of its distribution in Europe, some insight into its ecological requirements and causes of decline can be inferred from its behaviour elsewhere. In Ireland and the Netherlands, it is a typical species of the phytosociological alliance *Elymo-Rumicion crispae* (Nordhagen 1940), occurring in flooded swards (Westhoff & den Held 1969; White & Doyle 1982). Such vegetation is typical of seasonally inundated situations (including dune-slacks, lake banks and depressions where rain-water collects) with a marked summer to autumn draw-down leaving expanses of moist habitat with relatively low cover, and hence little competition. Although widespread in Europe, typically such vegetation occurs in more humid climates and where the site is liable to disturbance or intensive grazing, suppressing shade and maintaining open soil areas. The *Elymo-Rumicion* is classified by EUNIS/CORINE as **37*24** Flood Swards and Related Communities. *Agrostis stolonifera* is the characteristic grass in such communities (Ellenberg 1988). Examination of the **SOPHY** data base shows that in France *T. scordium* is mostly lowland or coastal and that amongst its usual associates (or species with markedly similar ecological requirements) are: *Eleocharis palustris*, Purple Loosestrife (*Lythrum salicaria*), *Mentha aquatica*, *Persicaria amphibia*, *Potentilla anserina* and *Sium latifolium*. Several of these are important species in the Cambridgeshire sites for *T. scordium*. Interestingly, two other species cited by **SOPHY** as having a similar ecology to *T. scordium* are Ribbon-leaved Water-plantain (*Alisma gramineum*) and Fen Ragwort (*Senecio*

paludosus), both extremely rare in Britain, typical of draw-down habitats, and with all or most of their recent sites within the Fenland basin.

Within central Europe, *T. scordium* apparently occurs in more closed fen habitats dominated by large sedges (*Magnocaricion*) or in fen-meadows of the *Molinietalia* (Oberdorfer 1977–1983). Both these vegetation groups are often associated with the *Elymo-Rumicion* at the same sites i.e. the large sedge communities occurring where disturbance/grazing is reduced and the fen-meadow where flooding is less prolonged and regular, and where mowing is often combined with grazing to suppress shrub-encroachment.

Further south in Europe, *T. s. scordium* is often replaced by *T. s. scordioides*, though both subspecies occur in România and France, for example. Within this region, Water Germander is still largely confined to seasonally wet habitats, often on somewhat calcareous sands in the coastal zone e.g. in Greece and România (JOM unpublished data). Many of the associated species in such habitats are once again draw-down specialists, including several that are extremely rare in the UK e.g. Brown Galingale (*Cyperus fuscus*) and Jersey Cudweed (*Gnaphalium luteo-album*), as well as widespread species like *Samolus valerandi* and dominant *Agrostis stolonifera*. In some sites near its southern limit of distribution, *T. s. scordioides* is found in more closed vegetation e.g. Mediterranean tall humid grasslands of the *Molinio-Holoschoenion*.

CONSERVATION OF *TEUCRIUM SCORDIUM* IN BRITAIN

When the success of the Kingfishers Bridge project is assessed in the context of what is known of the ecology of Water Germander, it is clear that the Fenland sites where *T. scordium* survived into the 20th century were in many respects becoming unsuitable. The evidence from the literature is that these habitats were suitable until possibly the middle of the century, when the reduced disturbance and grazing of wetlands, coupled to drainage and regulation of water-levels resulted in the relict sites becoming overgrown with shrubs and tall reeds (Crompton 2006; Perring *et al.* 1964). What evidence can be marshalled from the Devon sites suggests that falling water-tables and scrub encroachment were again major factors. Those healthy populations of this species observed by JOM in Ireland and

mainland Europe are frequently in early successional habitats that share natural summer draw-down with low competition, often facilitated by grazing in lowland calcareous situations.

It is apparent that the managers at Kingfishers Bridge have produced precisely these conditions in the early years of the wetland creation project. The continued success of the *T. scordium* introduction scheme at Kingfishers Bridge requires that these conditions be maintained through periodically renewed disturbance. Changes in *T. scordium* abundance in the reed swamp at Kingfishers Bridge and recent history at Bassenhally and Braunton strongly suggests that intervention is necessary to prevent succession eliminating suitable conditions. So long as *T. scordium* and similar draw-down specialists are confined to a few British sites, some interventionist management may be the only way to assure their survival, though the Kingfishers Bridge project offers the possibility of engineering new sites and introduction of propagules as a practical means to widely disperse these plants through the landscape. However, creation of several large restored wetlands in proximity to one another offers a more sustainable future. Kingfishers Bridge forms part of a new network of wetlands in Fenland that should be sufficiently large and intrinsically diverse for natural ecosystem processes to ensure that early successional stages are always represented somewhere within a dynamic range of habitats.

There is evidence that *T. scordium* occurs in rather different habitats in different parts of its range, possibly reflecting genetic differences. Biometric studies of the British and Irish populations, similar to those conducted by Toussaint *et al.* (2005), might help tailor management prescriptions to the needs of the local populations. There is concern that both the re-introduced Cambridgeshire populations derived from vegetative propagation will have low genetic diversity. Further research is thus required on the relative contributions of sexual and vegetative reproduction (including seed dormancy) in British, Irish and Continental populations of *T. scordium*, and the precise conditions required for seed germination and seedling establishment. However, results from the Millennium Seed Bank (R.B.G. Kew at Wakehurst Place) suggest that establishment from seed is much less important than vegetative reproduction in Britain. Evidence

from site management in the 1990s at both North Pit (Upware) and Bassenhally suggests that *T. scordium* does not reappear from dormant seed if suitable conditions for its growth are re-established. Our work with *T. scordium* together with the 6 wetland restoration schemes in Fenland offers realistic hope for building a sustainable mosaic of wetland habitats in Fenland, but still leaves some questions unanswered.

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REFERENCES

- BABINGTON, C. C. (1860). *Flora of Cambridgeshire*. J van Voorst, London.
- BEECROFT, R. (1999). *Population recovery of Teucrium scordium at Upware Pit SSSI*. Unpubl. rpt. For the Kingfishers Bridge Wetland Creation Project and English Nature. Wildlife and Countryside Services, Creeting St Mary, Suffolk.
- BENKERT, D., FUKAREK, F. & KORSCH, H. (1998). *Verbreitungsatlas der Farn- und Blütenpflanzen Ostdeutschlands*. Gustav Fischer, Stuttgart.
- CHEFFINGS, C. M. & FARRELL, L. eds (2005). *Species Status: No. 7 – the Vascular Plant Red Data List for Great Britain*. JNCC, Peterborough.
- CLAPHAM, A. R., TUTIN, T. G. & MOORE, D. M. (1987). *Flora of the British Isles*. Cambridge University Press, Cambridge.
- COLSTON, A. (2003). Beyond preservation: the challenge of ecological restoration. In *Decolonising Nature: strategies for conservation in a post-colonial era*. (ed. W. M. Adams and M. Mulligan) London: Earthscan. pp 247–267
- CROMPTON, G. (2006). *Catalogue of Cambridgeshire Flora Records since 1538*. Published on the Internet at www.Cambridgeshireflora.com
- ELLENBERG, H. (1988). *Vegetation Ecology of Central Europe: 4th edition*. Cambridge University Press, Cambridge
- GIBBONS, E. J. (1975). *The Flora of Lincolnshire*. Lincolnshire Naturalists Union, Lincoln.
- HAEUPLER, H. & SCHÖNFELDER, P. (1989). *Atlas der Farn- und Blütenpflanzen der Bundesrepublik Deutschland*. Verlag Eugen Ulmer.
- HILL, M. O., MOUNTFORD, J. O., ROY, D. B. & BUNCE, R. G. H. (1999). *Ellenberg's indicator values for British Plants*. ECOFACT Volume 2. Technical Annex Published for DETR by Institute of Terrestrial Ecology.
- HOLYOAK, D. T. (1998). *Rare Plant Surveys at Branton Burrows: Water Germander (Teucrium scordium) and Petalwort (Petalophyllum ralfsii)*. Unpubl. rept. to English Nature. (Contract F14-01-627).
- HUGHES, F. M. R., COLSTON, A. AND MOUNTFORD, J. O. (2005). Restoring Riparian Ecosystems: The Challenge of Accommodating Variability and Designing Restoration Trajectories. *Ecology and Society* **10** (1): 12.
- HULTÉN, E. (1950). *Atlas of the distribution of vascular plants in NW Europe*. Generalstabens Litografiska Anstalts Förlag, Stockholm.

- HULTÉN, E. and FRIES, M. (1986). *Atlas of North European vascular plants*. Koeltz, Königstein.
- IVIMEY-COOK, R. B. (1984). *Atlas of the Devon Flora*. The Devonshire Association for the Advancement of Science, Literature and Art, Exeter.
- LANGTON, P. H. (1970). *Bassenhally Pits Nature Reserve, Whittlesey*. Cambridgeshire and Isle of Ely Naturalists' Trust.
- LAUBER, K. & WAGNER, G. (2001). *Flora Helvetica*. Verlag Paul Haupt, Bern.
- MARTIN, W. K. & FRASER, G. T. (1939). *Flora of Devon*. Buncle & Co., Arbroath.
- MCCLINTOCK, D. (1975). *The Wild Flowers of Guernsey*. Collins, London.
- MOUNTFORD, J. O. & WADSWORTH, R. A. (2002). Looking forward to wilderness. *Planet Earth*, (winter issue) pp 2–4.
- OBERDORFFER, E. (1977, 1978, 1983). *Süddeutsche Pflanzengesellschaften. Parts I–III*. Gustav Fischer, Stuttgart.
- PALMER, M. G. (1946). *The fauna and flora of the Ilfracombe district of north Devon*. Townsend, Exeter.
- PERRING, F. H. & WALTERS, S. M. (1962). *Atlas of the British Flora*. Nelson, London.
- PERRING, F. H. SELL, P. D., WALTERS, S. M. & WHITEHOUSE, H. L. K. (1964). *A Flora of Cambridgeshire*. Cambridge University Press: Cambridge.
- POLWHELE, R. (1797). *History of Devonshire*. (Cited by Martin & Fraser 1939).
- PRAEGER, R. L. (1934). *The Botanist in Ireland*. Hodges, Figgis & Co., Dublin.
- PRESTON, C. D., PEARMAN, D. A. & DINES, T. D. (2002). *New Atlas of the British & Irish Flora* Oxford University Press, Oxford.
- RODWELL, J. S. (1991–2000). *British Plant Communities* (5 volumes). Cambridge University Press, Cambridge.
- RUTTERFORD, M. G. (1977). Water Germander *Teucrium scordium*. *Suffolk Natural History* **17**: 218–219.
- SHEAIL, J., TREWEEK, J. R. & MOUNTFORD, J. O. (1997). The UK transition from nature preservation to “creative conservation”. *Environmental Conservation* **24**: 224–235.
- SIMPSON, F. W. (1982). *Simpson's Flora of Suffolk*. Suffolk Naturalists' Society, Ipswich.
- TOMKINS, S. (1998). *The Kingfishers Bridge Wetland Creation Project: a report from the projects inception to autumn 1996*. *Nature in Cambridgeshire* **40**: 37–52.
- TOUSSAINT, B., DESTINÉ, B. & HENDOUX, F. (2005). Status of *Teucrium scordium* L. (Water Germander) in N. W. France, in S. J. LEACH, C. N. PAGE, Y. PEYTOUREAU & M. N. SANFORD, M. N. eds *Botanical Links in the Atlantic Arc*, pp. 261–268. Botanical Society of the British Isles, London.
- TUCKER, W. (1978). Botanical Records. *Transactions of the Devonshire Association* **110**: 204.
- VAUSE, S. J. (1982). Unpubl. dissertation for B. Sc. University of Bristol (cited in Holyoak 1998).
- WEBB, D. A. (1977 – 6th edition). *An Irish Flora*. Dundalk.
- WESTHOFF, V. & den HELD, A. J. (1969). *Plantengemeenschappen in Nederland*. Zutphen: Thieme.
- WHITE, J. & DOYLE, G. (1982). The vegetation of Ireland: a catalogue raisonné. *Royal Dublin Society Journal of Life Sciences*, **3**: 289–368.
- WIGGINTON, M. J. (1999) *British Red Data Books 1 Vascular plants* (3rd edition). Joint Nature Conservation Committee, Peterborough.

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The *Eleocharis mamillata* H. Lindb. fil. aggregate (Cyperaceae) in the British Isles

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ABSTRACT

We analysed stylopodium characters, perianth bristle number, vascular bundle number, stomatal length and fruit density for 50 stems of *Eleocharis mamillata* agg. throughout its British range. Stylopodium shape varies considerably within a spikelet and it is necessary to measure a large sample of fruits to establish an accurate reading. However there is highly significant variation between individuals for stylopodium shape and relative stylopodium width. Variation in these attributes between individuals is continuous. Nine individuals sampled, eight from N.W. Yorks (v.c. 64) and one from Selkirk (v.c. 79), have a stylopodium shape considered typical of subsp. *mamillata*, which has not been previously recorded from the British Isles. However, this material does not correspond to subsp. *mamillata* in any other character. Most individuals from the Borders region (v.cc. 67 and 70) are clearly referable to subsp. *austriaca* (Hayek) Strandhede, but many individuals in N.W. Yorks, and one from Selkirk belong to a distinctive intermediate type which is also distinguished by a high fruit density and vascular bundle number. We hypothesise that these may represent hybrids between previously isolated populations which have been recently transported into water bodies by ducks.

KEYWORDS: stylopodium, vascular bundle, hybrid vigour, Spike-rush.

INTRODUCTION

Eleocharis mamillata H. Lindb. fil. and its close relatives including *E. austriaca* Hayek are distinguished from *E. palustris* (L.) Roemer & Schultes in having fragile stems with an orbicular rather than oval cross-section, fewer vascular bundles, conical flowering heads, and the number of perianth bristles at the base of the fruit usually exceeding four (Walters 1980).

The *E. mamillata* aggregate are plants of a boreal or montane distribution and ecology in Europe, rarely inhabiting the lowland, more eutrophic locations that are typical of *E. palustris*.

E. austriaca was first collected in the British Isles in July 1947 by N.Y. Sandwith in a marshy ox-bow of the infant R. Wharfe below Buckden, Mid-W. Yorks. (v.c. 64) but was not identified until 1960 (Walters 1963). Shortly afterwards, it was discovered in similar habitats by streamsides in montane, usually forested areas, in S. Northumberland (v.c. 67), Cumberland (v.c. 70) (Walters 1963, Swan 1993, Halliday 1997), in Selkirk (v.c. 79) (Corner 1975) and in a number of further localities in the valleys of the R. Wharfe and R. Ribble in v.c. 64 (Roberts 1977). The exact habitats favoured by this species are impermanent since several are artificial water bodies and all are colonised by seral development resulting in conditions which become unsuitable to this primary coloniser. In v.c. 67 at least, the species has become very rare in recent years.

Although it has been traditional to separate *E. austriaca* from *E. mamillata* (Hayek 1910, Hegi 1966, Hess *et al.* 1967, Walters 1980), the two taxa are very similar in general appearance and are clearly closely related to one another. The character by which they are most readily separated is the shape of the stylopodium (the small discrete organ which links the top of the fruit to the style base) which all authors agree is wider than long in *E. mamillata* and longer than wide in *E. austriaca*. The perianth bristle number is said by Hayek to be more commonly six or more in the former species, but five in the latter, although neither Strandhede (1966) nor Walters (1953) confirm this. *E. mamillata*

has also been said by Hayek to have, on average, fewer vascular bundles in the stem (not exceeding 12). These are plants with very few quantifiable characters, so the possibility should be borne in mind that any character that shows variability, however trivial, had been given undue importance. This may be particularly true of stylopodium characters which we have found can vary greatly depending on the position of the fruit in the spike. It has been suggested that *E. austriaca* occurs in mountainous, calcareous areas, and is localised to parts of Norway within Scandinavia, whereas *E. mamillata* is more typical of peaty pools without competing vegetation and is more widespread in Scandinavia, although both species are common in central Europe and the Alps (Strandhede & Dahlgren 1968).

However, Strandhede (1966) recombined *E. austriaca* as *E. mamillata* H. Lindb. fil. subsp. *austriaca* (Hayek) Strandhede and recently he has been followed by others, especially Gregor (2003), who provided considerable biometric support for this treatment; it is evident, therefore, that the correct name for the British plant at specific rank should be *E. mamillata*. All the material that has been examined previously from v.c.c. 67 and 70 had a long and narrow stylopodium and were presumably correctly referred to subsp. *austriaca* (*E. austriaca*). However, fruits from a Yorkshire population in Strandhede (1966; see Fig. 7e) appear to have characters intermediate between *austriaca* and *mamillata* whilst drawings of some fruits in Walters (1963) and Roberts (1977) also led Gregor (2003) to consider plants from northern England to be typical of neither subspecies. Furthermore, some material sent to G. A. Swan (GAS) from Ribblesdale and Wharfedale by F.J. Roberts (FJR) was characterised by a broader and wider stylopodium. At the time GAS considered that this material fell within the limits of subsp. *mamillata*, which had not been recorded from the British Isles. For many years, GAS had been aware that the fruits of the plant drawn by Roberts (1977) differed from those of the plant which he (GAS) named subsp. *austriaca*. However, it was only when A. J. Richards (AJR) sent to GAS a copy of Gregor (2003) that GAS felt compelled to try and clarify the situation and he is grateful to AJR and FJR for catalysing and promoting the (albeit inconclusive) work published here.

MATERIALS AND METHODS

Growth in *E. mamillata* agg. is such that it is impossible to satisfactorily distinguish the limits of clonal individuals in the field. Populations typically have a rather even distribution of shoots that may represent many individuals that overlap one another, or may consist of only one or very few individuals. A total of 50 shoots were examined from 24 populations from various parts of the British range (Table 1). Voucher specimens of these are to be lodged at the Hancock Museum, Newcastle upon Tyne (HAMU). Most populations are represented by only a single specimen, but where more than one specimen was examined, it is not known for certain whether more than one individual was involved, although measurements suggest that this was the case. In order to eliminate bias due to the position of the fruit within the spike, all fruits in a spike were sampled as far as this was possible, and their position in the spike noted. 2300 fruits were analysed in total. Often, some fruits were missing or had dehisced, but it is doubtful if these absences seriously affected the data. In order to count perianth bristle number, fruits need to be mounted in water on a microscope slide but it did not prove possible to accurately count this in some specimens as the bristles on many fruits had been broken or lost.

Dry fruits were measured by means of a calibrated eye-piece scale at $\times 20$ using a Swift dissecting microscope. For each fruit, the following characters were noted:

- Ratio of the length to the maximum width of the stylopodium, known as 'stylopodium shape' (s.s.). (The length of the stylopodium is unambiguous in material which has lost style branches, although the style may not always break in the same position, causing a possible source of inaccuracy; in the few cases where style branches were still intact, the end of the stylopodium was judged to be where the style base reached its minimum width, which probably accords with the definition of Strandhede (1966), although this position is not always assessed readily).
- Ratio of the maximum width of the stylopodium to the maximum width of the fruit, known as 'relative stylopodium width' (r.s.w.).

TABLE 1. DETAILS OF SHOOTS EXAMINED. SHOOTS WERE CONSIDERED TO BELONG TO THE SAME POPULATION WHEN THEY OCCURRED IN THE SAME WATER BODY WITHIN ABOUT 100 M

Code	No. of fruits	V.C.	Site name and code	Grid Ref.	s.s.*	r.s.w.*	Date	Collector
5 m	39	64	Lodge Pond, Settle 5	SD822621	0.912	0.496	28/09/75	FJR
31 m	36	64	Ribble 12	SD777790	0.898	0.496	28/08/75	FJR
32 m	25	64	Ribble 7	SD782786	0.948	0.459	15/09/03	FJR
40 m	67	64	Ribblehead SLQ 8	SD773785	0.973	0.441	12/07/03	FJR
51 m	35	64	Ribblehead SLQ 8	SD773784	0.885	0.429	12/07/03	FJR
53 m	27	64	Ribblehead SLQ 8	SD773784	0.881	0.445	12/07/03	FJR
42 m	26	64	Ribble 21	SD785769	0.957	0.455	15/09/03	FJR
30 m	12	64	Buckden, Wharfe 11	SD944760	0.925	0.482	11/09/03	FJR
8 m	22	79	Tima Water ?pop	NT20	0.960	0.445	06/07/77	OM Stewart
7 i	53	64	Ribblehead Quarry 3	SD7678	1.156	0.414	04/09/04	FJR
9 i	45	64	Ribble 7	SD782783	1.084	0.436	15/09/03	FJR
14 i	51	64	Ribble 7	SD784780	1.100	0.418	15/09/03	FJR
10 i	84	64	Ribblehead SLQ 8	SD773785	1.073	0.426	26/08/75	FJR
39 i	74	64	Ribblehead SLQ 8	SD773785	1.043	0.442	12/07/03	FJR
11 i	77	64	Ribble 9	SD785778	1.013	0.436	15/09/03	FJR
12 i	36	64	Selside, Ribble 10	SD788787	1.017	0.419	18/10/73	FJR
41 i	77	64	Ribble 12	SD778789	1.049	0.407	03/09/03	FJR
38 i	75	64	Ribble 20	SD798745	1.156	0.417	15/09/03	FJR
45 i	41	64	Horton, Ribble 22	SD79.74.	1.068	0.428	14/07/75	FJR
57 i	28	64	BenRhydding gravel pit 24	SE146475	1.086	0.420	—/07/77	FJR
15 i	59	64	Buckden, Wharfe 11	SD943760	1.168	0.419	12/07/75	FJR
1 a	24	67	Byrness, Rede 1	NT770022	1.451	0.320	22/07/02	GAS
2 a	31	67	Kielder Burn 2	NY649955	1.426	0.340	06/05/62	GAS
4 a	30	70	Irthing, Gowk Bank 4	NY682737	1.412	0.407	16/09/63	GAS
6 a	36	79	Tima Water 6	NT283107	1.140	0.369	09/08/03	RWMCORNER
16 a	50	64	Ribble 12	SD778789	1.355	0.391	02/09/03	FJR
17 a	16	64	Ribble 12	SD778789	1.257	0.406	02/09/03	FJR
18 a	58	64	Ribblehead SLQ 8	SD773784	1.209	0.363	03/09/03	FJR
20 a	36	70	Irthing, below Butterburr 13	NY6873	1.196	0.386	—/—/90	FJR
50 a	48	70	Churnsike bridge, Irthing 23	NY6876	1.517	0.406	—/—/91	FJR
26 a	47	67	Whitehill quarry pond 16	NY701777	1.222	0.353	—/08/02	T&D Hardy
29 a	17	67	White Kielder Burn 19	NY677989	1.486	0.303	13/08/67	GAS
28 a	41	67	N Tyne, Charlton 18	NY809846	1.228	0.319	11/08/63	GAS
58 a	16	64	Ribble 7	SD782786	1.558	0.403	15/09/03	FJR
22 a	38	64	Ribblehead SLQ 8	SD773784	1.167	0.381	03/09/03	FJR
25 a	62	64	Ribblehead SLQ 8	SD772785	1.287	0.404	03/09/03	FJR
33 a	51	64	Ribblehead Quarry 3	SD7678	1.277	0.405	04/09/04	FJR
34 a	40	64	Ribblehead Quarry 3	SD7678	1.272	0.392	04/09/04	FJR
35 a	33	64	Ribblehead Quarry 3	SD7678	1.262	0.415	04/09/04	FJR
36 a	43	64	Ribblehead Quarry 3	SD7678	1.381	0.363	04/09/04	FJR
37 a	66	64	Ribblehead Quarry 3	SD7678	1.160	0.383	04/09/04	FJR
46 a	87	64	Ribblehead Quarry 3	SD7678	1.136	0.369	04/09/04	FJR
3 a	68	64	Ribblehead Quarry 3	SD7678	1.405	0.373	04/09/04	FJR
13 ?	64	64	Ribble 7	SD782785	1.125	0.456	15/09/03	FJR
19 ?	49	64	Ribblehead SLQ 8	SD773784	1.069	0.366	03/09/03	FJR
56 ?	35	64	Ribblehead SLQ 8	SD773784	0.884	0.365	12/07/03	FJR
24 ?	71	64	Ribblehead Quarry 3	SD7678	1.207	0.455	03/09/03	FJR
21 ?	55	70	Irthing, Shank End 14	NY6876	1.303	0.424	—/—/91	FJR
23 ?	45	70	Irthing, Churnsike bridge 15	NY6873	1.142	0.424	28/09/75	FJR
27 ?	25	67	Bells Braes, Irthing 17	NY691724	1.272	0.416	27/09/64	GAS

Code – a = plants identified as subsp. *austriaca*, m = plants identified as subsp. *mamillata*, i = plants belonging to the intermediate group with high indices for bundle number and fruit density, ? plants which do not fall readily into any category, *s.s. stylopodium shape, *r.s.w. relative stylopodium width

The mean and standard error of these characters were calculated for each shoot. In addition, for each shoot the following characters were recorded:

- Number of vascular bundles
- Stem diameter after soaking in hot water
 - Number of mature fruits in spikelet
 - Length of spikelet
 - Stomatal length (measured by compound microscope $\times 400$ from epidermal peels of dried material soaked in warm water, and mounted in tap water).

RESULTS

Across all 50 shoots there was highly significant variation between individuals for both stylopodium shape (s.s.: $F = 17.48$, $P < 0.0001$) and relative stylopodium width (r.s.w.: $F = 39.72$, $P < 0.0001$). For s.s., the mean reading varied between individuals by a factor of almost two, from 0.881 to 1.558, and for r.s.w. the mean reading varied from 0.303 to 0.496. There was a significant negative relationship between s.s. and r.s.w. (Fig. 1) as might be expected because these characters share the attribute of stylopodium width in which r.s.w. tends to increase and s.s. tends to decrease. The regression between these characters is identical for Yorkshire (v.c. 64) and "Borders" (v.c. 67, 70) material but, although there is some overlap between the "Borders" and about one third of the Yorkshire material, the majority of the Yorkshire material has a lower average s.s. and a higher average r.s.w. than any of the "Borders" material. Taken as a whole, the variation in mean readings of both characters is continuous, showing no obvious discontinuities.

We observed exceptional variability within shoots for both stylopodium shape and relative stylopodium width which, for both attributes, usually varied by a factor of two or more so that most specimens would have some fruits which were typical for subsp. *austriaca* and some typical for subsp. *mamillata* (for each of these attributes). For two individuals, both identified as subsp. *austriaca*, we investigated the relationship between these attributes and the position of the fruit on the spike. For individual 50 (from v.c. 70), an extreme

'austriaca' phenotype of mean s.s. (1.517), there was a significant relationship between fruit position and s.s. which tended to increase up the spike ($F = 7.27$, $P = 0.010$) (Fig. 2). All the fruits on this plant fell within the range of subsp. *austriaca* for s.s.. However for individual 46 (from v.c. 64) with a mean s.s. of 1.136, there was no relationship between s.s. and fruit position ($F = 1.25$, $P = 0.267$), and s.s. values of individual fruits varied from 0.64 (typical for subsp. *mamillata*) to more than 2.0 (an extreme value, even for subsp. *austriaca*). We found no relationship between fruit position on the spike and r.s.w. ($F = 1.87$, $P = 0.178$ for individual 50; $F = 2.27$, $P = 0.135$ for individual 46).

Almost all specimens examined had fruits with either four or five bristles and an average bristle number in the range 4.5–5.0. Only one specimen, number 5 from Lodge Pond, Settle (Table 1), deviated from this, having an average of 5.75 bristles ($n = 18$ fruits, four of which had seven bristles). In this character as well as for s.s., this specimen more or less accorded with Hayek's (1910) concept of *E. mamillata*.

Stomatal length varied relatively little, from 44 μm to 58 μm , and showed no significant relationship with any other character. The number of fruits in a spikelet was expressed as fruit density, by calculating the number per cm. This figure is usually higher, above 80, for shoots with an intermediate average stylopodium shape between 1.0 and 1.2 which is typical for neither taxon. Vascular bundle number also tended to be greatest for such intermediate individuals from v.c. 64, averaging over 20.5 (Fig. 3).

DISCUSSION

Based on an extensive biometric study from most of the range of *E. mamillata* agg., Gregor (2003) suggested that the morphological limits of the subspecies with respect to stylopodium characters are best given as:

Gregor considered that specimens with an r.s.w. of more than 0.5 can be attributed to subsp. *mamillata* and those with an r.s.w. of less than 0.4 to subsp. *austriaca*, although many of the specimens he attributes to subsp. *mamillata* in his Figure 4 and the appendix to his paper (Gregor 2003) have an r.s.w. that falls

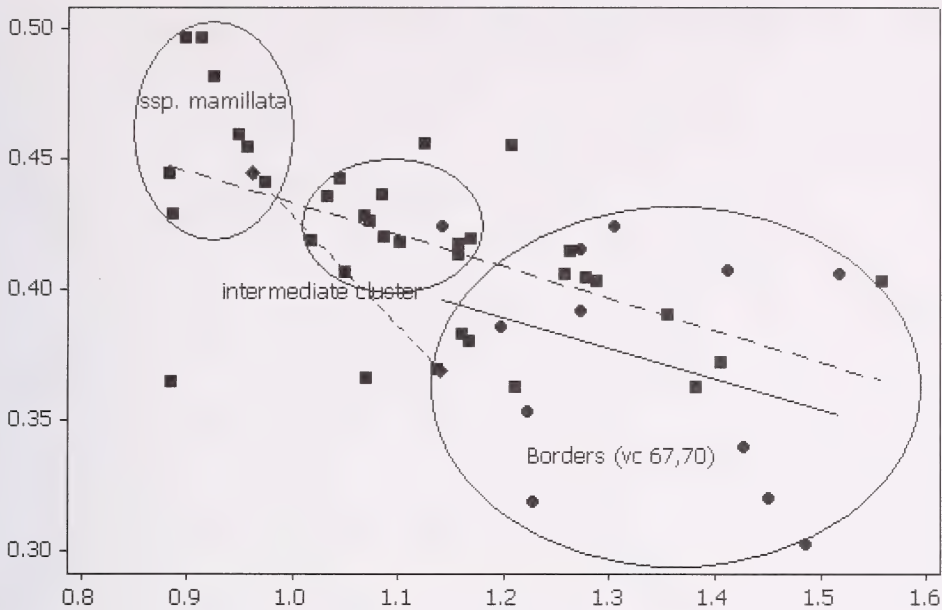


FIGURE 1. Scatter diagram of average stylopodium shape (s.s.) for a shoot (x-axis) against average relative stylopodium width (r.s.w.) (y-axis). Symbols: circles, samples from Borders populations (v.cc. 67, 70); squares, samples from N.W. Yorks (v.c. 64); diamond, samples from Selkirk (v.c. 79). Regression lines are shown: solid, Borders samples; heavy dashed, N.W. Yorks. Ellipses encircle (from the left) samples considered to represent subsp. *mamillata*, all from v.c. 64; samples representing the 'intermediate cluster'; and all the samples from the "Borders" region (v.cc. 67, 70) with one exception.

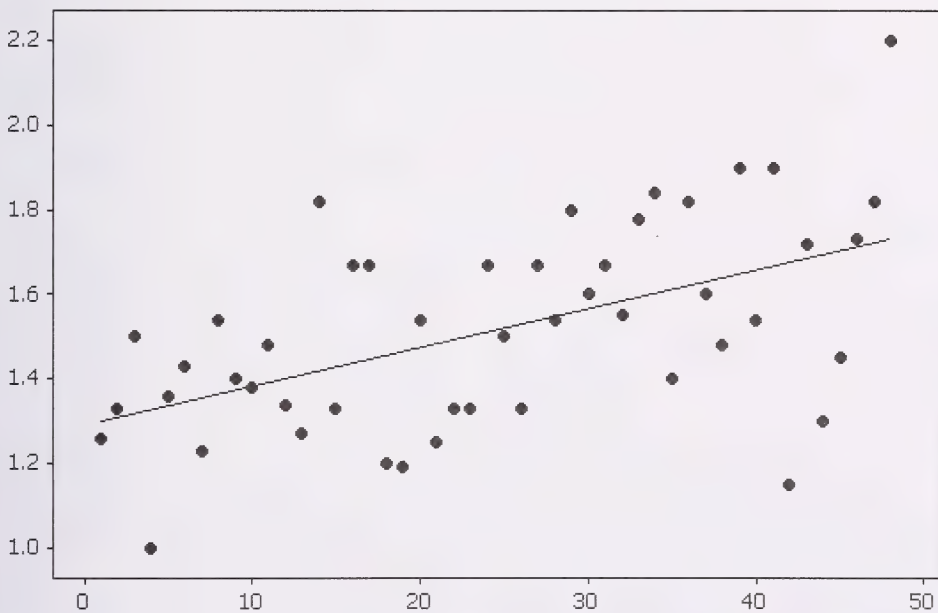


FIGURE 2. Scatter diagram of position of fruit on spike (x axis) against individual fruit stylopodium shape (s.s.) for individual 50. The regression line is shown. This relationship is significant ($F = 7.27$, $P = 0.010$).

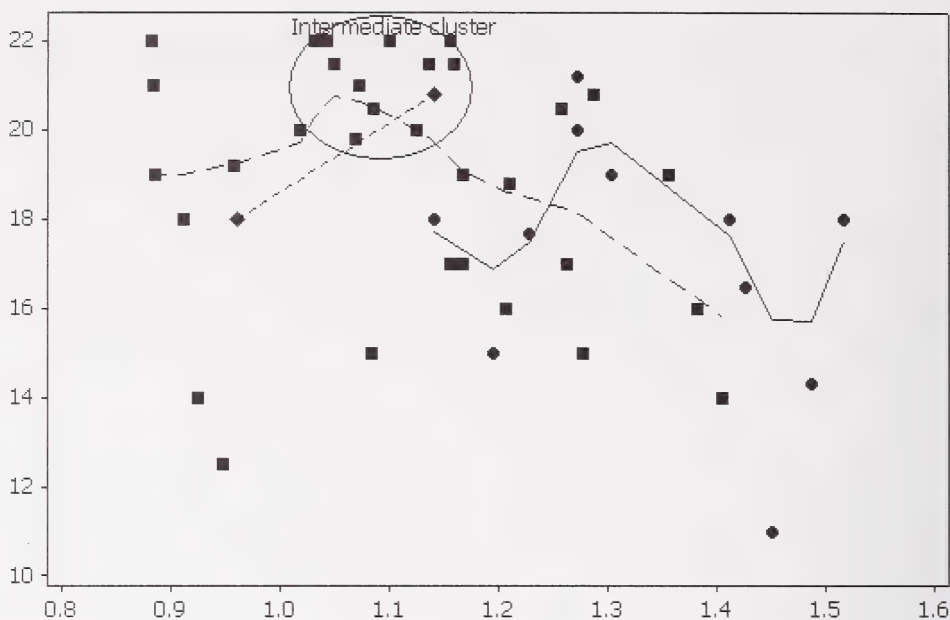


FIGURE 3. Scatter diagram of average stylopodium shape (s.s.) for a shoot (x-axis) against average fruit density on a spikelet (y-axis). Symbols: circles, samples from "Borders" populations (v.c. 67, 70); squares, samples from N.W. Yorks (v.c. 64); diamond, samples from Selkirk (v.c. 79). Smoothing lines of best fit are shown: solid, Borders samples; heavy dashed, N.W. Yorks. Plants considered to represent the intermediate cluster are encircled. Data was missing for some plants in Fig. 1 and these are excluded.

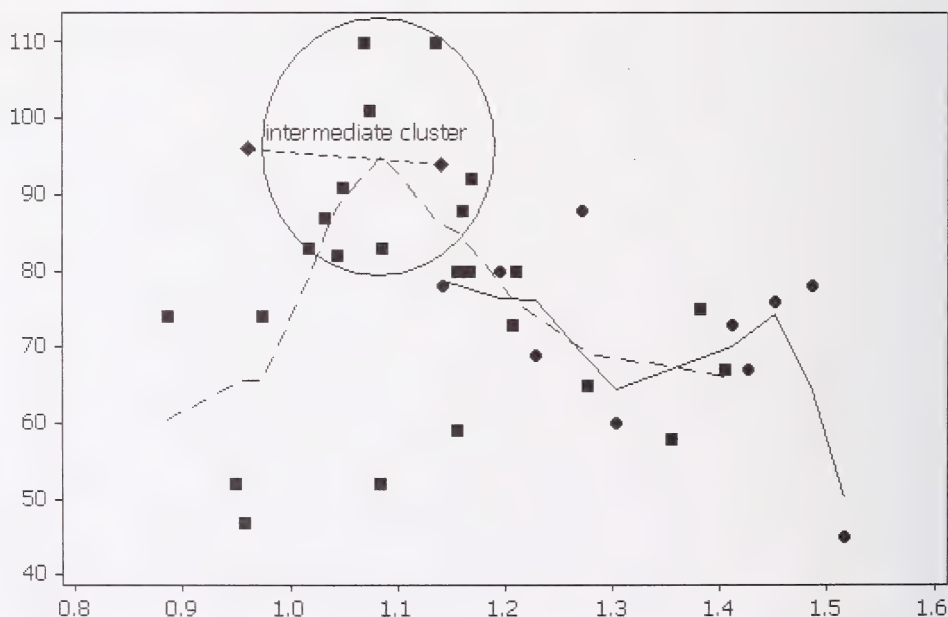


FIGURE 4. Scatter diagram of average stylopodium shape (s.s.) for a shoot (x-axis) against number of vascular bundles on that shoot (y-axis). Symbols: circles, samples from Borders populations (v.c. 67, 70); squares, samples from N.W. Yorks (v.c. 64); diamond, samples from Selkirk (v.c. 79). Smoothing lines of best fit are shown: solid, Borders samples; heavy dashed, N.W. Yorks. Plants considered to represent the intermediate cluster are encircled. Data was missing for some plants in Fig. 1 and these are excluded.

between 0.4 and 0.5. In fact, no British plant measured had an average r.s.w. of greater than 0.50. However, eight individuals from Yorkshire had an average s.s. of less than 0.97 which Gregor considered typical for subsp. *mamillata*. These plants also gave a relatively high r.s.w. reading of more than 0.429 (Fig. 1). A further plant from Selkirk also falls within this group. All the plants from the Borders region (vcc. 67 and 70) had an s.s. of more than 1.10 and so fall within Gregor's definition of subsp. *austriaca* for this character. For all (except five) the r.s.w. falls below 0.40 which is also diagnostic of subsp. *austriaca* according to Gregor. It is clear that it is necessary to measure a large number of fruits from all parts of the spikelet before a consistent average reading is obtained. Measurements of single fruits, or even much larger samples from the same part of the spikelet might give highly misleading readings. For instance, the average s.s. for the bottom half of spike 50 was 1.39, and that for the top half was 1.64 ($n = 24$ in each case). Gregor (2003) measured either three or five fruits per spike and does not state from which part of the spike these were taken from. It is our experience that such small samples would be liable to considerably bias average readings for s.s. and r.s.w., particularly if the part of the spike from which they were taken was not standardised. Nevertheless, when large samples are taken from the total spike, as in the present study, there is considerable statistically significant variation between individuals.

However, like Gregor, we conclude that there is no clear discontinuity in the distribution of the data across all populations which could have provided a natural basis to the delimitation of the subspecies. Also, like Gregor, we note that a proportion of individuals are intermediate in character and cannot be readily referred to either taxon. In fact, amongst our material, there is a distinct cluster of 12 shoots originating from Yorkshire with an average s.s. between 1.00 and 1.18 and an average r.s.w. between 0.40 and 0.45 which form a distinctive morphological group. This group of individuals has on average more vascular bundles than any other with a single exception (between 20.5 and 22.0) (Fig. 4), and a higher fruit density than any other (more than 80/cm) with three exceptions (Fig. 3). The only shoot from elsewhere which resembles this

intermediate group comes from the Tima Water, Selkirk, but this has a much lower r.s.w. average (0.37).

We are uncertain as to the significance of the high readings for fruit density and vascular bundle number for this intermediate group. Both characters have been regarded as having taxonomic significance in earlier work. Beauverd (1921) considered that a fruit density of 60–70 was typical of *E. benedicta* Beauverd which Walters (1953) regarded as synonymous with *E. (mamillata* subsp.) *austriaca*. This agrees well with our findings for plants classified (according to mean s.s.) as both subsp. *mamillata* and subsp. *austriaca*, but is lower than we find for our 'intermediates'.

Hayek (1910) stated that subsp. *mamillata* tends to have fewer vascular bundles than subsp. *austriaca* (i.e. less than 12). Gregor (2003) found that 61% of individuals he classified as subsp. *mamillata* had 13 bundles or fewer. However, all our shoots except two had more than 13 bundles, and there is no clear distinction in bundle number between our material which, according to mean s.s., was classified as 'typical' subsp. *mamillata* and 'typical' subsp. *austriaca*. Indeed, the number of bundles in the eight individuals that fall clearly within the s.s. character range for subsp. *mamillata* for which bundle number is known, shows the complete range present, from 12.5 to 22 (Fig. 3). Strandhede (1966) considered that bundle number was proportionate to stem diameter, and thus had no taxonomic significance, although in our opinion high bundle number could be a measure of vigour.

We believe two interpretations of this data are possible. Either, the intermediate individuals with high bundle and fruit density readings should be regarded as a distinct taxon, or these attributes can be considered as measures of vigour, in which case individuals with an intermediate stylopodium shape might be considered to show hybrid vigour.

If we regard these intermediate individuals as a distinct taxon, they have several features in common with the little-known *E. benedicta* Beauverd (1921), described from Lac Benit, Haute-Savoie, at 1500 m., notably: the stylopodium shape, said to average 1.07, the relative stylopodium width, said to average 0.39, the fruit density of 80/cm and the number of perianth bristles (5). However, *E. benedicta*, regarded by Walters (1953) as a synonym of

austriaca, was stated to have a low vascular bundle number (averaging 12, rather than more than 20 in our 'intermediates'). As the high bundle number is one of the main attributes of the latter, we hesitate to identify it with *E. benedicta*.

With regard to the vigour hypothesis, this assumes that two previously isolated demes have come together in Yorkshire and have hybridised. Some support for this hypothesis can be derived from the finding that three of the four Yorkshire sites from which three or more individuals were collected (Ribble 7, Ribble 12, and Ribblehead SLQ 8) contained spikes showing stylopodium characters of subsp. *austriaca*, subsp. *mamillata* and the intermediate. We have considered the possibility that plants of intermediate phenotype and characteristics of vigour are allotetraploids, but the only chromosome counts recorded are diploid ($2n = 16, 18$) (Walters 1953, Strandhede 1966). Stomatal length commonly differs between related diploids and tetraploids (e.g. Stebbins 1950) and there is no suggestion from stomatal length that intermediates are tetraploid.

Eleocharis fruits are readily dispersed, especially by ducks (Gregor & Barth 1998). Some of the localities for *E. mamillata* agg. in Britain are artificial (i.e. quarries, gravel pits and reservoirs) and most are impermanent. Whether or not this group has persisted within these islands for much of the post-glacial period, it is quite likely that immigrant wildfowl have mediated repeated colonisations of both subspecies over thousands of years, as is suggested by the Yorkshire sites. In this context, it is perhaps remarkable that most individuals in the Borders populations are clearly referable to subsp. *austriaca*, suggesting that they may have originated from relatively few founder events.

The question remains as to the correct name for the plants from N.W. Yorks and Selkirk which have a stylopodium shape (s.s.) within the range given by Gregor (2003) for subsp. *mamillata*. We suggest that it would be unacceptable to record this taxon from the British Isles for the first time on the basis of this single character. Using relative stylopodium width (r.s.w.), none of these plants fall within Gregor's stated limit for subsp. *mamillata* (although this is also true of many of his so-called subsp. *mamillata*), and they have a vascular bundle number well in excess of that

considered to be typical for this taxon. Except for one specimen, all of the material which we examined appeared to have an average perianth bristle number of five or less (i.e. typical of subsp. *austriaca*) including individuals such as number 31 which have an average s.s. typical of subsp. *mamillata*. Only individual 5 had an average bristle number typical of Hayek's concept of subsp. *mamillata*. Gregor (2003) shows that individuals assigned to subsp. *mamillata* can have the full range of average bristle number recorded, from 4.0 to 7.0. Although he found that no individual of subsp. *austriaca* had an average of more than 5.5 bristles, this character seems at best to be of very limited value.

Unfortunately, very few characters seem to separate these two taxa reliably and those that do so (s.s. and r.s.w.) are both based on the same basic character: the shape of the stylopodium. Nevertheless, our material is not typical of subsp. *mamillata* for r.s.w., perianth bristle number or vascular bundle number, and further work is needed before it can be safely assigned to ssp. *mamillata*. It has been suggested that the ecology of the two subspecies differs considerably, at least within Scandinavia. However, some of the British sites are man-made and appear to differ considerably from the natural localities in which they typically occur abroad, although Gregor (*in litt.* to F. J. Roberts) notes that in Germany both taxa occur predominantly in derelict ponds. As yet, there are no ecological data from British sites that can be compared with that gathered by Strandhede (1966) and Gregor & Barth (1998).

We conclude that plants in which the clear majority of fruits have a stylopodium longer than wide should be recorded as *E. mamillata* subsp. *austriaca*. All other British material should at present be referred to as *E. mamillata* agg.

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REFERENCES

- BEAUVERD, G. (1921). A propos d'une nouvelle espèce européenne du genre *Eleocharis*. *Bulletin de la Société Botanique de Genève* ser. II (2), xiii, 245–265.
- CORNER, R. W. M. (1975). *Eleocharis austriaca* Hayek new to Scotland. *Watsonia* **10**: 411–412.
- GREGOR, T. (2003). *Eleocharis mamillata* – distribution and infraspecific differentiation. *Folia Geobotanica* **38**: 49–64.
- GREGOR T. & BARTH, U. (1998). Die Weichstengelige Sumpfbinsse *Eleocharis mamillata* in Hessen. *Natur und Museum* **128**: 113–124.
- HALLIDAY, G. (1997). *A Flora of Cumbria*. Centre for North-West Regional Studies, University of Lancaster.
- HAYEK, V. A. (1910). *Schedae ad floram stiriacum exisccatum. 19 und 20. Lieferung*, Wien.
- HEGI, G. (1966). *Illustrierte Flora von Mitteleuropa*, 3rd ed., **2** (1): 61–64. Carl Hanser Verlag, Munchen.
- HESS, H. E., LANDOLT, E. & HIRZEL, R. (1967). *Flora der Schweiz und angrenzender Gebiete* **1**: 397. Birkhauser, Basel and Stuttgart.
- ROBERTS, F. J. (1977). *Eleocharis austriaca* in N. Yorkshire. *B.S.B.I. News* **15**: 16–17.
- STEBBINS, G. L. (1950). *Variation and Evolution in Plants*. Columbia, New York.
- STRANDHEDE, S.-O. (1966). Morphological variation and taxonomy in European *Eleocharis*, subser. *Palustres*. *Opera Botanica* **10**: 1–187.
- STRANDHEDE, S.-O. & DAHLGREN, R. (1968). Drawings of Scandinavian plants 9–10. *Eleocharis* R. Br. *Botaniska Notiser* **121**: 1–10.
- SWAN, G. A. (1993). *Flora of Northumberland*. Natural History Society of Northumbria, Newcastle upon Tyne.
- WALTERS, S. M. (1953). *Eleocharis mamillata* Lindb. fil. and allied species. *Bericht der Schweizerischen Botanischen Gesellschaft* **63**: 271–286.
- WALTERS, S. M. (1963). *Eleocharis austriaca* Hayek, a species new to the British Isles. *Watsonia* **5**: 329–335.
- WALTERS, S. M. (1980). *Eleocharis* R. Br., in T. G. TUTIN, V. H. HEYWOOD, N. A. BURGESS, & D. H. VALENTINE eds. *Flora Europaea* **5**: 281–284. Cambridge University Press, Cambridge.

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The University of Hull Herbarium

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ABSTRACT

The University of Hull Herbarium was transferred from the Botanic Gardens to the Geography Department in 1993 by which time almost all documentation, including the catalogues, had been lost. Over the following five years a computerised catalogue was created by transcribing the labels of over 18000 British vascular plants. The larger part of the collection was the teaching and research collection (HLU) created by Prof. Ronald Good in the period between his appointment in 1928 and retirement in 1959. An additional collection of 1262 specimens had been acquired by the University in 1983; this is now believed to be the Herbarium of the Hull Technical College (HLL), assembled by Thomas Stainforth. Although it was known that Good had acquired the herbarium of Dr John Fraser (1820–1909) of Wolverhampton, analysis of the new catalogue has revealed the presence of other substantial collections. Over 110 specimens from the herbarium of Rev. W. O. Newnham (1825–1893) have been located and almost 700 19th century specimens from the herbarium of the Barrow Naturalists' Field Club, recorded as having been destroyed in the 1930s. HLU also contains 676 plants from the undocumented herbarium created by Rev H. W. G. Kenrick (c.1863–1943). Geographical coverage of the material is wide but vice-counties 9, 37, 39, 61 and 69 are particularly well represented. The catalogue has now been made public *via* the internet and positive feedback has enabled the correction of many transcription errors.

INTRODUCTION

The University of Hull Herbarium was established by Prof. Ronald Good shortly after his appointment as head of the Botany Department at the newly founded University College in 1928. The collection of British material, which seems to have been primarily intended as a teaching resource, was added to until Good's retirement in 1959 and then only sporadically into the 1960s. In 1993 the herbarium was moved from the University's Botanic Gardens in Cottingham, where it had been since about 1975, to its present home within the Department of Geography. In the Geography Department it is now housed along with an extensive collection of South-east Asian material collected by Dr John Flenley

and others. Unfortunately most of the original catalogues and any documentation that may have once been associated with the material had been lost. This paper describes the recreation of the catalogue of British and Irish vascular plants and establishes the origins of Good's original University Herbarium. It has not yet been possible to assess the many thousands of still largely un-mounted European specimens, that originally formed part of the Fraser collection, or the mosses, lichens and fungi.

In 1997 a start was made to build a new computerised catalogue of the British material. After examining the alternatives, it was decided that the most convenient format for the catalogue would be in the form of a Microsoft Access relational database. This provided a widely used and accepted standard with the option of exporting the data in many other formats, as required. Rather than using direct data entry, a Borland Delphi application was written to ensure that the nomenclature conformed to recognised standards (Kent 1992; Clement & Foster 1994; Ryves *et al.* 1996). This was particularly important as, although the collections were organised according to Dandy (1958), many taxa and hybrids did not fit well into his system. It also ensured the correct spelling of the taxon name field in the database. Several small grants enabled all of the British vascular plant material to be catalogued and some of the previously unmounted material to be mounted.

Much of the data presented here has been derived from analysis of this computerised index. The value of the complete catalogue has proved to be greater than the simple sum of its individual parts and by sorting the records by collector, collection date and locality it has been possible to extract information that was not apparent from the original taxonomic ordering. Many virtually illegible labels have been deciphered by comparison with others. At the present time there are over 18000 catalogued vascular plants in the collection. Of these, approximately 14000 plants can be assigned a collector, 16500 a locality and 17000 a collection date.

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DESCRIPTION OF THE BRITISH MATERIAL

The University Herbarium was established by Prof. R. Good soon after his appointment as Lecturer in Botany in 1928 and it is first mentioned in the Hull University College Calendar for 1931–1932. The most recent published synopsis of the material has been the report resulting from the Northern Universities' Collection Survey (Arnold-Foster 1993). The entry for the Hull herbarium is brief and mistakenly states that all of the material was collected between 1884 and 1971. In fact more than a third of the material is earlier than this. The draft report of a survey of a visit for this survey of collections, sent to the University in 1991, still survives and it is clear that the misapprehension went unnoticed and uncorrected. This draft report does indicate that at that time there were five handwritten catalogue volumes for the British plants and a further one for the European material. These appear to have been lost around the time of the transfer to the Geography Department.

The British vascular plants had been organised into two sections, the larger part consisting of over 16000 mounted specimens grouped into folders by species, the folders then being grouped into genera covers. The folders were ordered according to Dandy (1958) and stored in wooden cupboards. With this were several boxes of unmounted British material, largely willows, interleaved with late 19th century newspaper. The second section was simply labelled the "Wilson Collection", consisting of 1263 mounted specimens arranged into folders by genus and then grouped into conveniently sized bundles.

The larger collection is the core of Good's Herbarium and its primary purpose seems to have been a taxonomic resource for teaching and research within the Botany Department. As other collections were acquired, they were merged with this and consequently lost their integrity. The description of **HLU** given by Kent and Allen (1984) "*Formed by past and present members of staff and students*" is basically correct but it hides the presence of older material that was acquired by donations and possibly purchase.

A card index to the East Yorkshire material has survived. This was created at some time in the later 1950s by Miss A. B. Mowatt (F. E. Crackles, pers. comm.), who worked in the herbarium for a while. It seems to represent preparations for an unpublished *Hand-list of*

the Flora of the East Riding of Yorkshire prepared by Good and Crackles at this time (Crackles 1990). Surprisingly, this index provides evidence for the origin of the "Wilson Collection". Each taxon card carries a list of early v.c.61 records, presumably taken from the literature, followed by two lists of localities, one labelled "HUH" and the other "Tech". After the former is a list of records taken from the University Herbarium and the latter corresponds to plants in the "Wilson Collection". "Tech" seems to refer to the Hull Technical College, the precursor of the Hull College of Higher Education. Kent and Allen (1984) record that A. K. Wilson's herbarium was held in the Hull Technical College Herbarium, **HLL**. The only reference to its acquisition is to be found in the draft report made in preparation for the Northern Universities' Collection Audit (Arnold-Foster 1991). This report records that E. K. Wilson's (*sic*) British and European Flora was acquired as a gift in 1983, although it is not recorded from where. It seems safe to conclude that the present University herbarium now incorporates both **HLU** and **HLL**.

The **HLL** material covers a much more restricted period than that in **HLU**. If the 80 sheets of Hull plants submitted for the 1864 British Botanical Competition, which clearly form a discrete collection, are excluded, only 60 specimens pre-date 1930 and none is later than May 1939. Most of the early specimens are attributable to exchange club material (Arsene, Melville, etc) or local amateurs (Boult, Robinson). This matches well the period that Thomas Stainforth was lecturer in Botany and Zoology at the Technical College and he may have established and developed the collection. Stainforth had strong links with the Hull Scientific and Field Naturalists' Club (HSFNC) which he served, at various times, as secretary, treasurer, editor and chairman (Walsh 1944). There is little duplication of specimens in **HLL** and it seems to represent a deliberate attempt to build a teaching collection.

CONTRIBUTORS

Over 300 collectors have contributed to the current herbarium at Hull University, those with the greatest number of specimens are listed in Table 1. Ronald Good has by far the most specimens with almost 20% of the collection being of his own material. A

TABLE 1. THE MAJOR CONTRIBUTORS TO THE HERBARIUM AT HULL UNIVERSITY

	HLU	HLL
Good, R. D'O.	3576	-
Wilson, A. K.	1237	784
Fraser, J.	1258+	-
Kenrick, H. W. G.	676	-
Wilkins, D. A.	297	-
Lewis, R.	277	-
Baynes, J. & T. C.	343	-
Fisher, J.*	257	-
Hardy, A. C.	231	-
Rob, C. M.	70	156
Ley, A.	173	-
Gardiner, W.	173	-
Worsdale, A. F.	140	-
Shoolbred, W. A.	137	-
Bennett, A.*	120	-
Baker, J. G.*	115	-
Newnham, W. O.	110+	-
Brotherston, A.	95	-
Baxter, T.	62	-
Smith, R. L.	53	52

* Indicates approximate numbers resulting from similarly named collectors

HLU = the original Hull University Herbarium

HLL = the former Technical College Herbarium

personal collection of over 800 specimens, collected prior to his appointment, may well have formed an early core. An interesting and unsuspected addition in the early years is a set of over 200 plants collected in the Harrogate area in 1914 and attributed to A. C. Hardy. These specimens were almost certainly collected by Sir Alister Hardy, who was appointed as head of the Zoology Department in 1948. Although Sir Alister Hardy later attained acclaim for his work on marine plankton, he had early botanical interests, entering Oxford University in 1914 to study forestry entomology.

Other collections were acquired, the most notable of which is the herbarium of John Fraser of Wolverhampton. Over 1000 specimens in the British collection can be assigned, with confidence, to Fraser. This includes a series of around 300 Staffordshire plants, collected in 1864 for the British Botanical Competition organised by the South Kensington Horticultural Society. Edees (1972) notes that Fraser won a silver medal with a collection of 530 species; clearly some of these must be elsewhere or lost.

There are other notable collections that once formed part of Fraser's herbarium. More than

110 specimens have been identified in **HLU** which may be assigned, with certainty, to Rev. William Orde Newnham (1825–1893). There is no doubt that these specimens at one time formed part of John Fraser's herbarium as there are examples where Fraser has altered his own printed labels to read "Ex Herbario Newnham". Most specimens, however, are identifiable only by the initials WON or even just N and there is even a note, in Fraser's hand, stating "Newnham specimens unlabelled", suggesting that some of the unattributed and unlocated specimens in his herbarium may also have originated with this collector. Although Desmond (1994) records the existence of material collected by Newnham in **CGE** (Cambridge University) and **MANCH** (Manchester Museum), none of his British material is catalogued in the former and only a few specimens (previously attributed to Newnham) are to be found in the latter. It would appear that **HLU** may hold the bulk of Newnham's surviving British material.

All dated Newnham specimens cover the period 1843–1846, when he would have been a Cambridge undergraduate, and most are from the vicinity of Chesham, Bucks. There are at least another 20 Buckinghamshire records from

this period that will almost certainly have been collected by Newnham. Although the records show that both William Orde Newnham and John Fraser were members of the Botanical Society (Desmond 1994), there is no other known link between the two men which might explain the transfer of large numbers of plants. However, examination of census records reveals that by 1861 W. O. Newnham's brother, Christopher Atkinson Newnham, was a doctor in Wolverhampton. As a fellow medical practitioner, C. A. Newnham would certainly have been well known to John Fraser as both men resided in the town for the following thirty years. It seems likely that W. O. Newnham's specimens arrived in Fraser's herbarium via his brother.

The 62 plants of T Baxter of Worcester may also have once been part of Fraser's collection. Fraser's extensive collection of European plants is also housed within the Herbarium but remains un-catalogued (much of it still being un-mounted).

A significant component of the **HLU** material is that derived from the Botanical Exchange Clubs. The **HLU** section has around 760 such specimens ranging in date from Baker's 1860 specimen to Druce's 1931 contribution. This is significant as although Fraser was a member of the Botanical Exchange Club and such specimens would be expected, he died in 1909 and seventy specimens post-date this. There must be specimens from another herbarium that were incorporated after 1930.

There is significant material from the Furness district of Cumbria. This was largely collected by Mr T. C. & Mrs J. Baynes and Mrs J. Fisher during the period 1876–1880. Examination of the *Transactions of the Barrow Naturalists' Field Club* for this period reveals that these collectors formed a nucleus of an active botanical section. Many of the specimens now in **HLU** were collected on the Club's organised field excursions. In 1878 Mrs. Joseph Fisher is recorded as obtaining a prize for "... the best herbarium of flowering plants, representing not less than 150 species..." (Anon 1878). How this material came to be in Hull was unclear until a note was found on an unattributed specimen of *Cephalanthera rubra* stating that it "... came with the Ferguson plants from Barrow ...". Dr J M Ferguson was an Assistant Lecturer in the Hull Botany Department from 1930 to 1932 and of the four specimens she left in the

herbarium one is from Walney, collected in 1931. Further examination of the Barrow Naturalists' Field Club Proceedings has revealed that the Club's collections were moved from their premises at Cambridge Hall around 1932 where they had suffered seriously from damp and dirt. The botanical collection had fared particularly badly and was

"...in such a condition, that the committee decided to destroy it, but on the advice of Dr Judith Philip, M.Sc. Sheffield, daughter of Mr. T. J. Ferguson, the whole collection was sent just as it stood to the Hull University College. Dr. Ronald D'O Good, M.A., Cambridge, Professor of Botany at the College, in acknowledgement, said that although the specimens had perished, the labels still remaining, were of great value ..."

(Christian & Richardson 1933)

It seems that the material was not in such a poor state as suggested by this, and that a significant number of specimens were re-mounted and added to the embryonic **HLU**. This misconception is propagated further when later proceedings report again that the specimens had "*mouldered into dust*" (Christian 1935) but that the record cards had been sent to Hull University.

Although there is no specific record of the size of the Barrow herbarium, it is possible to estimate it at around 800 specimens. The Barrow Club's Botanical Report for 1877–1878 states that Mrs Baynes had donated 356 specimens and that over 200 had been contributed by other members. **HLU** contains about 340 specimens attributed to J. or T. C. Baynes, for this period, and about 240 for Mrs J. Fisher. A later report (Anon 1902) notes that Mr John Hosking, a long-standing member, had donated over 200 specimens to the Club's herbarium in 1896. **HLU** only holds 59 specimens that can be attributed to J. Hosking but it is of interest that of the 49 plants specifically mentioned in the report, 43 can be positively identified in **HLU**. The best estimate that can be made of the surviving Barrow material is around 680 re-mounted specimens. This would suggest that, despite pessimistic reports, over 80% of the material may have survived.

The 676 specimens collected by H. W. G. Kenrick between 1889 and 1939 are of unknown origin. Little is known of this collector as a botanist but it is possible to

deduce from the labels that he was Rev. Henry William Gordon Kenrick (c.1863–1943), an Anglican Priest, who spent much of his ministry in London. Confirmation of this is provided by a 1903 Dandelion specimen from St John's vicarage, Hammersmith. He was born in Bangalore, India and completed an MA at Cambridge (Venn 1954). Coincidentally, between 1888 and 1890 he was attached to Holy Trinity Church, Hull, and his earliest specimen was collected at Bridlington, East Yorkshire during this time. He appears to have maintained a botanical interest through most of his life and his final specimens were collected in Dawlish in September 1939. It is noteworthy that there are no grasses in the collection and only a single rush. It seems likely that part of the collection was lost or is elsewhere.

As is to be expected in a provincial collection, many of the collectors do not figure in standard botanical directories (Britten & Boulger 1931; Desmond 1994). Both sections of the herbarium contain significant amounts of material collected by local amateurs. During the 1930s, when both the University and Technical College collections were being actively built, local and Yorkshire naturalists including A. K. Wilson, C. M. Rob and A. E. Wray contributed to both collections. The minute books of the HSFNC for this period show that Stainforth was the president of the Club in 1929, the year that Good applied for membership, and that A. K. Wilson became their Botanical recorder in 1931. During this period Ronald Good gave regular lectures to HSFNC and their meetings were often held in the University. The major exceptions to this pattern are the 168 specimens collected by G. A. Glister and the 300 or so specimens collected by Good himself in this decade, which are found only in **HLU**. Although the Diatomaceae recorder for HSFNC, Glister obviously had close association with the University College as the Botany Department is given as his address in Club records. Even Stainforth, more an entomologist by inclination, has 8 specimens in **HLU**. Considering that only 25 of Stainforth's plants are in **HLL**, the flow of material seems to have been a little one sided. The almost equal distribution of Royston L. Smith's Cardiff alien specimens between the two herbaria is undoubtedly a result of donations from A. K. Wilson. Wilson was extremely interested in dock aliens

(Wilson 1938) and it is known that the two collectors exchanged material.

After 1940 Good's connection with the HSFNC seems to have been a little more distant, although he was eventually made an Honorary Life Member of the Club. Approaching 70% of the Wilson specimens in **HLU** date from 1939 or later. It is not clear whether there was a constant trickle of donations or whether the post-war part of Wilson's collection was donated to the University at some time. The latter may be more likely as an undated (1950s) letter from Mr Foster, HSFNC's secretary at the time, in response to a request from Good concerning the whereabouts of Charles Waterfall's herbarium, suggests that Wilson might know (**DX/14/4**). The tone of the letter makes it clear that Wilson was not now an active member of the club and that Foster was unaware that Good and Wilson may be acquainted.

Robert Lewis provided a link between Good and Wilson in the early 1950s. Lewis was an active member of the HSFNC and donated almost 300 specimens to **HLU** between 1949 and 1955, after which he moved from the area. There are 18 specimens in **HLU** attributed jointly to Wilson and Lewis, the majority resulting from a visit to Westmorland in June of 1954. Lewis also botanised with D. A. Wilkins, Good's assistant at the time. Wilkins' 297 specimens were all collected during 1952 and all, bar one, are from v.c.61. Angus Worsdale, another HSFNC member also made a significant contribution of local specimens during this period. Dr Eva Crackles, HSFNC member, student of Good and graduate of Hull University, is also well represented in **HLU**. Almost fifty specimens, the majority of which are local, were contributed during the 1950s. A further 40 specimens, mainly from 1981, which formed a separate collection, have recently been integrated with the main body of specimens. Crackles made extensive use of the university herbarium in the preparation of her Flora of the East Riding of Yorkshire (1990).

Unsurprisingly, there are many specimens contributed by students and staff of the University. Usually there are only a few per collector but an exception to this is the material collected by the student Andrew Caldicott, mainly in 1967. These 73 specimens, mainly from Essex, form the last substantial addition to the herbarium.

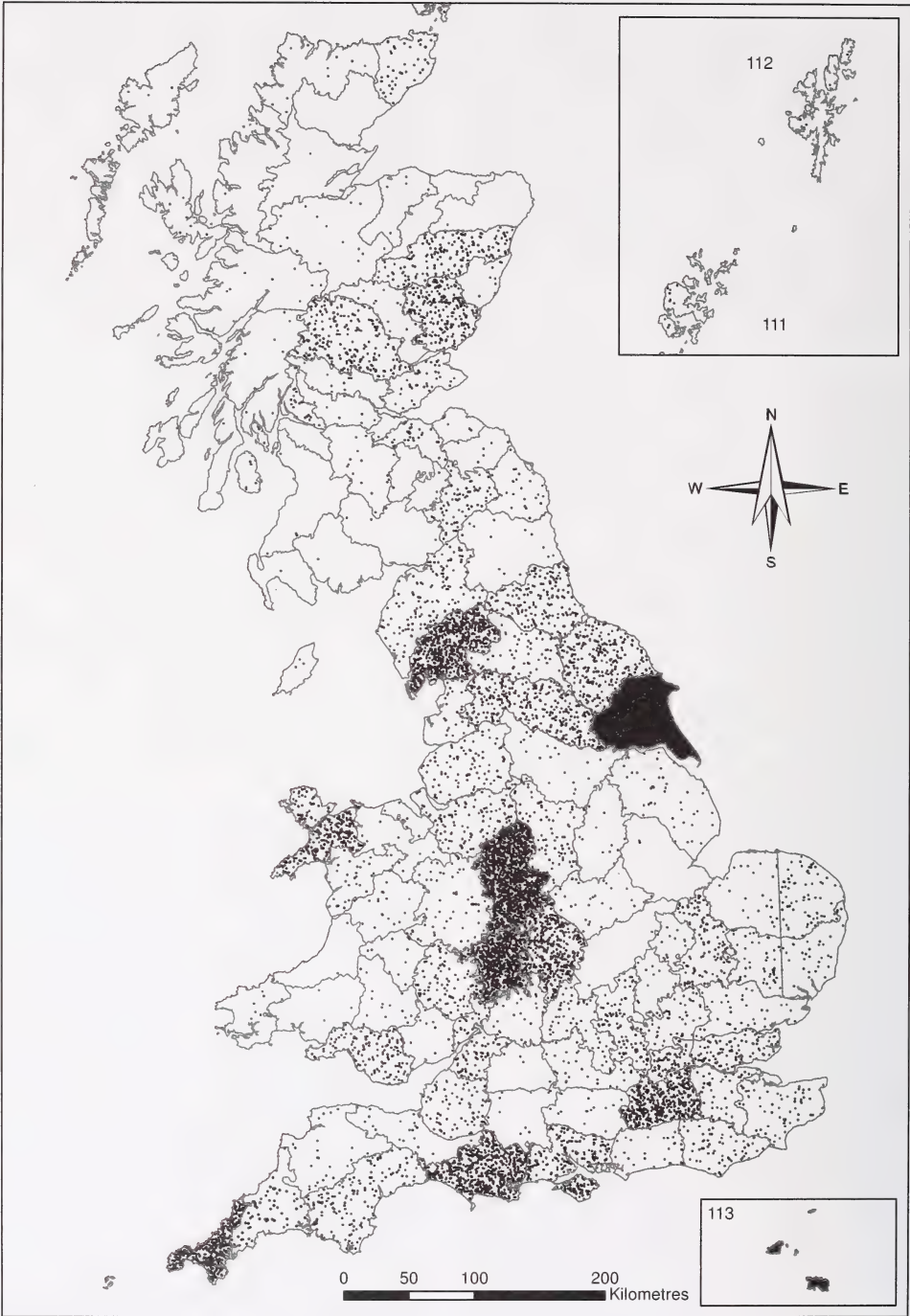


FIGURE 1. Geographical distribution of specimens in the herbarium (**HLU** and **HLL**) from within Great Britain. Each dot represents one specimen but is located randomly within the vice-county.

GEOGRAPHICAL DISTRIBUTION OF SPECIMENS

Figure 1 illustrates the spatial distribution of the specimens which can be assigned to the vice-counties of Great Britain. It is clear that there is a very uneven spatial distribution, a function of the dominance of certain collectors.

As to be expected, South-east York (v.c. 61) is extremely well represented with almost a third of all specimens originating within the vice-county. Over 2500 of these specimens were collected by Prof. Good with 87% being added in the 1950s. A. K. Wilson made the next largest contribution, almost 1800 specimens, all but 30% of which were collected before 1950.

Staffordshire (v.c. 39) is the next best-represented county. Although only 258 of these specimens are undoubtedly John Fraser's, the great bulk of the 1059 bearing no collector's name are almost certainly from his herbarium. The actual number of Staffordshire specimens will be greater than indicated as many of Fraser's labels are illegible. The adjacent vice-counties are also reasonably represented, particularly Worcester (v.c. 37). Almost 100 of the 760 specimens are known to have been collected by, or are from the herbarium of John Fraser. Although these plants are supplemented by 36 specimens collected by T. Baxter of Worcester, the great majority of those without a known collector are probably Fraser's.

Numerically the collections of plants from Westmorland (v.c. 69) are worthy of mention. They are dominated by the Baynes, Fisher and Hosking material of the 1870s described earlier, but there are significant contributions from H. W. G. Kenrick, who appears to have made several summer visits to the area. The Dorset specimens (v.c. 9) are also of significance. Around 80% of the Dorset material was collected by Prof Good, the bulk from the period 1914–1939. These will be part of the collection made for his Dorset Flora (Good 1948). Some manuscript maps and draft material for this work are among the little surviving herbarium documentation. The 260 specimens for Mid Perth (v.c. 88) are unsurprising and they comprise the contributions of over 25 individuals, most of whom were visiting Ben Lawers.

TAXONOMIC COVERAGE

As is to be expected of a university departmental collection, coupled with Ronald Good's own interests, which were often closer to

biogeography than to taxonomic botany, **HLU** covers the British flora reasonably comprehensively with representatives of 2001 taxa. The extensive incorporation of earlier herbaria into **HLU** has, however, resulted in better representation in groups which were of particular interest to their original owners. Until 2002 Fraser's *Salix* collection remained un-mounted and still interleaved with 19th century newspaper sheets. Of the 524 Willows in **HLU**, probably a third result from Fraser's own collectings. Andrew Brotherston is also strongly represented and an interleaved letter shows that Fraser had requested specimens from him. Other notes show that Fraser was also corresponding with W. H. Beeby and E. F. Linton about Willows. Both *Rubus* and *Rosa* are well represented in **HLU**, with 269 and 264 specimens respectively. Much of this material appears to have originated from Fraser's herbarium where Bloxam, Bagnall and other 19th century collectors feature strongly.

HLL, despite containing less than a tenth of the specimens, contains representatives of almost half as many taxa as **HLU**. This is consistent with the hypothesis that it was established as a teaching rather than research collection. Alien species are particularly well represented in **HLL** with 55 specimens collected by R. L. Smith, mainly from Cardiff, supplementing Wilson's material from the Hull docks. Table 2 lists the specimens from **HLU** and **HLL** which appear on the Red Data List as being either *extinct in the wild* or *critically endangered*. In addition **HLU** holds specimens of 56 taxa classified as *endangered* and 16 are to be found in **HLL**.

DISSEMINATION OF INFORMATION

It was the intention, from the start of this project, to make the catalogue freely available to as wide an audience as possible. A pilot internet service was established in early 2000 using a provisional version of the catalogue. As no commercial software suitable for the task was available at the time, a dedicated program was written in Borland Delphi. This program, which could be called from a standard web page, permitted interrogation of the catalogue by taxon, collector, locality or v.c. number, together with several options for the sorting of results. The results were returned as a web page, requiring no special software on the user's part. The software was upgraded several times over the following two years and now

TABLE 2. SPECIMENS OF TAXA APPEARING ON THE RED DATA LIST AS EITHER EXTINCT IN THE WILD OR CRITICALLY ENDANGERED

	v.c.	Locality	Collector	Year
HLU taxa now extinct in the wild				
<i>Euphorbia peplis</i>	3	Slapton Sands	Curnow, W.	1878
<i>Euphorbia peplis</i>	3	Dartmouth	Ralfs, J.	1878
<i>Euphorbia peplis</i>	3	Slapton Sands	Ralfs, J.	1878
<i>Euphorbia peplis</i>	3	Beesands	Waterfall, W. B.	1878
<i>Euphorbia peplis</i>	3	Torcross	Waterfall, W. B.	1878
<i>Euphorbia peplis</i>	3	Beesands	Marshall, E. S.	1898
<i>Galeopsis segetum</i>	49	Bangor	Ley, A.	1888
<i>Arnoseris minima</i>	9	Verwood	Good, R. D'O.	1938
<i>Arnoseris minima</i>	17	Wrecchlesham		1851
<i>Arnoseris minima</i>	61	Crosswood, Allertorpe	Nelson, G. A.	1927
<i>Crepis foetida</i>	15	Kingsdown, Deal	Bennett, A.	1875
<i>Crepis foetida</i>	16	Dartford to Greenhithe	Linton, W. R.	1885
<i>Filago gallica</i>	19	Berechurch	Tempere, J.	1877
<i>Filago gallica</i>	19	Berechurch	Dufrey, J. ?	1882
<i>Filago gallica</i>	19	Colchester	Linton, W. R.	1886
<i>Filago gallica</i>	20	Bayford	Groves, H.	1875
<i>Otanthus maritimus</i>	113	St Ouen's Bay, Jersey	Blow, T. B.	1873
<i>Otanthus maritimus</i>	113	St Ouen's Bay, Jersey	Mathews, W.	1874
<i>Otanthus maritimus</i>	113	St Ouen's Bay, Jersey	Lomax, A. E.	1882
<i>Otanthus maritimus</i>	113	St Ouen's Bay, Jersey	Lind, J.	1883
<i>Otanthus maritimus</i>	H12	Wexford	Hurst ?	1901
<i>Tephroseris palustris</i>	27	East Norfolk	Hanbury, F. J.	1884
<i>Spiranthes aestivalis</i>	11	Lyndhurst	Teesdale, M. J.	1878
<i>Spiranthes aestivalis</i>	11	Lyndhurst	Goss, H.	1884
<i>Spiranthes aestivalis</i>	113	St Ouen's Pond, Jersey	Fraser, J.	1870
<i>Spiranthes aestivalis</i>	113	St Ouen's Pond, Jersey	Fraser, J.	1876
HLU critically endangered taxa				
<i>Dryopteris cristata</i>	39	Kingston Pool	Fraser, J.	1885
<i>Dryopteris cristata</i>	58	Wybunbury Bog		1874
<i>Ranunculus arvensis</i>	9	Ruddipole, Weymouth	Good, R. D'O.	1914
<i>Ranunculus arvensis</i>	17	Thames Ditton	Preston, A. W.	1877
<i>Ranunculus arvensis</i>	20	Berkhamstead	Good, R. D'O.	1916
<i>Ranunculus arvensis</i>	22	Maidenhead	Good, R. D'O.	1923
<i>Ranunculus arvensis</i>	39	Lower Penn	[Fraser, J.]	1864
<i>Ranunculus arvensis</i>	61	Waudby	Wilson, A. K.	1939
<i>Ranunculus arvensis</i>	61	Cottingham	Good, R. D'O.	1946
<i>Ranunculus arvensis</i>	61	Kilnsea	Good, R. D'O.	1947
<i>Ranunculus arvensis</i>	61	Bewholme	Allison, J. H.	1951
<i>Ranunculus arvensis</i>	61	Burstwick	Worsdale, A. F.	1953
<i>Ranunculus arvensis</i>	61	Fitling	Good, R. D'O.	1954
<i>Ranunculus arvensis</i>	62	Easingwold	Good, R. D'O.	1955
<i>Chenopodium urbicum</i>	17	Kew Bridge		1863
<i>Chenopodium urbicum</i>	17	Chobham		1872
<i>Chenopodium urbicum</i>	17	Waddon, nr. Croydon	Bennett, A.	1875
<i>Chenopodium urbicum</i>	18	Epping Forest	Crespigny, E. de	1878
<i>Chenopodium urbicum</i>	18	Epping Forest	Crespigny, E. de	1881
<i>Chenopodium urbicum</i>	61	Cottingham	Good, R. D'O.	1957

TABLE 2 CONTINUED

	v.c.	Locality	Collector	Year
<i>Corrigiola litoralis</i>	1	Looe Pool, Helston	Beeby, W. H.	1873
<i>Corrigiola litoralis</i>	1	Looe Pool, Helston	Curnow, W.	1875
<i>Corrigiola litoralis</i>	1	Looe Pool, Helston		1876
<i>Corrigiola litoralis</i>	1	Helston	Fraser, J.	1878
<i>Corrigiola litoralis</i>	3	Slapton	Fooks, K.	1949
<i>Corrigiola litoralis</i>	69	Walney	Baynes, J.	1877
<i>Sorbus domestica</i>	17	Kew (cult.)	Baker, J. G.	1874
<i>Sorbus domestica</i>	17	Kew (cult.)	Nicholson, G.	1878
<i>Sorbus domestica</i>	37	Wyre Forest, Bewdley	Jordan	1849
<i>Sorbus domestica</i>	37	Wyre Forest		1853
<i>Sorbus domestica</i>	39	Arley Castle		1865
<i>Sorbus domestica</i>	39	Arley Castle grounds	Fraser, J.	1878
<i>Sorbus domestica</i>	39	Arley Castle		1887
<i>Cotoneaster cambricus</i>	49	Great Orme's Head	G. Seeb., truncated	-
<i>Cotoneaster cambricus</i>	49	Llandudno		1853
<i>Cotoneaster cambricus</i>	49	Great Orme's Head	Baxter, T.	1855
<i>Cotoneaster cambricus</i>	49	Great Orme's Head	Woodward, J.	1856
<i>Cotoneaster cambricus</i>	49	Ormeshead		1863
<i>Cotoneaster cambricus</i>	49	Great Orme's Head	Griffith, J. E.	1884
<i>Cotoneaster cambricus</i>	49	Great Orme's Head	Griffith, J. E.	1889
<i>Eryngium campestre</i>	3	Devil's Point	Goulding, F. H.	1846
<i>Eryngium campestre</i>	3	Devil's Point	Hayward, W. R.	1873
<i>Eryngium campestre</i>	3	Devil's Point	Briggs, T. R. A.	1876
<i>Scandix pecten-veneris</i>	9	Sydling St. Nicholas	Good, R. D'O.	1914
<i>Scandix pecten-veneris</i>	22	Holypot, Maidenhead	Good, R. D'O.	1923
<i>Scandix pecten-veneris</i>	37	Cowleigh Park ?	Fraser, J.	1877
<i>Scandix pecten-veneris</i>	39	Trysull	Fraser, J.	1864
<i>Scandix pecten-veneris</i>	61	King George Dock, Hull	Wilson, A. K.	1937
<i>Scandix pecten-veneris</i>	54	Goxhill	Glistler, G. A.	1938
<i>Scandix pecten-veneris</i>	61	Pocklington	Nelson, G. A.	1939
<i>Scandix pecten-veneris</i>	61	Welwick	Sledge, W. A.	1946
<i>Scandix pecten-veneris</i>	61	Kilnsea Warren	Wilson, A. K.	1952
<i>Scandix pecten-veneris</i>	61	Skidby	Good, R. D'O.	1952
<i>Scandix pecten-veneris</i>	61	Fitling	Good, R. D'O.	1954
<i>Scandix pecten-veneris</i>	69	Roosebeck	Fisher, J.	1877
<i>Bupleurum rotundifolium</i>	37	Bredicot		-
<i>Bupleurum rotundifolium</i>	37	Cracombe Hill	Baxter, T.	1860
<i>Bupleurum rotundifolium</i>	38	Harbury	Fraser, J.	1877
<i>Cynoglossum germanicum</i>	17	Norbury Park	Groves, H.	1875
<i>Cynoglossum germanicum</i>	17	Norbury	Goss, H.	1886
<i>Cynoglossum germanicum</i>	17	Norbury	Goss, H.	1888
<i>Cynoglossum germanicum</i>	33	Tewkesbury		1854
<i>Galeopsis angustifolia</i>	17	Dorking	Morgan, J. H.	1896
<i>Galeopsis angustifolia</i>	61	Wauldby	Good, R. D'O.	1951
<i>Galeopsis angustifolia</i>	61	Millington Grange	Lewis, R.	1952
<i>Galeopsis angustifolia</i>	61	Huggate Dikes	Good, R. D'O.	1953
<i>Galeopsis angustifolia</i>	61	South Dalton	Good, R. D'O.	1956
<i>Galeopsis angustifolia</i>	61	Brantingham	Good, R. D'O.	1956

TABLE 2 CONTINUED

	v.c.	Locality	Collector	Year
<i>Galeopsis angustifolia</i>	61	West Heslerton Brow	Good, R. D'O.	1956
<i>Galeopsis angustifolia</i>	62	Ellerburn	Worsdale, A. F.	1952
<i>Clinopodium menthifolium</i>	10	Apesdown	Stratton, F.	1872
<i>Clinopodium menthifolium</i>	10		Tucker, R.	1875
<i>Clinopodium menthifolium</i>	10	Apesdown	Melville, J. C.	1882
<i>Galium tricornutum</i>	9	Portland	Good, R. D'O.	1919
<i>Galium tricornutum</i>	19	Saffron Walden	Groves, J.	1875
<i>Galium tricornutum</i>	37	Craycombe Hill	Baxter, T.	1860
<i>Galium tricornutum</i>	37	Upper Howsell, Malvern	Baxter, T.	1860
<i>Galium tricornutum</i>	38	Whitnash		1879
<i>Centaurea calcitrapa</i>	13	Brighton		1872
<i>Centaurea calcitrapa</i>	15	Shoreham		1881
<i>Centaurea calcitrapa</i>	17	Barnes	Groves, J.	1874
<i>Centaurea calcitrapa</i>	113	Jersey	Piquet, W.	1878
<i>Hieracium pseudocurvatum</i>	88	Killin	Linton, W. R.	1883
<i>Hieracium pseudocurvatum</i>	92	Ben na Mac Duhi		1846
<i>Hieracium pseudocurvatum</i>	92	Corrie Etachen	Linton, E. F.	1884
<i>Hieracium pseudocurvatum</i>	92	L. Kander		1885
<i>Hieracium pseudocurvatum</i>	108	Ben Loaghal	Shoolbred, W. A. and Marshall, E. S.	1897
<i>Pulicaria vulgaris</i>	9	Portland Island		-
<i>Pulicaria vulgaris</i>	37	Malvern	Baxter, T.	1857
<i>Damasonium alisma</i>	17	Thames Ditton		1874
<i>Damasonium alisma</i>	17	Mitcham Common	Bennett, A.	1881
<i>Potamogeton acutifolius</i>	14	Pevensey Levels	Wilson, A. K.	1934
<i>Schoenoplectus triqueter</i>	17	Bank of Thames	Newnham, W. O.	1846
<i>Schoenoplectus triqueter</i>	17	Putney, by the Thames	Bennett, A.	1874
<i>Schoenoplectus triqueter</i>	17	Mortlake	Groves, H. and J.	1875
<i>Schoenoplectus triqueter</i>	17	Kew - Richmond	Morgan, J. H.	1893
<i>Lolium temulentum</i>	1	Penzance		1878
<i>Lolium temulentum</i>	3	Plympton	Briggs, T. R. A.	1878
<i>Lolium temulentum</i>	59	Liverpool, north of	Lewis, J. H.	1872
<i>Cypripedium calceolus</i>	64	Grassington	H I for F A L [Lees]	1878
HLL critically endangered taxa				
<i>Ranunculus arvensis</i>	61	King George Dock, Hull	Wilson, A. K.	1932
<i>Scandix pecten-veneris</i>	61	Cottingham		1864
<i>Scandix pecten-veneris</i>	61	King George Dock, Hull	Wilson, A. K.	1932
<i>Galeopsis angustifolia</i>	63	Kirk Smeaton	Rob, C. M.	1937
<i>Galium tricornutum</i>	61	King George Dock, Hull	Wilson, A. K.	1937
<i>Centaurea calcitrapa</i>	41	Splott, Cardiff	Smith, R. L.	1937
<i>Potamogeton acutifolius</i>	14	Pevensey Levels	Wallace, E. C.	1934
<i>Lolium temulentum</i>	41	Cardiff	Smith, R. L.	1938

runs, with little attention, on a PC running the Microsoft Internet Information Server (IIS) software. Although this system may not be suitable for servicing a large number of requests, it is more than adequate for the level of use experienced and expected.

The response to the pilot launch was both exhilarating and disheartening. It was clear that there were many specimens in the herbarium that were of interest to others and that a valuable service could be provided by putting the catalogue into the public domain. Feedback

from users did, however, reveal the shortcomings of the index. Many data entry errors were identified, mainly involving the spelling of localities and assignment of v.c. numbers. Subsequent programmes of checking have considerably reduced these errors. More importantly, feedback has enabled corrections and additions to be made on the basis of information provided by others and not available when the catalogue was compiled. In addition to the internet implementation of the catalogue, a stand-alone version has also been produced on compact disc (CD). This consists of a dedicated program and a specially formatted dataset. With this version it is possible to perform more sophisticated searches, there is no need for an internet link and it has been possible to integrate scanned documents into the database. The major disadvantage is that the program is platform specific (PC only) and the database is fossilised. Corrections and updates can easily be applied to the internet version but require a new version of the CD. Despite the drawbacks it is considered that the CD version will probably be the most convenient for persistent users and the internet version better for casual use.

The system of dissemination described here is flexible and easy to implement. Although unsuitable for large herbaria, it would certainly be adequate for collections of up to 100,000

specimens. The most time-consuming element of the process has been the data entry and validation and any herbarium already having a computerised catalogue could implement a similar system with a relatively small investment. The ready availability and low cost of modern computers now opens up even more radical prospects. It would be a relatively simple matter to scan the sheets and make the collection available as a virtual herbarium. Although this would not obviate the examination of the specimens for some purposes, most users would probably not need to use the originals. In addition to saving wear and tear on fragile specimens it would open up access to the herbarium by making it universally available.

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REFERENCES

- ANON. (1878). Barrow Naturalists' Field Club 1877–1878. *Proceedings of the Barrow Naturalists' Field Club and Literary and Scientific Association* 2: 4–7.
- ANON. (1902). Botany Report. *Proceedings of the Barrow Naturalists' Field Club and Literary and Scientific Association* 14: 4–7.
- ARNOLD-FORSTER, K. (1993). *Held in Trust*. HMSO, London.
- BAMFORD, T. W. (1978). *The University of Hull : the first fifty years*. Oxford University Press, Oxford.
- BRITTEN, J. & BOULGER, G. S. (1931). *A biographical index of deceased British and Irish botanists*. (revised and completed by A. B. Rendle) Taylor & Francis, London.
- CHRISTIAN, W. H. (1935). Botanical Report. *Proceedings of the Barrow Naturalists' Field Club and Literary and Scientific Association* 3(New series): 25–26.
- CHRISTIAN, W. H. & RICHARDSON, F. N. (1933). Botanical Report. *Proceedings of the Barrow Naturalists' Field Club and Literary and Scientific Association* 2(New series): 57–58.
- CLEMENT, E. J. & FOSTER, M. C. (1994). *Alien plants of the British Isles*. Botanical Society of the British Isles, London.
- CRACKLES, F. E. (1990). *Flora of the East Riding of Yorkshire*, Hull University Press & Humberside County Council, Hull.
- DANDY, J. E. (1958). *List of British vascular plants*. British Museum & Botanical Society of the British Isles, London.
- DESMOND, R. (1994). *Dictionary of British and Irish Botanists and Horticulturalists*. Taylor and Francis, London.
- EDEES, E. S. (1972). *Flora of Staffordshire*. David and Charles, Newton Abbot.
- GOOD, R. (1948). *A geographical handbook of the Dorset Flora*. The Dorset Natural History and Archaeological Society, Dorchester.

HULL UNIVERSITY ARCHIVES, Ronald Good's Letters. **DX/14/4**

KENT, D. H. (1992). *List of vascular plants of the British Isles*. Botanical Society of the British Isles, London.

KENT, D. H. & ALLEN, D. E. (1984). *British and Irish Herbaria*. Botanical Society of the British Isles, London.

RYVES, T. B., CLEMENT, E. J. & FOSTER, M. C. (1996). *Alien grasses of the British Isles*. Botanical Society of the British Isles, London.

SLEDGE, W. A. (1975). Catherine Muriel Rob F.L.S. *Naturalist* **100**: 67–68.

VENN, J. A. (1954). *Alumni Cantabrigienses*. Cambridge University Press, London.

WALSH, G. B. (1944). Thomas Stainforth BA BSc (1882–1944), in memoriam. *Naturalist* **69**: 77–78

WILSON, A. K. (1938). *The Adventive Flora of the East Riding of Yorkshire*. Occasional papers of the Hull Scientific and Field Naturalists' Club **1**, Hull.

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A new far northern hybrid horsetail from Scotland:

Equisetum ×*mchaffieae* C. N. Page (*Equisetum fluviatile* L. × *E. pratense* Ehrh.)

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ABSTRACT

DESCRIPTION AND DIAGNOSIS

A new hybrid horsetail *Equisetum* ×*mchaffieae* C. N. Page hybr. nov., with the parentage *E. fluviatile* L. × *E. pratense* Ehrh., is described from Caithness, Scotland, v.c.109. It is only the second known British *Equisetum* hybrid involving the northern *E. pratense* in its parentage, a species which itself is rare in the British Isles as a whole. A description is given, diagnosis with other hybrids made and the ecology of this unusual taxon outlined.

KEYWORDS: *Equisetum*, hybrid, morphology, ecology, Caithness, Scotland.

INTRODUCTION

A new hybrid horsetail, *Equisetum* ×*mchaffieae* C. N. Page, hybr. nov., with the parentage *E. fluviatile* L. × *E. pratense* Ehrh., is described. First found by Heather McHaffie in Caithness, v.c.109, northern Scotland, in August 2003 and submitted to the referee for *Equisetum*, this plant is clearly of hybrid origin and presents a distinctive individual vegetative morphology closely intermediate between that of its two, somewhat contrasting, parents. It is only the second known British *Equisetum* hybrid involving the northern *E. pratense* in its parentage, a species which itself is scarce in the British Isles as a whole. The formal description given here follows the initial format of most other hybrids in the *Equisetum* subgenus *Equisetum* (e.g. Page 1963, 1973, 1988a, 1995; Dines & Bonner 2002) to facilitate comparison. Further morphological details are given, diagnosis with other hybrids in *Equisetum* subgenus *Equisetum* involving either parent made, and the ecology so-far known of this unusual taxon outlined.

Equisetum ×*mchaffieae* hybr. nov.

(*E. fluviatile* L. × *E. pratense* Ehrh.) Fig. 1

Caules 25–45 cm alti, 1.8–2.3 mm diameter, viridis, alte 7–12 sulcati, porci angulosus, pagina minutus asperatus; vaginae (dentibus exclusis) 3.5–4.1 mm, virides; dentes tot quot sulci, subulati, piliferous-acuminatus, nigrescentes, marginibus basium angustis scariosis, 1-costati; cavitas centralis 1/2 caulis diam. Ramuli patentes vel suberecti, regularites verticillati, simplices, tenuis, plerumque trigonis et tetragonis, carina aculis, internodium infimum vaginam caulis proximam aequans vel 1.5 superans; vaginae pallidae, dentibus acuminatis, patens, viridis.

Stems 25–45 cm, erect, 1.8–2.3 mm diameter, green, grooves 7–12, ridges angular, surface minutely rough; sheaths (excluding teeth) 3.5–4.1 mm, green; teeth as many as the grooves, subulate, piliferous-acuminate, blackish with narrow scarious basal margins, 1-ribbed; central hollow 1/2 diameter of stem. Branches spreading to suberect, in regular whorls, simple, slender, three or four angled, ridges acute, the lowest internode 1.0–1.5 times the length of the adjacent stem sheath; sheaths pale, teeth acuminate, non-spreading, pale green.

HOLOTYPE: Scotland, Caithness, St. John's Loch, Scotland, U.K., GR ND 220 718, 12 August 2003, Heather McHaffie (E).

Equisetum ×*mchaffieae* is clearly intermediate in shoot vegetative structure between *E. fluviatile* and *E. pratense*. Plants have slightly

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FIGURE 1. Silhouette of type material of *Equisetum mchaffieae* C. N. Page, hybr. nov. (*E. fluviatile* L. $\times$ *E. pratense* Ehrh.).

decumbent to erect main stems 25–45 cm in height, but only 1.8–2.3 mm shoot diameter, with a broadly ovate outline closely reminiscent of that of *E. $\times$ litorale* (*E. arvense* $\times$ *fluviatile*), but with overall more slender, more delicate structure throughout and with more numerous notably more slender branches. Nodes throughout the middle 3/4 of the shoot are branch bearing, with typically 3–4 or more at the base of the shoot non-branch-bearing and 5–6 or more of the most distal forming a long slender 0.6–0.8 mm diameter or less gradually tapering terminal ‘tail’ to the upper extremity of each shoot. Main shoot internodes with numerous (7–12) shallow, highly angular ridges and grooves, with an overall minutely roughened surface texture of fine siliceous spicules detectable especially when a finger nail tip is drawn gently along. All main stem internodes also lack the easy elastic compressability in fresh material of those of *E. $\times$ litorale* resulting from the central canal of this hybrid being mostly little more than 1/2 the overall diameter of the stem combined with smaller diameter and tougher shoot structure. Characteristic main stem sheaths throughout the lower third of the shoot are scarcely inflated but strongly vertically grooved, c. 2.4 mm diameter and 3.5–4.0 mm long excluding teeth, green throughout or sometimes irregularly dark-patched at the base, their free teeth particularly numerous (7–12) for the sheath width, up to 1.9 mm long, dark brown to blackish throughout, initially broad at the base but tapering rapidly with narrow pale brown scarious margins in the basal portions only, and for their final half to two thirds (c. 0.8–1.0+ mm) tapering only slowly to form distinctive, individual, relatively long, straight, narrow, fine, entirely black, somewhat delicate piliferous acuminate teeth tips, which can become rather easily broken free in dried material. Branches slender and particularly numerous, up to 12 per whorl, neatly regimented, spreading-ascending to somewhat upward curving throughout the shoot, c. 9.5–10.5 cm long in the middle of the shoot, reducing to 4.5–5.5 cm in the upper part of the shoot, c. 0.6 mm or less diameter, their internodes (3)–4 angled, strongly furrowed, the furrow base with a shallow sulcus, the ridges acute, minutely pearly along their apices but not saw-toothed, the branch sheaths green, uniangulate, the teeth simple, mostly pale green sometimes tinged translucent brown towards the tips, slender, straight, not spreading.

The hybrid is named after Heather McHaffie, who collected the material, first recognised it to be distinctive in the field, and submitted it to the referee.

TAXONOMIC COMPARISONS

Equisetum $\times$ mchaffieae is a distinctive hybrid, with shoots which are strikingly intermediate in size, morphology and anatomy between the somewhat contrasting morphologies of *E. fluviatile* L. and *E. pratense* Ehrh. As seems characteristic of a majority of colonies of hybrid horsetails, and often a feature of them, no shoots of this hybrid have yet been found to bear cones, but their strong intermediacy of vegetative structure is sufficiently consistent and distinctive to be a reliable guide to parentage, with clear characters which link directly with each of the above species. *Equisetum $\times$ mchaffieae* possesses the overall markedly ovate *E. fluviatile*-dominated overall shoot outline characteristic of all of the known hybrids of this parent (*E. $\times$ litorale* Kuhl. ex Rupr., *E. $\times$ dyciei* C. N. Page, *E. $\times$ willmotii* C. N. Page), and especially with a branchless portion at the base and a relatively long branchless terminating ‘tail’ portion to the tip of the shoot. However *E. $\times$ mchaffieae* has an overall marked slenderness and delicacy of form with a thin but tough and angular main stem and overall slender branch structure readily apparent both in the field and in herbarium material, which distinguish it especially from the above hybrids. Further, the distinctive minute roughness of the main stem internodes to touch is unusual for any hybrid and is characteristic only of hybrids involving either *E. pratense* or *E. sylvaticum* in their parentage, but especially the former, which the notable angularity of the ridges in its main shoot cross-section also most closely approaches. Additionally in *E. $\times$ mchaffieae*, the numerous long, straight, narrow, fine, delicate, black, entirely free teeth to the main stem sheaths through at least the lower third of the main shoot, with markedly piliferous acuminate tips, the highly angular slender branches, and lack of secondary branching of the branch systems, all confirm the unusual involvement of *E. pratense* in the parentage of this hybrid.

In more detailed comparisons with the other *Equisetum fluviatile* hybrids, *Equisetum $\times$ mchaffieae* is thus superficially similar mainly

only to *E. xlitore* in general outline, in comparison with which it looks smaller, much more slender and delicate, with clearly rougher surface texture, longer, narrower, numerous, dark, free, main stem teeth, and lack of the the 'plastic-like' yield (Page 1997a) of the main shoot internodes when gently squeezed between finger and thumb, so characteristic in the field of *E. xlitore*. In comparison with *E. xdycei*, *E. xmhaffieae* has also a typically rougher surface and more copious spreading-ascending more angular, more slender, branches and the distinctive *E. pratense*-like teeth to the main stem sheaths; and in comparison with *E. xwillmotii* is also of very much more overall slender and more delicate structure, with rougher main stem internode surfaces and more slender, simple, uniangular, branch internodes with sheaths which are not bicarinate. In more detailed comparison with *E. xmildeanum*, the only other *Equisetum* *pratense* hybrid so far known in Britain, *E. xmhaffieae* differs clearly in possessing only simple (ie. unbranched) branch structure and in possession of the distinctive terminal 'tail' to the tip of the shoot, more often 4-angled branches (combining the tendency of respective parents to be dominated by 3 and 4-5 angled branches respectively), and clearly simpler more separated free teeth segments to the main shoot sheaths.

However, this particular hybrid would most easily be dismissed (as might also *E. xdycei*) in the field as merely a slender and perhaps depauperate form of *E. xlitore* (as might also *E. xwillmotii*, for example, as being a more robust form of *E. xlitore*), and thus either mis-recorded or overlooked or not collected at all for being 'aberrant'. It may well be that the occurrence of this hybrid has been overlooked for these reasons. However, this hybrid is between two species of *Equisetum* which would also appear to not be especially closely-related (Page 1972), and the phylogenetic distance apart of their parents (but within the same subgenus) would seem likely to be a factor in its apparent rarity of occurrence. This distance apart, however, approximates also to that of the parents of each of *E. xwillmotii*, *E. xbowmanii* and *E. xrobertsii*, all of which have so far proved to have a relatively small number of scattered stations in Britain and Ireland (in comparison with the relative frequency of *E. xlitore* sites – now well over 100 in these islands), and all too, typically not necessarily always with both parents present (an aspect, which may well echo past distributions, which the hybrids have outlived).

FIELD ECOLOGY

Equisetum xmhaffieae occurs at the edge of St. John's Loch, Caithness, where it is associated with a slightly flushed fen near to the water's edge. The surrounding overall vegetation type includes mainly *Filipendula ulmaria*, *Potentilla palustris*, *Salix repens*, *Eriophorum angustifolium*, *Succisa pratensis*, *Achillea ptarmica*, *Senecio palustris*, *Parnassia palustris*, *Caltha palustris*, *Triglochin palustris*, *Lychnis flos-cuculi*, *Hydrocotyle vulgaris*, *Stachys palustris*, *Juncus effusus*, *J. conglomeratus*, *Carex panicea*, *Calamagrostis stricta*, *Molinia caerulea*, *Holcus lanatus*, *Anthoxanthum odoratum*, *Deschampsia cespitosa*, *Equisetum fluviatile* and *Equisetum palustre*. There are strips of fields running between a nearby road and the water's edge, with the upper part of each field above the 25 m contour usually cultivated, but their lower edges at least 10 m wide towards the loch are not cultivated, though might be sometimes grazed. The loch is freshwater, with a water level artificially maintained for native brown trout, for which there is a hatchery, and a track to the water's edge to access fishing boats.

Of the parent species, *Equisetum fluviatile* is present around the loch margins. *E. pratense* is not present immediately nearby, but is however, not insignificant in occurrence around the overall vice-county and adjacent region and has long been known from both 10 km grid squares immediately adjacent to the south of the loch (where it is most likely present along banks and sandy shoulders of upland streams and rivers feeding the lochs). It also grows as a substantial colony on Thurso riverside at ND1113673, and has also previously been found in rough vegetation at Dunnet links (ND215688, 1997, although its present survival at this location is questioned).

Within this overall setting, *Equisetum xmhaffieae* is present in a small bay at the edge of the loch over a substratum of shelly clay originally of marine origin deposited within an area otherwise bounded by Old Red Sandstone. In terms of micro-topography, the hybrid occurs clinging to the wave-worn bare vertical clay created by wave action and through the vegetation behind. This sheer bank is some 1 m high topped by a thin layer of peat and bears the same flora as above. At the loch, hybrids of *Equisetum* would appear to be relatively vigorous, since, other collections from this location recognised as unusual in the field by Heather McHaffie and submitted to the referee for checking have proved to contain

also *E. $\times$ litorale*, *E. $\times$ dycei* and *E. $\times$ rothmaleri* at this site. Shoots of what are possibly all of *E. $\times$ mchaffieae* are scattered at a frequency of maybe 1 shoot per metre over a length of 1 km of shore explored, centred on the grid point ND22007211, and with a possible higher density in parts. Overall, members of the genus and especially *Equisetum* hybrids as a whole are clearly remarkably successful in this overall location, and their patterns of distribution are likely complex and may well be highly intermixed.

DISCUSSION

Equisetum $\times$ mchaffieae is the sixth known hybrid in the genus *Equisetum* recognised within Scotland, and brings to a total of eleven the number of inter-specific hybrids within the genus as a whole known within Britain and Ireland. It also brings to nine, the number of hybrids known within *Equisetum* subgenus *Equisetum* (the deciduous-shooted horsetails) formed between the six native species of this subgenus in these islands. *Equisetum $\times$ mchaffieae* is also the fourth known hybrid to involve *E. fluviatile* L. in its parentage: the others being [in order of frequency] *E. $\times$ litorale* (*E. arvense* $\times$ *fluviatile*), *E. $\times$ dycei* (*E. fluviatile* $\times$ *palustre*) and *E. $\times$ willmotii* (*E. fluviatile* $\times$ *telmateia*), all of which hybrids are known in Britain now in multiple locations. *Equisetum $\times$ mchaffieae* is, however, only the second known hybrid in Britain to involve *E. pratense* in its parentage, the other being *E. $\times$ mildeanum* Rothm. (*E. pratense* $\times$ *sylvaticum*), which has now several known scattered stations in highland Scotland and in the mountains of northern and central Europe (Rothmaler 1944; Page 1988a, 1997a; Lubien-ski 2003). No known extra-British localities for this particular hybrid have, however, been either reported or as yet found in herbarium material from elsewhere, although, of its parents, both are species with extraordinarily wide temperate ranges (Hultén & Fries, 1986).

Equisetum fluviatile is circumboreal, occurring across Eurasia and far eastern Asia to Japan, northward from approximately latitude 36 degrees N and across North America at similar latitudes (Hultén & Fries 1986; Derrick *et al.* 1987). In Europe, *E. fluviatile* occurs widely from extreme southern Greenland, Iceland, and northern Scandinavia to approximately the Pyrenees and Caucasus, with outlying stations to southern Spain and Italy

(Jalas & Suominen 1972). It is most abundant at middle to northerly latitudes, where it is a species of "shores of lakes and slow rivers, often bordering reed swamp communities down to 1.5 m depth, forming large pure stands especially in oligotrophic lakes, mesotrophic and eutrophic mires, margins of bogs and oligotrophic fens, *Salix* and *Alnus* carrs" (Jonsell 2000). Within Britain and Ireland, *E. fluviatile* is similarly widespread, from the Orkneys and Shetlands to Cornwall (Jermy *et al.* 1978, Preston *et al.* 2002), especially at low to moderate elevations, and of a similar habitat range, but mainly a species of low to moderate altitude, part-shaded to exposed, lake and other of standing water margin, ditch and carr vegetation communities, sometimes forming dense and extensive cone-bearing stands in open water reedswamp communities. In Scotland it occurs quite widely at lower altitudes but ascends as mostly smaller-statured, often cone-inhibited, sparser stands to alpine lochans and even into wet heathland communities to an altitude of about 900 m.

Equisetum pratense is an arctic-alpine species which is most abundantly northern in its circumboreal range. It is present across Eurasia to the Altai, Manchuria, Kamtchatka and the Chukotsk Peninsula of far eastern Siberia, most abundantly north of approximately latitude 48 degrees N, and at similar latitudes across North America from Alaska to Labrador (Rothmaler 1944; Lellinger 1985; Hultén & Fries 1986; Derrick *et al.* 1987). In Russia, it is widespread and locally frequent across northern Russia and especially in Siberia from the South Siberian mountains northward (Komarov 1934; Krasnoborov 1988); and in northwestern Canada sometimes forms 'dense stands on open wooded floodplains of rivers and streams' (Cody & Britton 1989). In western Europe, it ranges from Iceland and northern Scandinavia to Central Europe and the Alps (Jalas & Suominen 1972; Hegi 1984), and especially in more northerly latitudes can be locally com-mon mainly on moist, base rich substrates in open woods, pastures, river banks, hay-meadows, alpine tall-herb communities, snow-beds and talus slopes (Jonsell 2000). Within Britain and Ireland, *E. pratense* is confined to the northern half of these islands, where it has scattered stations in the northern Pennines and in Northern Ireland, but more widely spread only in Scotland and especially in the central and eastern Highlands and north

to Caithness (Jermy *et al* 1978, 1994; Preston *et al.* 2002). In this range, *E. pratense* is a scarce British species largely of sandy-clayey river and streambanks, especially in moist, lightly shaded slopes, hence chiefly in the lower valleys of mountain districts, in sites typically where the ground contains a high mineral component, and this is especially of sand which is either calciferously derived or is base-flushed. In Scotland it ascends as more scattered populations near to tumbling mountain rills and on ledges over mica-schist rock to at least 915 m (and reported to ascend to 1,400 m in the mountains of mainland Europe (Prelli 2001). It is, however, only in its more northern stations in Britain (central Perthshire north) that I have found *E. pratense* currently to produce fertile cones (though a century ago, herbarium evidence shows that colonies were freely fertile as far south as Coquetdale, Weardale and Teesdale (Page 1988b, 1997b), where recent fieldwork shows the plant to still persist, but in entirely vegetative condition.

Equisetum. xmhaffieae thus occurs within the northern part of the sympatric portion of the ranges of its two parents in Britain, and especially within the zone in which both are cone-bearing. The geological aspects of its Caithness site are also clearly especially suited to *Equisetum* growth as a whole, occurring within an area bounded by Old Red Sandstone and directly over a substrate of shelly clay of originally marine origin, overlain by peat and now exposed in a small freshwater lochside bay. For such exposed clay is a particularly edaphically-appropriate mineral habitat for the occurrence of species of *Equisetum*, since it provides the essential mineral combination of a substrate combining both available silica and calcium at the same time, here the calcium-source being especially in the form of the marine shell component within the sandy-clay

matrix (Page 1988b, 1997). The close association of this hybrid in this location with the face of a 1 m high eroding bank face of this shelly clay also appears significant. Clearly this face must afford rather better drainage than would occur within the fen vegetation itself, but nevertheless be influenced by both moving ground moisture and locally enhanced humidity. Further, the association of this hybrid with such a clear erosion-surface is notable as such erosion-surfaces which are in a more or less constant state of micro-disturbance are believed to be especially important in providing sites for the co-occurrence of prothalli of disparate species of *Equisetum* within cross-fertilisation distance, and hence especially effective in the induction of hybrid formation, in climates as recurrently moist and relatively mild as many of those of the British Isles, where, by European standards as a whole, hybrids within *Equisetum* subgenus *Equisetum* are especially rich (Page 1979, 2002; Page & Barker 1985; Page & McHaffie 1991; Dines & Bonner 2002). Here, at this Caithness site, the presence of such a concentration of co-extent different *Equisetum* hybrids (*E. xlitorale*, *E. xdycei*, *E. xrothmaleri* and *E. xmhaffieae*), collectively involving different combinations of four local parent species, emphasises the significance of the combined role of appropriately moist climate, edaphic mineral balance, exposure of the mineralised surfaces and recurrent small disturbance processes operating on these, can generate in opening the opportunity for hybrids in this genus to form.

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REFERENCES

- CODY, W. J. & BRITTON, D. M. (1989). *Ferns and Fern Allies of Canada*. Agriculture Canada, Ottawa.
- DERRICK, L. N., JERMY, A. C. & PAUL, A. M. (1987). Checklist of European pteridophytes. *Sommerfeltia* 6: 1–94.
- DINES, T. D. & BONNER, I. R. (2002). A new hybrid horetail, *Equisetum arvense* × *E. telmateia* (*E. xrobertsii*) in Britain. *Watsonia* 24: 145–157.
- HEGL, G. (1984). *Illustrierte Flora von Mittel-Europa. Band I. Pteridophyta*. Paul Parey, Berlin & Hamburg.
- HULTÉN, E. & FRIES, M. (1986). *Atlas of North European Vascular Plants*. Konigstein, Federal Republic of Germany.
- JALAS, J & SUOMINEN, J (1972). *Atlas Florae Europaeae*. 1. Pteridophyta. Committee for mapping the Flora of Europe, Helsinki.
- JERMY, A. C. (1994). *Equisetum pratense* Ehrh., in A. STEWART, D. A. PEARMAN, & C. D. PRESTON. eds. *Scarce Plants in Britain*, p.154. Joint Nature Conservation Committee, Peterborough.

- JERMY, A. C., ARNOLD, H. R., FARRELL, L. & PERRING, F. H. (1978). *Atlas of Ferns of the British Isles*. Botanical Society of the British Isles & British Pteridological Society, London.
- JONSELL, B. (2000). *Flora Nordica*. The Royal Swedish Academy of Sciences, Stockholm.
- KOMAROV, V. L. (ed.). (1934). *Flora of USSR*. Vol. 1. Academy of Sciences of USSR, Leningrad.
- KRASNOBOROV, I. M. (ed.). 1988. *Flora of Siberia*. Vol. 1. Nauka, Novosibirsk.
- LELLINGER, D. B. (1985). *A Field manual of the Ferns and Fern-allies of the United States and Canada*. Smithsonian Institution Press, Washington, D.C.
- LUBIENSKY, M. (2003). *Equisetum × mildeanum* Rothm. (*E. pratense* Ehrh. × *E. sylvaticum* L.), en snellehybrid ny for Norge. *Blyttia* **61**: 171–178.
- PAGE, C. N. (1963). A hybrid horsetail from the Hebrides. *British Fern Gazette* **9**: 117–119.
- PAGE, C. N. (1967). Sporelings of *Equisetum arvense* in the wild. *British Fern Gazette* **9**: 335–338.
- PAGE, C. N. (1972). An assessment of inter-specific relationships in *Equisetum* subgenus *Equisetum*. *New Phytologist* **71**: 355–369.
- PAGE, C. N. (1973). Two hybrids in *Equisetum* new to the British Flora. *Watsonia* **9**: 229–237.
- PAGE, C. N. (1979). *Equisetum × trachyodon* in western Scotland. *Fern Gazette* **12**: 178–179.
- PAGE, C. N. (1988a). Two hybrids of *Equisetum sylvaticum* new to the British Flora. *Watsonia* **17**: 2273–2277.
- PAGE, C. N. (1988b). *Ferns: Their Habitats in the Landscape of Britain and Ireland*. Collins New Naturalist no 74, London & Glasgow.
- PAGE, C. N. (1995). *Equisetum × willmotii* C. N. Page – a new hybrid horsetail from County Cavan, Ireland. *Glasra* **2**: 135–138.
- PAGE, C. N. (1997a). *The Ferns of Britain and Ireland*. 2nd edn. Cambridge University Press, Cambridge.
- PAGE, C. N. (1997b). Pteridophytes as field indicators of natural biodiversity restoration in the Scottish flora. *Botanical Journal of Scotland* **49**: 405–414.
- PAGE, C. N. (2001). Ferns and allied plants, in D. L. HAWKSWORTH ed. *The changing wildlife of Great Britain and Ireland*. Systematics Association Special Volume 62, pp 50–77. Taylor & Francis, London & New York.
- PAGE, C. N. (2002). The role of natural disturbance regimes in pteridophyte conservation management. *Fern Gazette* **16**: 284–290.
- PAGE, C. N. & BARKER, M. A. (1985). Ecology and geography of hybridisation in British and Irish horsetails. *Proceedings of the Royal Society of Edinburgh* **86B**: 265–272.
- PAGE, C. N. & MCHAFFIE, H. S. (1991). Pteridophytes a indicators of landscape changes in the British isles in the last hundred years, in J. M. CAMUS ed. *The History of British Pteridology*, pp. 25–40. British Pteridological Society, London.
- PRELLI, R. (2001). *Les Fougères et Plantes Alliées de France et d'Europe Occidentale*. Belin, Paris.
- PRESTON, C. D., PEARMAN, D. A., & DINES, T. D. (2002). *New Atlas of the British and Irish Flora*. Oxford University Press, Oxford.
- ROTHMALER, W. (1944). Pteridophyten Studien I. *Feddes Repertorium* **54**: 55–82.

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A fine scale study of selected environmental and floristic parameters in three populations of *Euphrasia vigursii* (Davey), a rare annual endemic to Devon and Cornwall

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ABSTRACT

Euphrasia vigursii is an endangered hemiparasitic annual, endemic in Devon and Cornwall. This investigation has evaluated fine scale patterns of floristic composition and nutrient distribution in selected populations of *E. vigursii* in Devon and Cornwall to increase understanding of their ecology for use in future management strategies in Devon. Two particular questions were formulated:

1. Is *E. vigursii* immediately surrounded by other particular plant species?

2. If the soil was analysed in the direct location of the site of *E. vigursii* would the pH, Nitrogen, Phosphorus and Potassium content be different from the areas where *E. vigursii* is not present?

Phytosociological analysis indicated that *E. vigursii* is associated with heath and acidic grassland communities typically containing *Ulex gallii*, *Agrostis curtisii*, *Calluna vulgaris*, together with *Molinia caerulea* and *Potentilla erecta* mire. Within the individual sites spatial scale comparison (macro vs. micro) indicated significant differences in Phosphorus levels and pH levels but these were not consistent across the sites. Germination of *E. vigursii* at microenvironment level was closely correlated with the presence of *A. curtisii* rather than its other known host species *Ulex gallii*. This is contrary to published research which suggests that *E. vigursii* avoids the more open, species-poor areas dominated by *A. curtisii*. Correlations between the environmental parameters assessed may reflect present management regimes within the Dartmoor populations.

KEYWORDS: spatial scale, species distribution, hemiparasitic, soil nutrients, conservation, Vigurs' Eyebright.

INTRODUCTION

E. vigursii (Vigurs Eyebright) is confined to Cornwall and Devon where it is considered endangered and is classified as vulnerable (Cheffings & Farrell 2005). Until 1979 it had been located in 53 sites in Cornwall; later

surveys have revealed only 25 active sites. This represents approximately 50% loss of localities in Cornwall mainly due to habitat destruction (French *et al.* 1999). In Devon there are only 2 sites, rediscovered in 1995 and 1998 and situated on the north-west perimeter of Dartmoor National Park. Ecologists at the National Park aim to conserve and increase the population of *E. vigursii* as part of the Dartmoor Biodiversity Action Plan, as it has been categorised in the priority list of the UK steering group report on biodiversity as being of 'global conservation concern' (HMSO 1995). In order to establish a management strategy that would address the objectives of Dartmoor National Park authority, a greater understanding of the ecology of *E. vigursii* and specifically knowledge of the local populations is essential.

The processes and mechanisms that result in species being rare and endemic are complex traits involving interactions of abiotic, biotic and historical factors. Investigating the factors which influence the distribution of *E. vigursii* must therefore involve an amalgamation of demographic, genetic, resource allocation (Davy & Jefferies 1981; Palmer 1987; Schemske *et al.*, 1974) alongside historical systematic and stochastic perturbations (Shaffer 1981).

E. vigursii is a hemiparasitic summer annual, an erect to 20 cm branched therophyte (Grime 1996) located in heathland containing *Ulex gallii* and *Agrostis curtisii* in both Devon and Cornwall. The leaves are dull greyish green often suffused with violet or black (Stace 1999) due to anthocyanin pigment (Pankhurst 1977). The corolla is usually lilac/purple/reddish and on the upper leaves and bracts are long glandular hairs. *E. vigursii* is only one of four diploids in the genus and considered a stable hybrid between *Euphrasia micrantha* and

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FIGURE 1. Location of study sites in Devon and Cornwall.

Euphrasia anglica (Pankhurst 1977). An open grass sward provided by regular grazing and controlled burning (swaling) is considered characteristic of the habitat in which *E. vigursii* is found (Norman Baldock, Ecologist Dartmoor National Park; pers. comm., 2000). Very little specific research on *E. vigursii* has been conducted: therefore, the aims of this study have been to evaluate some of the ecological and environmental parameters influencing three separate populations of *E. vigursii* to gain better understanding of its ecology and habitat requirements and to answer two specific questions:

1. Is *E. vigursii* immediately surrounded by other particular plant species?
2. If the soil was analysed in the direct location of *E. vigursii* would the pH, Nitrogen, Phosphorus and Potassium content differ from areas where *E. vigursii* is not present?

MATERIALS AND METHODS

Two surveys were carried out at each of three locations in Devon and Cornwall (Fig. 1). The first survey entailed micro sampling of the

target species *E. vigursii* to determine at individual plant level the composition of neighbouring plant associations together with recordings of soil nutrients (Potassium, Phosphorus and Nitrogen) and pH status. The second survey involved macrosampling to give a general indication of the vegetative community composition in which *E. vigursii* was found together with the soil nutrient and pH status within areas where *E. vigursii* was not present.

SITE 1

Lydford, Dartmoor National Park, Devon.
Altitude: 320 m. Sample site size: 10 m × 50 m
In the surveyed area *Ulex* spp. (gorse) and heather formed a mosaic of islands surrounded by pathways containing a grass and herbaceous sward. *E. vigursii* was located in most instances at the parameter of mature and new vegetative growth of *U. gallii* and where *A. curtisii* in the 'pathways' was of low sward height and also where periodic swaling had taken place.

SITE 2

St. Neot, Bodmin Moor Cornwall.
Altitude: 170 m. Sample site size: 7 m × 50 m.
The surveyed area contained a linear grass

and herbaceous sward, 15 m wide, which cut through a patchy landscape of gorse, heather and scrubland at the perimeters. *E. vigursii* was situated within the short grass sward from the edge of tall *Ulex* spp. at the perimeter of the survey area to within 5 m of the linear grass sward.

SITE 3

St. Agnes, nr Redruth, Cornwall.

Altitude: 85 m. Sample site size: 3.5 m × 50 m. In the surveyed area there was a blanket of dwarf gorse and heather species with pathways formed by walkers and erosion by the weather. *E. vigursii* was situated approximately 20 m from the cliff edge on one of the many worn paths that connect the coastal path that runs along the cliff edge with a parallel inland pathway. It was present amongst shorter vegetation at each side of the pathway although a greater percentage of the population was situated north east facing and was therefore sheltered from south-westerly winds.

SURVEY METHODS

Each survey site was marked out into a 1 m² grid framework and random co-ordinates used for macro sampling (1 m² quadrats). Micro sampling used 40 mm circular quadrats that were positioned non-randomly; the quadrat was placed over the target species (*E. vigursii* in the centre) and species frequency within the microsampling area recorded. Soil samples were collected 10 mm from the stem of *Euphrasia vigursii*. For the macro survey a 1 m² collapsible quadrat was randomly positioned in the survey area and the percentage cover for each species was recorded. Identification of the floristic species was carried out using keys by Stace (1999), Hubbard (1985) and Fitter *et al.* (1995).

Soil samples were taken from the centre of the quadrat using a 15 mm × 150 mm metal corer, to a depth of 25 mm to 75 mm depending on soil texture. In each survey site 60 soil samples were taken; 30 in the macro quadrats and 30 in the circular micro quadrats.

ANALYSIS OF SOIL SAMPLES

In total the surveys yielded 180 soil samples. Each was crushed and put through a 2 mm metal sieve before testing for pH, Potassium, Phosphorus, and Nitrogen using recommended methodology (ADAS Bulletin RB 427) for NPK and pH while C: N ratio was determined with a Leco FP 2000 C and N Analyser.

COMMUNITY CLASSIFICATION AND PHYTOSOCIOLOGY

In order to define the floristic community in which *E. vigursii* occurs the floristic data (using percentage cover data) were classified using two-way indicator species analysis and the computer program TWINSpan. The TABLEFIT programme was then used to link the resulting communities in to the categories of the National Vegetation Classification (Dinsdale 1997).

The total micro floristic data (frequency data) were also run through TWINSpan and Detrended Correspondence Analysis computer program applied using PC ORD in order to examine which were the associative and most frequent floristic species with *E. vigursii*. This was carried out for the micro floristic data between and in each individual site.

RESULTS

Floristic data and soil cores were obtained from a total of 180 quadrats collected from the three sites. The 90 micro quadrats yielded 21 plant species in total while the macro quadrats contained 28 plant species (Table 1). Bare ground and dead material were also recorded. All the species occurred at both survey scales, apart from *Poa* spp. which was only found only in the micro quadrats.

CLASSIFICATION AND PHYTOSOCIOLOGY

Interpretation of two-way indicator species analysis and definition of plant communities

The classification groups resulting from TWINSpan analysis and synoptic frequency of occurrence within each group are shown in Table 2. Five TWINSpan groups were defined and their associated NVC plant communities categorised (Table 3). Groups 1 and 2 were heath communities of Site 3, St Agnes. In group 1 *Agrostis curtisii*, *Erica cinerea*, *Potentilla erecta*, and *Ulex gallii*, *Thymus* spp., *Serratula tinctoria* and *Ulex europaeus* were frequent; however, there was a low frequency of *Erica tetralix*. In group 2 *Ulex gallii*, *Thymus species*, *Erica tetralix*, *Carex flacca*, *Serratula tinctoria*, *Viola* spp., *Agrostis curtisii* and *Potentilla erecta* were frequent. Dead material was a feature of both groups 1 and 2 and bare ground was a feature of the group 2.

Group 3 were heath communities of Site 1, Lydford. *Agrostis curtisii*, *Ulex gallii*, *Thymus* spp., *Potentilla erecta*, *Galium saxatile* and

TABLE 1. ASSOCIATES OF *EUPHRASIA VIGURSII* IN MACRO AND MICRO SURVEY SITES IN DEVON AND CORNWALL

Macro		Micro
Bare ground	Dead material	
<i>Agrostis capillaris</i>	<i>Pilosella officinarum</i>	<i>Agrostis capillaris</i>
<i>Agrostis curtisii</i>	<i>Plantago lanceolata</i>	<i>Agrostis curtisii</i>
<i>Anthoxanthum odoratum</i>	<i>Polygala serpyllifolia</i>	<i>Carex flacca</i>
<i>Calluna vulgaris</i>	<i>Potentilla erecta</i>	<i>Erica cinerea</i>
<i>Carex flacca</i>	<i>Pteridium aquilinum</i>	<i>Erica tetralix</i>
<i>Dactylis glomerata</i>	<i>Rubus fruticosus</i>	<i>Euphrasia vigursii</i>
<i>Danthonia decumbens</i>	<i>Senecio jacobaea</i>	<i>Galium saxatile</i>
<i>Erica cinerea</i>	<i>Serratula tinctoria</i>	<i>Hypericum</i> spp.
<i>Erica tetralix</i>	<i>Stachys officinalis</i>	<i>Hypochaeris radicata</i>
<i>Euphrasia anglica</i>	<i>Teucrium scorodonia</i>	<i>Lotus corniculatus</i>
<i>Euphrasia micrantha</i>	<i>Thymus</i> spp.	<i>Pilosella officinarum</i>
<i>Euphrasia vigursii</i>	<i>Ulex europaeus</i>	<i>Poa</i> spp
<i>Galium saxatile</i>	<i>Ulex gallii</i>	<i>Potentilla erecta</i>
<i>Holcus lanatus</i>	<i>Vaccinium myrtillus</i>	<i>Senecio jacobaea</i>
<i>Hypericum</i> spp.	<i>Viola</i> spp.	<i>Serratula tinctoria</i>
<i>Hypochaeris radicata</i>		<i>Thymus</i> spp.
<i>Lotus corniculatus</i>		<i>Ulex gallii</i>
<i>Molinia caerulea</i>		<i>Viola</i> spp.

Molinia caerulea were frequent but with low frequencies of *Danthonia decumbens*, *Pilosella officinarum*, *Erica cinerea*, *Carex flacca* and bare ground.

Group 4 and 5 were a mixture of heath, mire, and under shrub communities of Site 2, St Neot. In group 4 *Agrostis curtisii*, *Potentilla erecta*, *Pteridium aquilinum*, *Molinia caerulea*, and *Ulex europaeus* were frequent with a low frequency but high abundance of *Ulex gallii*. Less common was *Agrostis capillaris*. In group 5 *Agrostis curtisii*, *Potentilla erecta*, *Pteridium aquilinum*, *Agrostis capillaris*, *Senecio jacobaea*, *Molinia caerulea* and *Galium saxatile* and *Hypochaeris radicata* were frequent with *Ulex gallii*, *Euphrasia vigursii*, *Carex flacca*, *Euphrasia anglica* and *Anthoxanthum odoratum* less so.

Euphrasia vigursii was found to be most frequent in group 2 (7 quadrats) at Site 3 compared to its presence in Site 3, group 1 (1 quadrat); Site 1, group 3 (1 quadrat) and Site 2, group 5 (4 quadrats). In group 2 it was associated with NVC U3, H4 and H8 (Table 3). The quadrats in which *E. vigursii* was found in the other groups were classified as NVC: U3; M25a – *Erica tetralix* sub community; H4 and H8b *Danthonia decumbens* sub community.

DIRECT ORDINATION WITH *E. VIGURSII* USING DETRENDED CORRESPONDENCE ANALYSIS (DCA)

The distribution of the floral species from all three sites formed distinct floristic groups with the exception of *Erica cinerea*, *Hypochaeris radicata* and *Agrostis curtisii* (Fig. 2).

There was close correlation between *A. curtisii* and *E. vigursii* in terms of how frequent *A. curtisii* was encountered in each of the micro quadrats at all of the sites.

When the sites were individually analysed using DCA there were still strong correlations between *A. curtisii* and *E. vigursii* (Fig. 2) although not all the species named were present within each site.

In Site 1 there were close correlations of *E. vigursii* with *A. curtisii*, *Potentilla erecta*, and *Pilosella officinarum*. Species which showed as outliers in this site were *Lotus corniculatus*, *Ulex gallii*, *Thymus* spp. and *Erica tetralix*.

In Site 2 *E. vigursii* was strongly correlated with *A. curtisii* and *P. erecta* and associated with *Agrostis capillaris*, *Viola* spp. and bare ground whilst the species that show as outliers were *Galium saxatile*, *Carex flacca* and *Hypochaeris radicata*.

TABLE 2. SPECIES COMPOSITION OF THE THREE COMMUNITY TYPES DEFINED BY TWO-WAY INDICATOR SPECIES ANALYSIS OF THE QUADRAT DATA FROM THE THREE SITES OF *EUPHRASIA VIGURSII* IN DEVON AND CORNWALL

Species	Twinspan group				
	1	2	3	4	5
<i>Ulex gallii</i>	V	VI	VI	III	III
<i>Euphrasia vigursii</i>	II	III	I		III
<i>Thymus</i> spp.	V	VI	IV		
<i>Erica tetralix</i>	II	VI	IV		
<i>Carex flacca</i>	VI	IV	III	II	III
<i>Hypochaeris radicata</i>	IV	IV		II	IV
<i>Dactylis glomerata</i>	II	III			
<i>Teucrium scorodonia</i>		III			
<i>Stachys officinalis</i>		III			
<i>Serratula tinctoria</i>	VI	VI			
<i>Viola</i> spp.	V	VI	II		II
<i>Erica cinerea</i>	VI	III	III		II
<i>Plantago lanceolata</i>	II	II			II
<i>Ulex europaeus</i>	IV	II		V	II
<i>Agrostis curtisii</i>	III	VI	VI	VI	VI
<i>Potentilla erecta</i>	VI	VI	VI	VI	VI
<i>Vaccinium myrtillus</i>			III		
<i>Pilosella officinarum</i>		II	III		
<i>Danthonia decumbens</i>			III		
<i>Euphrasia micrantha</i>			I		
<i>Calluna vulgaris</i>			IV		II
<i>Polygala serpyllifolia</i>			III	II	II
<i>Euphrasia anglica</i>			II	II	III
<i>Galium saxatile</i>			VI	II	VI
<i>Lotus corniculatus</i>		II	II	II	
<i>Molinia caerulea</i>			VI	VI	IV
<i>Hypericum</i> spp.				II	II
<i>Pteridium aquilinum</i>				VI	VI
<i>Senecio jacobaea</i>				III	VI
<i>Anthoxanthum odoratum</i>					III
<i>Holcus lanatus</i>					IV
<i>Agrostis capillaris</i>			I	III	VI
<i>Rubus fruticosus</i>					II
Bare ground	II	IV	II	II	III
Dead material	VI	IV			

Key to species frequency in each group:

I = 1–5%; II = 6–20%; III = 21–40%; IV = 41–60%; V = 61–80%; VI = 81–100%

TABLE 3. CORRELATION OF NVC COMMUNITIES WITH INDICATOR SPECIES GROUPS AND STUDY SITES

Two way indicator species groups	NVC communities
1	H6 <i>Erica vagans</i> – <i>Ulex europaeus</i> heath H8 <i>Calluna vulgaris</i> – <i>Ulex gallii</i> heath H4 <i>Ulex gallii</i> – <i>Agrostis curtisii</i> heath
2	H8 <i>Calluna vulgaris</i> – <i>Ulex gallii</i> heath U3 <i>Agrostis curtisii</i> heath
3	U3 <i>Agrostis curtisii</i> heath H4 <i>Ulex gallii</i> – <i>Agrostis curtisii</i> heath H8 <i>Calluna vulgaris</i> – <i>Ulex gallii</i> heath
4	U3 <i>Agrostis curtisii</i> heath U20 <i>Pteridium aquilinum</i> – <i>Galium saxatile</i> community W25 <i>Pteridium aquilinum</i> – <i>Rubus fruticosus</i> underscrub M25 <i>Molinia caerulea</i> – <i>Potentilla erecta</i> mire
5	U3 <i>Agrostis curtisii</i> heath W25 <i>Pteridium aquilinum</i> – <i>Rubus fruticosus</i> underscrub M25 <i>Molinia caerulea</i> – <i>Potentilla erecta</i> mire
Site	NVC communities
Site 1	U3 <i>Agrostis curtisii</i> heath H4 <i>Ulex gallii</i> – <i>Agrostis curtisii</i> heath H8 <i>Calluna vulgaris</i> – <i>Ulex gallii</i> heath
Site 2	U3 <i>Agrostis curtisii</i> heath U20 <i>Pteridium aquilinum</i> – <i>Galium saxatile</i> community M25 <i>Molinia caerulea</i> – <i>Potentilla erecta</i> mire W25 <i>Pteridium aquilinum</i> – <i>Rubus fruticosus</i> underscrub
Site 3	H4 <i>Ulex gallii</i> – <i>Agrostis curtisii</i> heath H6 <i>Erica vagans</i> – <i>Ulex europaeus</i> heath H8 <i>Calluna vulgaris</i> – <i>Ulex gallii</i> heath U3 <i>Agrostis curtisii</i> heath

In Site 3 close associations were apparent between *E. vigursii*, *Hypochaeris radicata* and *Agrostis curtisii* as well as *Ulex gallii* and *Potentilla erecta*. Species that were outliers and therefore showed less of an association were *Serratula tinctoria*, *Carex flacca*, *Erica tetralix* and *Erica cinerea*.

ENVIRONMENTAL SITE COMPARISON

The macro results for both the UNIANOVA analysis (Potassium and Phosphorus) and for the Kruskal-Wallis test (pH and Nitrogen) indicate significant differences between the sites for environmental variables ($P < 0.05$). Differences were observed in pH between the macro and micro-quadrats in Site 2 and Site 3 but not in Site 1 (Fig. 3). However, mean values for the micro quadrats were higher than for the macro quadrats at all three sites.

On the sites surveyed, *E. vigursii* distribution was strongly linked to soil micro-environment,

germination correlating with a pH range from 3.3 to 4.8, a Potassium range of between 15 mg/100 g to 53.60 mg/100 g, a Phosphorus range between 0.04 mg/100 g and 7.44 mg/100 g and a Nitrogen range between 0.34% and 9.62%. Results of the UNIANOVA analysis indicated a significant difference in Phosphorus levels ($F = 7.446$, $P > 0.05$) but the results for Potassium were not significant. Results of the Kruskal-Wallis test indicated a significant difference in pH ($P < 0.05$) and in Nitrogen ($P < 0.05$) between the spatial scales (micro and macro). Chemical comparisons of the individual sites at micro and macro levels revealed significant differences in Phosphorus levels at Site 1 (t-test, $P < 0.05$), and pH levels at Site 2 and Site 3 (Kruskal-Wallis test, $P < 0.05$). No significant differences were seen in the other parameters recorded. Comparing these results with the descriptive vegetation analyses suggests that *E. vigursii* distributions generally link with higher levels of nutrients and pH.



FIGURE 2. Combined Ordination plot of total floristic species associated with *Euphrasia vigursii* from Detrended Correspondent Analysis of the ninety micro quadrats in Site 1, Site 2 and Site 3.

DISCUSSION

FLORISTIC COMMUNITY

The phytosociological analysis indicates that *E. vigursii* is a species associated with heath and acidic grassland communities typically containing *Ulex gallii*, *Agrostis curtisii*, *Calluna vulgaris* together with *Molinia caerulea* and *Potentilla erecta* mire. In all the sites there are external influences which reduce the plant communities' ability to transpire to successional community processes.

Colonisation in these communities by plants is limited to those species that are characteristically tolerant of environmental stresses, low nutrient availability and low soil pH (acidity), which in turn is associated with high Aluminium and Iron toxicity (Crawley 1997). Acidification of soil is a result of influences of the base substrate by mineral weathering, temperature, hydrology and leaching (Crawley 1997). Particular plant species can acidify the immediate edaphic environment, for example *Calluna* and *Ulex* species produce strong acidifying litter which rapidly reduces the pH

of the soil beneath them (Grubb & Suter 1971).

ASSOCIATED FLORA OF *E. VIGURSII*

Germination of *E. vigursii* within the microenvironment was closely correlated with the presence of *A. curtisii* as opposed to its other known host species, *U. gallii*. Studies by Silverside (1999) however, indicate the opposite – i.e. *E. vigursii* apparently avoids the more open, species-poor areas dominated by *A. curtisii*. Silverside does mention, however, that *E. vigursii* is frequently reported as an associate.

The species that are associated with *E. vigursii* (Tables 1 and 3) have attributes, apart from *Carex flacca*, for counteracting low nutrient availability by the adoption of possessing VA mycorrhizals (Grime 1996). They therefore have the ability to use normally unavailable complex organic nitrogen sources, making them less dependant on mineralisation of organic matter (Aerts 1999). Nutrient-poor ecosystems are associated with low litter production and slow decomposition that leads to low rates of Nitrogen cycling; the ability to

survive in such environments may prevent the invasion of highly competitive species dependant on high Nitrogen availability (Aerts 1999). *E. vigursii* does not possess symbiotic associations such as mycorrhizals but can, if resources are inadequate, parasitise other species, forming haustoria to obtain water, mineral nutrients and carbohydrates from the host's root system. (Lammi *et al.* 1999).

ENVIRONMENTAL VARIABLES

pH

Significant differences in pH were evident between macro and micro environments in sites 2 and 3 with levels ranging between 3.4 and 4.35. In Site 1 pH levels for both macro and micro samples were intermediate between these ranges and not significantly different, which suggests that in Site 1 any micro site would be suitable for germination in terms of pH preference. pH levels can be a good indicator of the nutrient availability to plants in a soil and previous work indicates that soils may show small scale heterogeneity in pH levels over small distances (Crawley 1997). This has been confirmed in this study.

Phosphorus

In Site 1 *E. vigursii* had germinated in a microsite significantly higher in Phosphorus than the macro environment (Fig. 3) suggesting a preference for Phosphorus levels that range from 0.26 mg/100 g to 19.01 mg/100 g. Phosphorus and Nitrogen are considered the two limiting factors which control plant growth and are geo-chemically complex (Zheng *et al.* 1999). There was a significant difference between the sites; in particular Site 1 had generally low levels of Phosphorus. In environments with low pH levels Phosphorus availability can be limited. However, if pH levels are increased Phosphorus utilisation improves more markedly than that of Potassium or Nitrogen (Rorison 1971). Low pH levels are associated with deficiency in Calcium, an element that renders phosphoric acid unavailable to plants and which might account for the lower levels observed. (Crawley 1997).

Potassium

E. vigursii germinated in a micro environment with Potassium levels ranging from 26.2 mg/100 g to 52.5 mg/100 g. Although differences between the macro and micro environment for each site were not statistically significant, in Site 1 the mean Potassium levels

were slightly lower in the micro environment. There was a significant difference between the sites (Fig. 3) and the mean levels were higher in Site 1 than in Site 2 and Site 3, which could be the result of periodic swaling. Higher levels of Potassium have been reported in ash deposits following normal management fires although much is lost through leaching (Legg *et al.* 1992).

Nitrogen

No significant differences between Nitrogen supply at macro and microsite level were evident at any of the sites, but there was a definite trend for increased levels where *E. vigursii* had germinated. There were significantly higher Nitrogen levels in Site 1, possibly linked to the grazing regimes in place. Nitrogen levels in grazed swards fluctuate with patterns of defoliation and severity of grazing determines the relative importance of the two Nitrogen recycling pathways: internal recycling – remobilization from senescent leaves; and external recycling – via animal intake and urine and faeces return (Lemaire & Chapman 1996). The former process is subject to leaching and gaseous loss, increasing the stock rates within grazing systems and thus leading to lower of Nitrogen utilisation efficiency by vegetation when uptake rates are lower than input rates. (Lemaire & Chapman 1996).

Spatial distribution of *E. vigursii*

The position in a habitat of an individual plant is determined by its capability for colonisation, competition and longevity and that is dependent initially on its immediate spatial separation from neighbours (Ross & Harper 1972; Tilman 1994).

E. vigursii has to recognise, after the arrival of a seed in a micro site, the location of a potential host species which is an important factor in determining its survival; it does not have a persistent seed bank (Grime 1996). Studies on species of *Euphrasia* in cultivation indicate that when a seed is planted 2.5 cm from a host, it establishes a week earlier than those spaced 4.5 cm and two weeks earlier than those spaced 6.5 cm apart; the latter also result in lower percentage survival (Yeo 1964). In addition the seeds are very small (<1 mm) and wind dispersed (Stace 1999) and upon landing are subjected to a highly heterogeneous micro soil surface. As a result they may require a particular morphological dispersal site in order to establish (Harper *et al.* 1965).

The soil solution contains dissolved substances that can affect germination, in

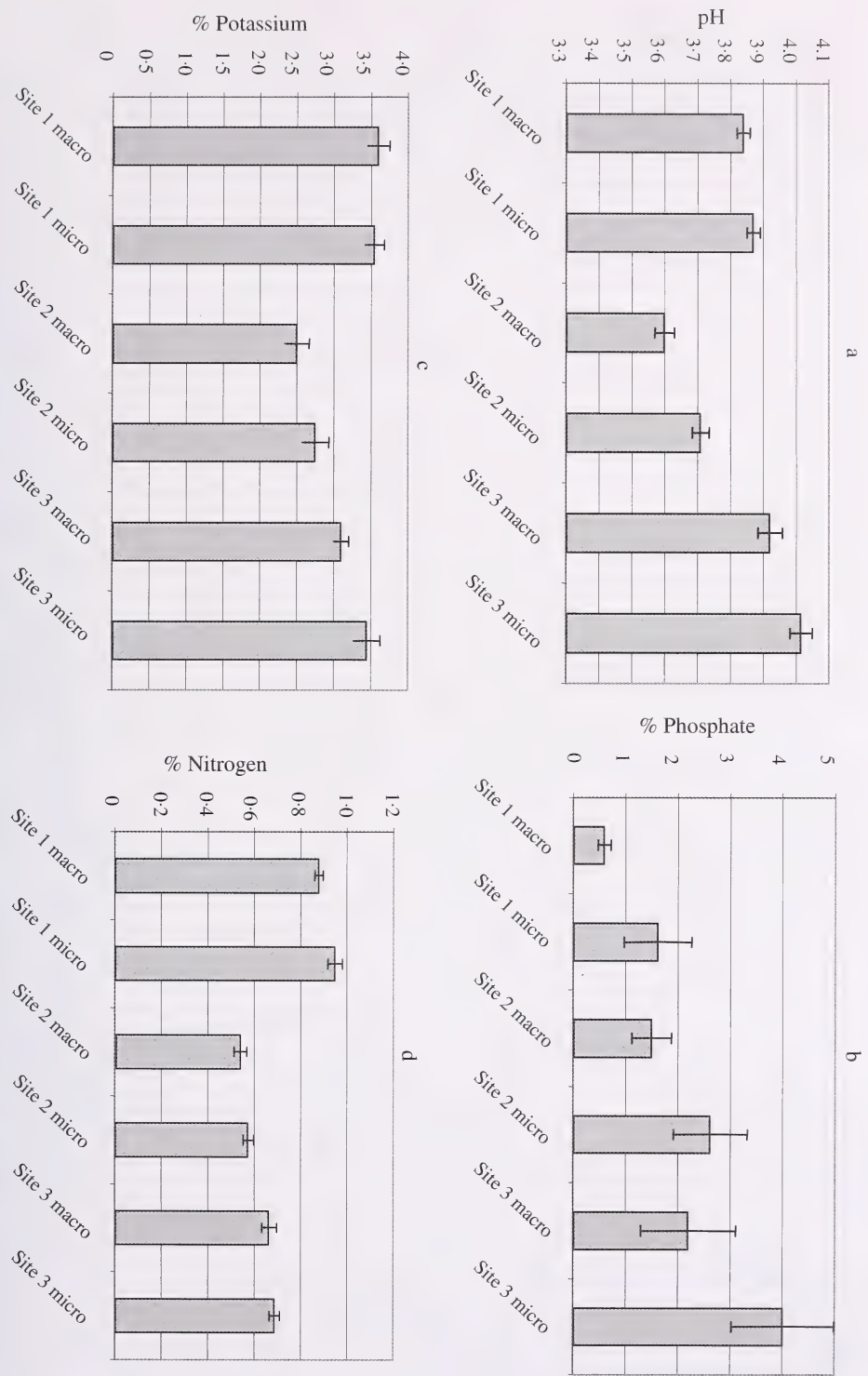


FIGURE 3 (a) Soil pH, (b) Phosphorus, (c) Potassium and (d) Nitrogen values in Macro and Micro Quadrats in Site 1, Site 2 and Site 3. Vertical bar = $\pm$ standard deviation.

particular allelochemicals that inhibit germination; but the host plants of parasitic angiosperms produce chemical signals that stimulate germination of the parasitic seeds and allelochemicals at low concentrations may also be stimulatory (Karssen & Hilhorst 1992). It is possible that nutrient and pH levels may also indicate the spatial position in relation to a host species.

The subsurface of the edaphic environment contains a matrix of root systems and although in this study *E. vigursii* has been found to be closely associated with *A. curtisii*, it remains possible that new young plants of *Ulex gallii* were also forming but were not detected above ground level. *Euphrasia* species show a particular preference for Leguminosae over Gramineae because of increased Nitrogen fixation (Yeo 1964).

Competition

The species associated with *E. vigursii* are predominately of low or retarded growth, either because they have an ascending growth form or their vigour is kept in check by grazing or abiotic influences. A separate study by Dartmoor National Park (Norman Baldock, Ecologist Dartmoor National Park; unpublished data 1997) targeted a 10 m × 10 m grazing exclusion site close to Site 1. This reported that over a seven year period shrubby species such as *Ulex* and *Calluna* formed a dense canopy reducing the frequency and abundance of low herb species. Heathland communities are a direct result of disturbance by natural stochastic events or anthropogenic management regimes and are considered an essential resource for seasonal grazing of livestock by farmers. Disturbance of heath and grassland communities by fire and grazing blocks succession to dominant competitive species (Smith & Rushton 1994). Selective grazing produces a patchy distribution of vegetation and irregular edges, creating gaps (Hearn 1995; Bullock *et al.* 1994) which can be utilised by species which require high light availability and are poor competitors. This is considered an essential factor in successful colonisation of *E. vigursii* (Yeo 1964).

The main associate with *E. vigursii* is *Agrostis curtisii*, which can be found in a number of important heathland communities where it can form dense patches and is considered unpalatable to herbivores. It is highly competitive with other Poaceae species, not by its ability to compete for light but its

ability to reduce possible establishment sites for other Poaceae species due to its dense sward; it is also known to become especially abundant after burning (Rodwell 1992) together with *Ulex* species (Grime 1996). *Euphrasia* species and rare species in general and are considered superior competitors to common grasses (Rabinowitz 1981).

Potentilla erecta can have either a prostrate or ascending growth form which reduces the damage caused by trampling and is not as readily grazed, affording a competitive advantage in grazed situations (Hearn 1995). Similarly *E. vigursii* also overcomes possible competitive interactions with other low growing species by forming dense clusters of individual plants (Yeo 1964). Inter and intra-specific interactions between individuals may occur in *E. vigursii*, as Yeo also reports that *Euphrasia* species can parasitise more than one host at a time – for example *Carex curta*, *Poa annua* and *Trifolium pratense*, and also members of its own species.

Many endangered endemic species have low population numbers, together with small geographical ranges and narrow habitat specificity which can cause natural selection to favour traits which offset the disadvantages of small local population size (Rabinowitz 1981). However, natural selection can also reinforce narrow habitat selection imposing further distribution restrictions (Rosenzweig & Lomolino 1997). *E. vigursii* is able to coexist with species that have adapted to benefit from an environment that is otherwise hostile to many of the common competitive species and its habitat preference and choice is a result of evolutionary habitat selection (Bazaz 1991).

Within this study it has become evident that there are differences in environmental variables at the areas where *E. vigursii* has germinated and those where it has not and that there are significant spatial associations with particular plant species not normally closely associated. Significantly, variation in the environmental parameters may reflect the present management regimes within the of the Dartmoor sites. The evidence from these sites indicates that management within preferred habitats should continue to maintain gaps and habitat heterogeneity, but further research is required into temporal affects of management, influences of grazing and fire regimes on edaphic factors and also the key floristic species which associate with *E. vigursii*.

REFERENCES

- AERTS, R. (1999). Interspecific competition in natural plant communities: mechanisms, trade-offs and plant-soil feedbacks. *Journal of Experimental Botany* **50**: 29–37.
- BAZAZ, F. A. (1991). Habitat selection in plants. *The American Naturalist* **137** (Supplement): S116–S130.
- BULLOCK, J. M., HILL, B., DALE, M. P. & SILVERTOWN, J. (1994). An experimental study of the effects of sheep grazing on vegetation change in a species-poor grassland and the role of seedling recruitment into gaps. *Journal of Applied Ecology* **31**: 493–507.
- CHEFFINGS, C. M. & FARRELL, L. eds. (2005). *The Vascular Plant Red Data List for Great Britain. Species Status 7*: 1–116. Joint Nature Conservation Committee, Peterborough.
- CRAWLEY, M. J. (1997). Life History and Environment, in M. J. CRAWLEY ed. *Plant Ecology*, 2nd Edition. Blackwell Science.
- DAVEY, A. J. & JEFFERIES, R. L. (1981). Approaches to the monitoring of rare plant populations, in *The biological aspects of rare plant conservation*. John Wiley & Sons.
- DINSDALE, J., DALE, P. & KENT, M. (1997). The biogeography and historical ecology of *Lobelia urens* L. (the heath lobelia) in Southern England. *Journal of Biogeography* **24**: 153–175.
- FITTER, R., FITTER, A. & FARRER, A. (1995). *Grasses, sedges, rushes, and ferns of Britain and Northern Europe*. HarperCollins, Hong Kong.
- FRENCH, C. N., MURPHY, R. J. & ATKINSON, M. G. C. (1999). *Flora of Cornwall. Atlas of the flowering plants and ferns of Cornwall*. Wheal Seton Press, Camborne.
- GRIME, J. P., HODGSON, J. G. & HUNT, R. (1996). *Comparative Plant Ecology: A functional approach to common British species*. Chapman & Hall, London.
- GRUBB, P. J. & SUTER, M. B. (1971). The mechanism of acidification of soil by *Calluna* and *Ulex* and the significance for conservation, in E. DUFFEY & A. S. WATT eds. *The Scientific Management of Animal and Plant Communities for Conservation*. Blackwell Scientific Publications, Edinburgh.
- HARPER, J. L., WILLIAMS, J. T. & SAGAR, G. R. (1965). The behaviour of seeds in soil. 1. The heterogeneity of soil surfaces and its role in determining the establishment of plants from seed. *Journal of Ecology* **53**: 273–286.
- HEARN, K. A. (1995). Stock grazing of semi-natural habitats on National Trust Land. The National Trust and nature conservation 100 years on. *Biological Journal of the Linnean Society* **56** (Supplement) 25–37.
- HMSO (1995). *Biodiversity: the UK Steering Group Report 1995*. Volume 2. Action Plans. HMSO, London.
- HUBBARD, C. E. (1985). *Grasses: A guide to their structure, identification, uses and distribution in the British Isles*. Penguin Books, London.
- KARSSSEN, C. M. & HILHORST, H. W. M. (1992). Effect of chemical environment on seed germination, in M. FENNER ed. *Seeds: The Ecology of Regeneration in Plant Communities*. C.A.B. International, Wallingford, Oxford.
- LAMMI, A., PIKKO, S. & SALONEN, V. (1999). The role of local adaptation in the relationship between an endangered root parasite *Euphrasia rostkoviana* and its host *Agrostis capillaris*. *Ecography* **22**: 145–152.
- LEMAIRE, G. & CHAPMAN, D. (1996). Tissue flows in grazed plant communities, in J. HODGSON & A. W. ILLIUS eds. *The Ecology and management of grazing systems*. C.A.B. International, Wallingford, Oxford.
- LEGG, C. S., MALBY, E. & PROCTOR, M. C. F. (1992). The ecology of severe moorland fire on the Yorkshire Moors: Seed distribution and seedling establishment of *Calluna vulgaris*. *Journal of Ecology* **80**: 737–752.
- PALMER, M. E. (1987). A critical look at rare plant monitoring in the United States. *Biological Conservation* **39**: 113–127.
- PANKHURST, R. J. (1977). The identification of the British species of *Euphrasia* L. (Eyebrights) (experimental draft). Pankhurst, R. J., London.
- RABINOWITZ, D. (1981). Seven forms of rarity, in H. SYNGE ed. *The Biological Aspects of Rare Plant Conservation*. John Wiley & Sons Ltd., Bognor Regis.
- RORISON, I. H. (1971). The use of nutrients in the control of floristic composition of Grassland, in E. DUFFEY & A. S. WATT eds. *The Scientific Management of Animal and Plant Communities for Conservation*. Blackwell Scientific Publications, Edinburgh.
- ROSENZWEIG, M. L. & LOMOLINO, M. V. (1997). Who gets the short bits of the broken stick? in W. E. KUNIN & K. J. GASTON eds. *The Biology of Rarity*. Chapman & Hall, London.
- ROSS, M. A. & HARPER J. L. (1972). Occupation of biological space during seedling establishment. *Journal of Ecology* **60**: 77–88.
- SCHEMSKE, D. W., HUSBAND, B. C., RUCKLESHAUS, M. H., GOODWILLIE, C., PARKER, I. M. & BISHOP, J. G. (1974). Evaluating approaches to the conservation of rare and endangered plants. *Ecology* **75**: 584–606.
- SHAFFER, M. L. (1981). Minimum population sizes for species conservation. *BioScience* **31**: 131–143.
- SILVERSIDE, A. J. (1999). *Euphrasia*, in M. WIGGINGTON ed. *British Red Data Books. 1. Vascular Plants 3rd Edition*. Joint Nature Conservation Committee, Peterborough.
- SMITH, R. S., RUSHTON, S. P. (1994). The effects of grazing management on the vegetation of mesotrophic (meadow) grassland in Northern England. *Journal of Applied Ecology* **32**: 13–24.

- STACE, C. A. (1999). *Field flora of the British Isles*. Cambridge University Press, Cambridge.
- TILMAN, D. (1994). Competition and biodiversity in spatially structured habitats. *Ecology* **75**: 2–16.
- YEO, P. F. (1964). The growth of *Euphrasia* in cultivation. *Watsonia* **6**: 1–24.
- ZHENG, D. W., AGREN, G. I. & BENHGTSSON, J. (1999). How do soil organisms affect total organic nitrogen storage and substrate nitrogen to carbon ratio in soils? A theoretical analysis. *Oikos* **86**: 430–442.

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Clonal diversity in British populations of the alien invasive Giant Knotweed, *Fallopia sachalinensis* (F. Schmidt) Ronse Decraene, in the context of European and Japanese plants

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ABSTRACT

Fallopia sachalinensis (F. Schmidt) Ronse Decraene was introduced to Europe during the 19th century, and whilst not as invasive as the notorious *F. japonica* var. *japonica* (Houtt.) Ronse Decraene, it is still an invasive plant capable of both clonal and sexual reproduction. It is also a significant pollen source for the male-sterile *F. japonica* var. *japonica*, producing the highly invasive hybrid *F. xbohemica* (Chrtěk & Chrtěková) J. P. Bailey. Given the lack of diversity in *F. japonica* var. *japonica*, *F. sachalinensis* is a potentially important source for introducing novel variation into *F. xbohemica*. The majority of British *F. sachalinensis* was found to be one of two widespread genotypes, either a male-fertile or a male-sterile clone. In contrast there was a much higher level of genetic variation detected in both the rest of the introduced range and in the native range. Evidence is given for two separate introductions of native material into Britain; one from Niigata, Honshu, directly into Britain, and the other from Northern Japan, via St. Petersburg (Russia) to Europe.

KEYWORDS: genetic variation, introduced plants, Giant knotweed, Polygonaceae.

INTRODUCTION

The introduction of plants to new environments often brings together species that may not have been sympatric in their native range. These factors can lead to interspecific hybridisation occurring between a native and an invading plant species, or two invading species. This

hybridisation can have numerous effects, the extremes being the evolution of new plant taxa e.g. *Senecio cambrensis* Rosser, which arose as an allohexaploid hybrid between Groundsel, *S. vulgaris* L., and the introduced species, Oxford Ragwort, *S. squalidus* L. (Harris & Ingram 1992), or the extinction of the native species (Sakai *et al.* 2001).

Genetic variation may be lower in newly established introduced populations because either the number of plants introduced is often small or genetic drift during colonization may reduce genetic variation in the newly established population. Thus a newly established population is likely to be much less genetically diverse than the population from which it is derived (Sakai *et al.* 2001). When an introduced ornamental plant can be easily propagated by vegetative means, such as is the case with Japanese Knotweed *sensu lato* (*s.l.*) the likelihood is that very little material is introduced at any one time.

Clonal growth is a widespread phenomenon in the plant kingdom, which can also occur in lichens, fungi and some groups of lower animals. Plants can reproduce clonally in many ways, including the formation of ramets on creeping stems above or belowground, and the vegetative production of plantlets and bulbils on aerial plants (Stuefer *et al.* 2001). For the plants that comprise the group Japanese Knotweed *s.l.*, clonal spread is achieved through large underground rhizomes, and in the case of the most renowned member of the group,

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TABLE 1. LOCATION DETAILS OF *F. SACHALINENSIS*, SEX OF THE PLANT WHERE KNOWN, CHLOROPLAST HAPLOTYPE (MPH) AND GENOTYPE (G) RESULTS

Plant ID	MPH	G	Location	Grid reference/ location	Sex
B9	6	i1	Caernywnich, Water gardens, Wales	SH7518	male-fertile
B10	6	i1	Caernywnich, Wales	SH7518	male-fertile
B11	6	i1	Congerstone, Leicestershire, England	SK3605	male-fertile
B12	6	i4	Wanlip, Leicestershire, England	SK5919	
B13	6	i1	Amroth Beach, Wales	SN1608	male-fertile
B14	6	i1	Amroth, Wales	SN1608	male-fertile
B15	6	i4	Cwrt Newydd, Wales	SN4947	male-sterile
B16	6	i4	Howey village, Wales	SO0558	male-sterile
B17	6	i1	Nant Y Frith, Wales	SO2654	male-fertile
B18	6	i1	Cirencester Roundabout, England	SP0201	male-fertile
B19	6	i1	Cirencester Abbey grounds, England	SP0202	male-fertile
B20	6	i6	Guys Cliff, Warwick, England	SP2865	male-sterile
B21	6	i6	Guys Cliff, Warwick, England	SP2865	male-sterile
B22	6	i4	Epwell, Warwicks, England	SP3540	
B23	6	i4	Nuneaton, Warwickshire, England	SP3592	
B24	6	i4	Tiscott, Cornwall, England	SS2309	male-sterile
B25	6	i4	Coed-y-felin Woods, Wales	ST1882	male-sterile
B26	6	i4	Scarrier, Cornwall, England	SW7244	male-sterile
B27	6	i4	Polzeath, Cornwall, England	SW9378	male-sterile
B28	6	i13	Christchurch road, South Hampshire, England	SZ2392	male-fertile
B29	6	i1	Hempstead Old Rectory, England	TG4028	male-fertile
B30	1	i8	Colchester, Bunting's nursery, England	TM0025	male-sterile
B31	1	i16	Colchester, Bunting's nursery, England	TM0025	male-fertile
G1	6	i15	Aachen, Germany		male-fertile
G2	6	i14	Aachen, Stadtwald, Germany		male-fertile
G3	6	i9	Aachen, Stadtwald, Germany		male-sterile
G4	6	i3	Leverkusen, Germany		
G5	6	i10	Umminger, Germany		
C1	6	i5	Konopiste, (Benesov), Czech Republic		male-sterile
C2	6	i4	Kostelec, (Kolin.), Czech Republic		male-sterile
U1	6	i7	Aberdeen, Washington, USA		male-sterile
U2	6	i12	125th Street, Seattle, USA		male-fertile
J1	1	n2	Joetsu, Niigata, Honshu, Japan	N 37 06 E 138 15	
J2	1	n13	Joetsu, Niigata, Honshu, Japan	N 37 06 E 138 15	
J3	4	n10	Yonezawa Rd, Fukushima, Honshu, Japan	N 37 50.37 E 140 22.36	
J4	4	n11	Yonezawa Rd, Fukushima, Honshu, Japan	N 37 50.37 E 140 22.36	male-fertile
J5	5	n15	Zao Quasi National Park, Yamagata, Japan	N 38 07.73 E140 26.19	
J6	2	n8	Mt. Aoba-yama, Miyagi, Honshu, Japan	N 38 15.00 E 140 53.14	male-fertile
J7	5	n5	Yamagata, Japan	N 38 38.97 E 140 10.36	male-fertile
J8	2	n12	Eai River Valley, Miyagi, Honshu, Japan	N 38 44.05 E 140 46.12	
J9	3	n3	Hirosaki, Iwaki river, Aomori, Honshu, Japan	N 40 36.00 E 140 26.37	male-sterile
J10	3	n14	Hirosaki, Iwaki river, Aomori, Honshu, Japan	N 40 36.00 E 140 26.37	male-fertile

TABLE 1 CONTINUED

Plant ID	MPH	G	Location	Grid reference/ location	Sex
J11	6	n1	Memuro, Hokkaido, Japan	N 42 50.12 E 143 00.44	
J12	6	n7	Memuro, Hokkaido, Japan	N 42 50.12 E 143 00.44	
J13	6	n6	Memuro, Hokkaido, Japan	N 42 50.12 E 143 00.44	
J14	6	n4	Ishikari, Hokkaido, Japan	N 43 12.24 E 141 23.11	
J15	6	n9	Ishikari, Hokkaido, Japan	N 43 12.24 E 141 23.11	
J16	6	n16	Ishikari, Hokkaido, Japan	N 43 12.24 E 141 23.11	

i – genotype possessed by a plant from the introduced range

n – genotype possessed by a plant from the native range

Fallopia japonica var. *japonica* (Houtt.) Ronse Decraene, as little as 0.7 g is required to give rise to a new plant (Brock & Wade 1992). Well-established plants develop woody stocks with a central taproot that penetrates vertically into the ground. Buds form on the stock and woody rhizomes between autumn and winter, and emerge to give vertical shoots the following spring. Woody stocks continue to increase in width by secondary thickening with age, and also produce lateral creeping rhizomes within their first year (Beerling *et al.* 1994). The rhizomes of a mature plant can extend up to 7 m away from the parent plant (Child & Wade 2000).

Japanese Knotweed *s.l.* comprises taxa from the genus *Fallopia* Adans., section *Reynoutria* (Houtt.) Ronse Decr. This includes *F. japonica*, which in Britain can be found as both var. *japonica* and var. *compacta* (Houtt.) Ronse Decr. (Hook. f.) J. P. Bailey; *F. sachalinensis* (F. Schmidt) Ronse Decr., which is also commonly known as Giant Knotweed; the hybrid between *F. japonica* and *F. sachalinensis* called *F. ×bohemica* (Chrtek & Chrtková) J. P. Bailey; and any backcrosses these plants may form (Bailey & Conolly 2000). The different species were introduced to Britain from parts of Asia at various times during the 19th century whilst the hybrids are believed to have arisen since the introduction of the parental species.

Fallopia japonica var. *japonica*, the most common of the Japanese Knotweed *s.l.* plants in Europe, was shown to be represented in

Britain by a single male-sterile octoploid ($2n = 88$) clone. This clone was also found in France, Germany, the Czech Republic and the U.S.A. (Hollingsworth & Bailey 2000a), and in Holland (Pashley 2003). In contrast there appeared to be higher levels of genetic variation within the UK in the related Giant Knotweed, *F. sachalinensis* (Hollingsworth 1998; 2000b), than in the other introduced *Fallopia* species.

Fallopia sachalinensis was first recorded in the wild in Germany in 1869, in the Czech republic in 1869, and in Great Britain in 1896 (Sukopp & Starfinger 1995). Examination of historical plant collection and distribution records suggest that there were at least two routes by which *F. sachalinensis* may have arrived in Europe. The first is via St. Petersburg, Russia, and the second route is via Kew Botanic Gardens, London (Bailey & Conolly 2000). *F. sachalinensis* has not spread to the same extent as *F. japonica* var. *japonica*. Instead, its occurrence appears to reflect many independent primary escapes (Conolly 1977). *F. sachalinensis* may not be as invasive as *F. japonica* var. *japonica*, but it can be a significant pollen source for the male-sterile *F. japonica* var. *japonica*, producing the hybrid *F. ×bohemica* (Chrtek & Chrtková) J. P. Bailey. *F. ×bohemica* is gaining in notoriety, and is thought to be at least as invasive as *F. japonica* var. *japonica* (Brabec & Pyšek 2000; Bímová *et al.* 2001). Given the lack of diversity in *F. japonica* var. *japonica*, and the rarity of *F. japonica* var. *compacta* (Hook. f.) J. P. Bailey

(the alternative *F. japonica* parent for *F. ×bohemica*), the genetic composition of *F. sachalinensis* is an important factor for potentially introducing novel variation into *F. ×bohemica*.

AIMS

The main aims of this study were to estimate levels of genetic variation among British *F. sachalinensis*, in order to determine whether sexual reproduction or clonal spread best explain the current distribution. We have compared genetic diversity within the British plants to a limited number of plants from other countries where *F. sachalinensis* has been introduced, namely Germany, the Czech Republic, and the USA, to see if the genetic diversity within Britain is similar or different from the rest of the introduced range. We have investigated the levels of genetic variation among native *F. sachalinensis* from Japan in order to compare levels of genetic diversity between the introduced and native range, and to potentially determine the region of Japan from which the introduced plants originated.

MATERIALS AND METHODS

PLANT MATERIAL

Leaf material was obtained from 56 *F. sachalinensis* accessions, 40 from the introduced range and 16 from the native, as detailed in Table 1. The introduced plants include 31 individuals representing 21 populations from Britain, five from Germany, two from the Czech Republic and two from the USA. The 16 native plants were chosen to represent the geographical distribution of the plants within Japan. Voucher specimens for each accession were collected and deposited at the University of Leicester herbarium (LTR).

DNA EXTRACTION

Total genomic DNA was isolated from approximately 100 mg of fresh leaf tissue using the DNeasy plant mini kit (QIAGEN, Valencia, CA). Duplicate extractions were prepared for each plant.

CHLOROPLAST RFLP ANALYSIS

The chloroplast regions *trnC-trnD* and *trnF-trnV* were amplified using the universal primers of Demesure *et al.* (1995) and Dumolin-Lapegue *et al.* (1997) respectively. PCR reactions were carried out in a total

volume of 25 µL containing 2.5 µL 10 × NH₄ reaction buffer (TaKaRa), 2.5 µL dNTPs (2 mM), 0.5 µL of each primer (10 µM), 0.5 units of Ex taq polymerase (TaKaRa) and 2.5 µL of genomic DNA (1 ng/µL). Amplification was carried out using the following PCR profile: 1 cycle of 94 °C for 4 min; 32 cycles of 45s at 94 °C, 45s at 58 °C, and 2 min 30s at 72 °C; a soak at 72 °C for 10 min; and finally held at 10 °C for 30 min.

Chloroplast PCR products were digested for a minimum of one hour at 37 °C, with the restriction enzyme *HinfI* following the method of Ferris *et al.* (1993). 10 µL of the restriction digest products were then run on 3% MetaPhor XR agarose gel for *trnC-trnD* products or 1.6% multipurpose agarose gel for *trnF-trnV*. Fragments were visualized by staining with ethidium bromide (0.5 µg/ml).

INTER-SIMPLE-SEQUENCE REPEAT (ISSR) ANALYSIS

Thirty primers from the University of British Columbia (UBC) primer set nine and twelve from the laboratories of Professor Mike Wilkinson (University of Reading) were screened. A final set of seven polymorphic primers was selected on the basis of reproducibility between duplicate DNA extractions from the same plant, and between different PCR runs (details available on request). PCR reactions were carried out in a total volume of 25 µL containing 2.5 µL 10 × NH₄ reaction buffer (Bioline), 2.5 µL dNTPs (2 mM), 1.25 µL magnesium chloride (50 mM), 0.33 µL of primer (15 µM), 1 unit of BIOTAQ DNA polymerase (Bioline) and 10 µL of genomic DNA (1 ng/µL). Amplification was carried out using the following PCR profile: 1 cycle of 94 °C for 4 min; 40 cycles of 20s at 94 °C, 30s at X °C, and 1 min at 72 °C; a soak at 72 °C for 7 min; and finally held at 4 °C for 30 min. X is primer specific (details available on request). Reactions were performed in duplicate using the independently extracted DNA, and 10 µL from each reaction, with duplicates placed in adjacent wells, were run on a 1.6% agarose gel with a 1 kb ladder in the outer wells. Products were visualized by staining with ethidium bromide (0.5 µg/ml). Bands were considered to be reproducible when the same DNA pattern was obtained using the two different DNA isolates. A table of presence/absence of ISSR fragments was constructed and is available from the corresponding author on request.

DATA ANALYSIS

RFLP bands were scored by eye and recorded in a binary data matrix table, as presence (1) and absence (0). Each combination of these bands for a given chloroplast product is referred to as a haplotype. The combination of these haplotypes is referred to as a multi-primer-haplotype (MPH) and is intended to represent the chloroplast type of the plants in which it was found.

Winboot (Yap & Nelson 1996) was used to bootstrap the ISSR binary data 1000 times using the Jaccard's coefficient to produce confidence values. The companion program WinDist was then used to produce a matrix of pair-wise genetic distances between all individuals using the complement of the Jaccard's similarity coefficient. A Neighbour-Joining tree was drawn from the resulting matrix using the NEIGHBOUR option in PHYLIP version 3.6a3 (Felsenstein 2002) and TreeView version 1.6.6 (Page 1996). Additionally, the number of differences between each ISSR genotype was calculated and analysed using MINSPNET (Excoffier & Smouse 1994) to produce a minimum spanning tree.

RESULTS

CHLOROPLAST HAPLOTYPES

Six different MPH were detected from the native plants, designated MPH 1–6. All 47 of the introduced *F. sachalinensis* accessions were found to have a MPH also found in the native samples, 44 having MPH 6 and the remaining three having MPH 1 (Table 1).

ISSR GENOTYPES

Each ISSR primer generated a banding pattern referred to as a phenotype. From five to thirteen bands were scored per primer, resulting in between five and twenty-eight phenotypes depending upon the primer. A total of fifty-nine bands was scored, of which 52 were polymorphic. A unique combination of these phenotypes is assumed to be representative of a genotype. A total of 32 genotypes were detected (Table 1). Sixteen genotypes were found in plants from the introduced range; these have been given the letter "i" followed by a unique number. The remaining sixteen genotypes were from native Japanese plants; these have been given the letter "n" followed by a number. No native genotypes were found in the introduced plants.

DISTRIBUTION OF GENOTYPES

Sixteen native *F. sachalinensis* plants were analysed. As seen in Fig. 1, each plant possessed a unique genotype, indicating a high level of genetic diversity among native plants. Plants from the same geographical area share the same chloroplast haplotype, however none from the same area shared a genotype. Whilst some plants within populations were genetically similar (Fig. 2, MPHs 1, 3, and 4), this was not true for all of them.

By contrast, in Britain only eight genotypes were found from the thirty-one plants analysed (Fig. 3). As can be seen there were two widespread clones, i1 shared by eleven accessions and i4 by thirteen. These represent a male-fertile and a male-sterile clone respectively, both with chloroplast MPH 6. The remainder of the genotypes were found at single localities, with a maximum of two plants sharing the genotype. The three accessions with MPH 1 were found to contain different ISSR genotypes. The other three genotypes with MPH 6 were represented by a male-fertile plant from South Hampshire (i13), two male-sterile stands from Warwick (i6), and a single stand from Merioneth (i2).

There were nine *F. sachalinensis* accessions analysed from the introduced range that were not from Britain. The two plants from the U.S.A had unique genotypes (i7 and i12). Five plants came from Germany, three of which were from the same area of Germany, Aachen, however all five were found to have unique genotypes (i3, i9, i10, i14 and i15). Two plants were analysed from the Czech Republic. Whilst one had a unique genotype, i5, the other possessed the male-sterile genotype, i4, which was common in Britain.

NEIGHBOUR JOINING TREE

The Neighbour Joining tree for all genotypes is shown in Fig. 4. The internal branches are short and the majority of the distances are confined to the terminal branches. Bootstrapping 1,000 times has shown that only four of the branches were supported over 50% of the time. In each case the support was for a group of two genotypes. There was support of 68.0% for the two genotypes with MPH 4, native plants from Fukushima (n10 and n11), and a bootstrap value of 91.5% for the two native genotypes with MPH 1, which came from Niigata (n2 and n13). The other support was for introduced plants. The genotypes i8 and i11 (76.9% bootstrap) consisted of two of the three British

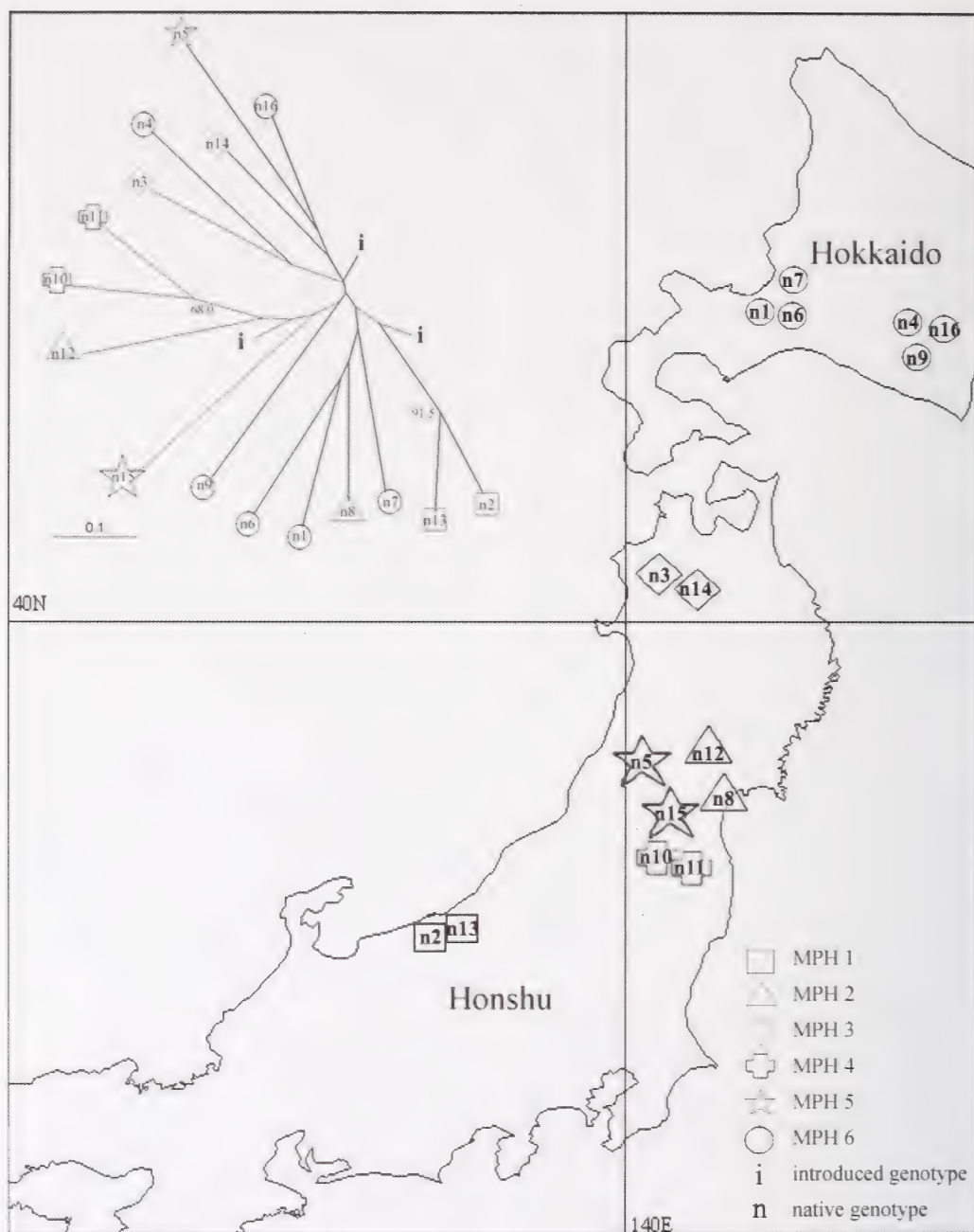


FIGURE 1. Localities of Japanese *F. sachalinensis* genotypes. The map was produced using Dr. A. J. Morton's DMAP program. A simplified version of the unrooted Neighbour-Joining tree (Fig. 4) has been included to show the relationship between the different native genotypes, and their relationship to the introduced plants.

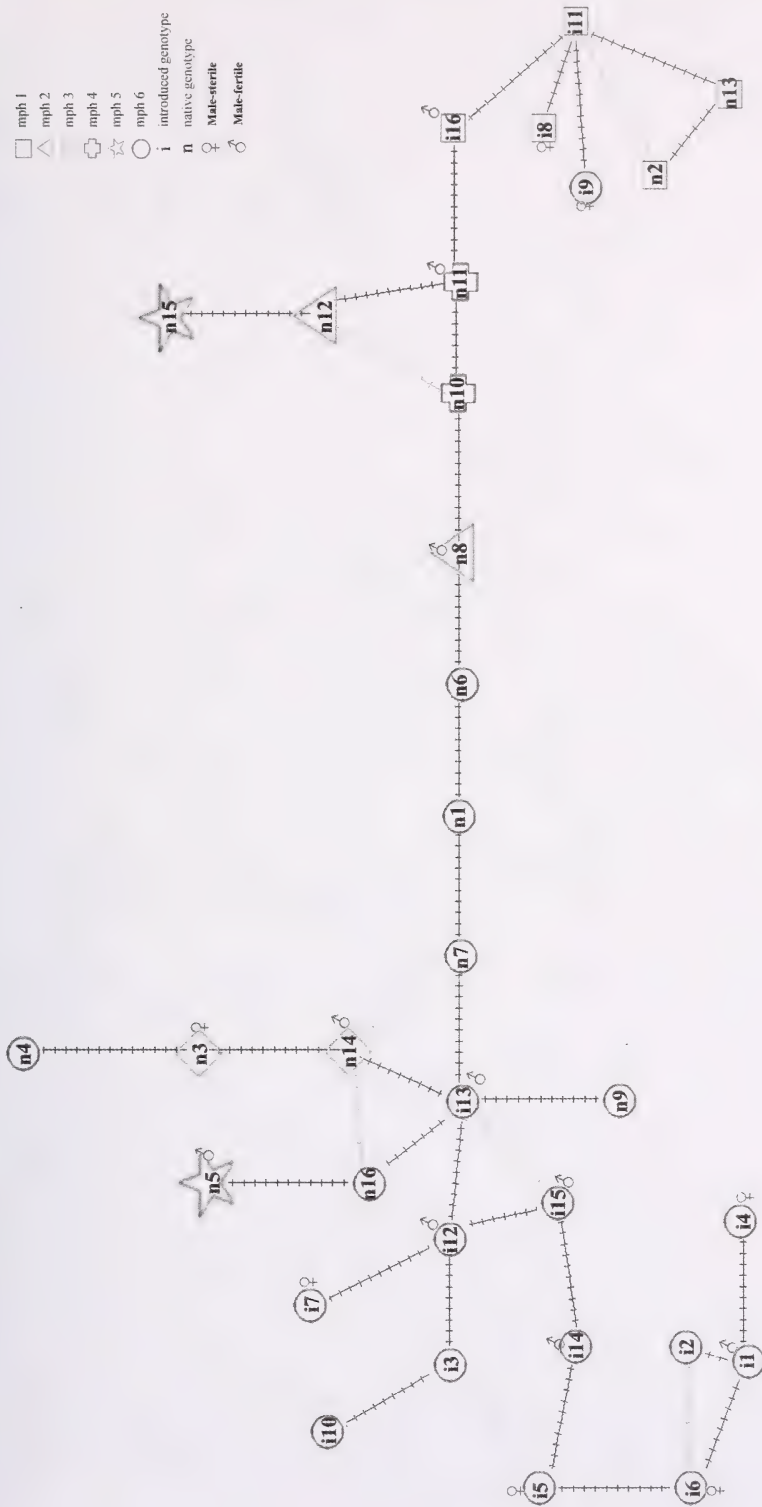


FIGURE 2. Minimum spanning network showing the number of differences between *F. sachalinensis* genotypes. The cross-links show the number of differences. The grey links are equally likely alternatives between genotypes. The shape superimposed over the genotype represents the chloroplast haplotype that corresponds with the genotype. Sex of the genotype is indicated where known.



FIGURE 3. Localities of British *F. sachalinensis* genotypes. The map was produced using Dr. A. J. Morton's DMAP program. The position of some genotypes have been moved slightly, to allow all samples to be seen, due to multiple records in single recording 10 km squares. A simplified version of the unrooted Neighbour-Joining tree (Fig. 4) has been included to show the relationship between the British genotypes, and their relationship to the non-British introduced plants, and the native plants.

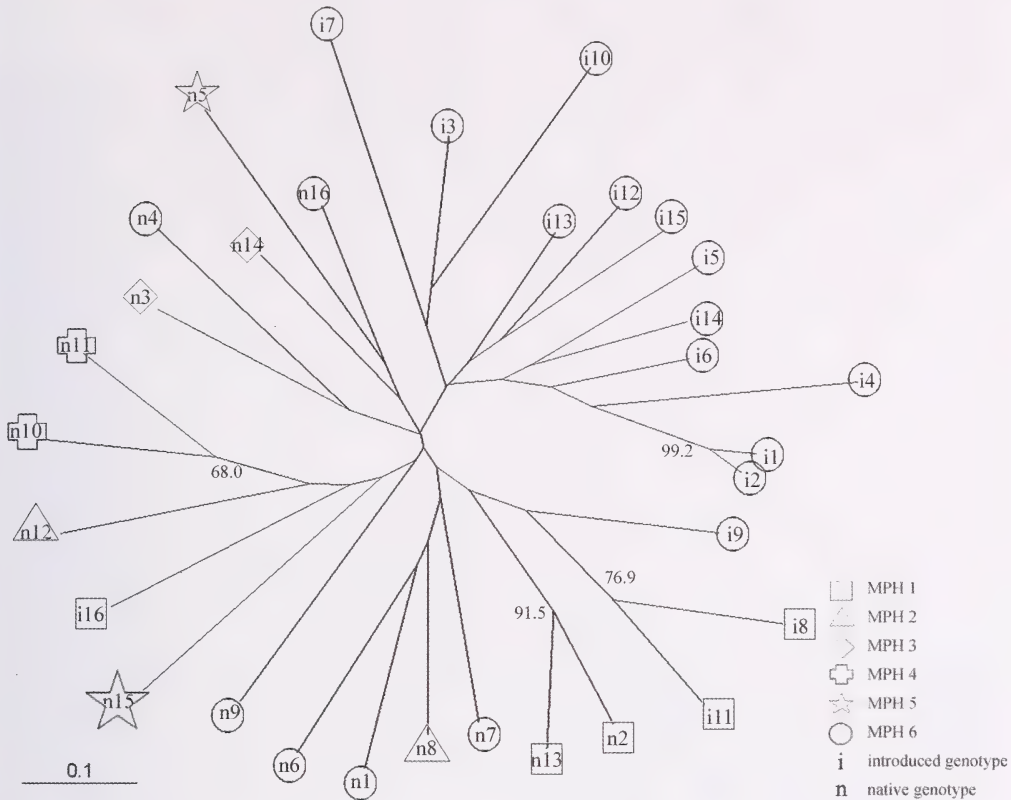


FIGURE 4. Unrooted Neighbour-Joining tree depicting relationships between the various ISSR genotypes, based on Jaccard's similarity coefficient. Numbers along branches are confidence values based on 1,000 bootstraps. Only bootstrap values greater than 50% are shown. The shape superimposed over the genotype represents the corresponding chloroplast haplotype.

plants with MPH 1: the male-sterile plant from Colchester and a plant of unknown sex from Glasgow. The other introduced genotypes that grouped together were i1 and i2 (99.2% bootstrap) representing the common male-fertile genotype (i1) and an individual stand from Merioneth.

The majority of the introduced genotypes, twelve of the 16, were all found to diverge from a single branch with no native genotypes forming part of the group, although this group is not statistically supported (Fig. 4). In contrast the native genotypes appeared to arise from four main branches, with two of the branches closer to the branch with the majority of the introduced genotypes than the other two. One of the four branches was further divided into two clear groups, one comprising n2 and n13, and the other made up of n1, n6, n7 and n8. The three introduced genotypes from plants

with MPH 1 were found intermingled with native genotypes, two of them grouping with the Japanese plants with MPH 1 as well as a genotype, i9, that came from a plant with MPH 6. The other genotype that was found mixed in with the native genotypes was the British male-fertile genotype with MPH 1, i16.

MINIMUM SPANNING NETWORK

The minimum-spanning network (Fig. 2) is based on the number of band differences between each pair of genotypes. Next to the genotype is a symbol to represent whether the genotype is male-fertile or male-sterile. There was no obvious separation between male-fertile and male-sterile genotypes. The network is almost linear in shape, with only seven equally likely alternative links throughout the whole network. The genotypes found in the introduced plants occupy either end of the

network, with six native genotypes found between the nearest of the introduced genotypes at either end. These six genotypes represent 65 band differences between i13 and i16, which were the closest of the genotypes from the two ends. The two common British genotypes (i1 and i4) were closely related and were found to have only ten band differences. The group of twelve introduced genotypes to the left of the network were the same genotypes that came from the single branch in the Neighbour Joining analysis (Fig. 4). The minimum-spanning network showed a closer relationship between the four introduced genotypes that were not grouped with the other introduced genotypes than did the Neighbour Joining analysis, being interconnected by genotype i11.

DISCUSSION

DISTRIBUTION AND GENETIC DIVERSITY OF THE NATIVE PLANTS

Sixteen native *F. sachalinensis* plants were analysed, each of which possessed a unique genotype. The native plants harboured a much higher level of genetic diversity than the introduced plants, a common phenomenon found in many different species as a result of the genetic bottleneck experienced during the introduction process (Barrett & Richardson 1986; Barrett & Shore 1989). Whilst plants from the same geographical area shared the same chloroplast haplotype, there was less geographic structuring evident with the genotypes, although there does appear to be some correlation between genetic relationship and geographical distribution. Japanese individuals with MPH 1 came from Niigata, Honshu, and had genotypes n2 and n13, which form a supported group (91.5% bootstrap) on the Neighbour-Joining tree (Fig. 4), and are each others nearest neighbours on the minimum-spanning network (Fig. 2). Likewise the individuals with MPH 3 from Aomori, Honshu cluster together as do those with MPH 4 (68% bootstrap) from Fukushima, Honshu. In general, the taxa to the left of the minimum-spanning network as it is portrayed in Fig. 2 were found in the northernmost part of Honshu and on Hokkaido, and those to the right in the central and southernmost part of the native range (Fig. 1).

DISTRIBUTION AND GENETIC DIVERSITY OF THE INTRODUCED PLANTS

The majority of the introduced genotypes, twelve of the 16, were found to group together both on the Neighbour-Joining tree (Fig. 4) and the minimum-spanning network (Fig. 2). The four introduced genotypes not clustering with these being the three British genotypes with MPH 1 and a male-sterile German plant (G3) with genotype i9 and MPH 6.

It is interesting to note that, on both the Neighbour-Joining tree (Fig. 4) and the minimum-spanning network (Fig. 2), the non-British introduced genotypes appear to be more closely related to each other than they do the other genotypes found in Britain (genotypes i3, i5, i7, i10, i12, i14 and i15), the exception being genotype i9. Genotype i13, the British genotype most closely associated with the non-British introduced genotypes in both analyses being found in Britain in a plant from the closest collection point to mainland Europe. The lack of support for this observation could, however, imply that this is mere coincidence. The odd non-British (German) introduced genotype, i9, having the same chloroplast haplotype (MPH 6) as the majority of the introduced *F. sachalinensis*, yet has a genotype more closely related to the British introduced plants with the rarer MPH 1. The reason for this is unclear and further sampling and analysis would be required to better understand how this individual arose.

The sharing of the male-sterile genotype between Britain and the Czech Republic implies that the majority of the plants (those with MPH 6) were introduced from the same collection, presumably from St. Petersburg botanic garden. There also appears to be a higher level of genetic variation within the non-British introduced *F. sachalinensis* individuals, as demonstrated by each having a unique genotype, although further sampling of mainland Europe and USA would be required to support or refute this point.

Spread of two clones, a male-fertile and a male-sterile clone, appears to be the primary explanation for the current *F. sachalinensis* distribution within Britain (Fig. 3). The male-sterile clone, i4, being found as far north as Fort William, Scotland, and as far south as Cornwall, England. The male-fertile clone, i1, appears to have a more restricted distribution, being found predominantly in the centre of England, and Wales, but spreading from the

East to the west coast. The remainder of the British genotypes were found at single localities, with a maximum of two plants sharing the genotype. Unlike in Britain, the remainder of the introduced plants demonstrate no signs of clonal spread, although as noted above they do appear to be closely related to each other. This greater diversity could be the result of in situ sexual reproduction, but further sampling would be needed to support or refute such a claim.

A largely unpublished preliminary study cited by Hollingsworth & Bailey (2000b) also found more clonal diversity in *F. sachalinensis* (14 genotypes from 30 samples) than in the uniclinal *F. japonica* var. *japonica*. However, unlike the current study no shared genotypes were detected between populations. It is probable that in the previous study the lack of shared genotypes among at least some of the sites is erroneous and is attributable to PCR artefacts (a lack of time prevented duplicate DNA extractions being used to test the reliability of different genotypes; Hollingsworth 1998).

SOURCE OF THE INTRODUCED *FALLOPIA*

SACHALINENSIS

Both of the MPHs found in introduced material were found in native plants. The most common in the introduced plants, MPH 6, was found only in individuals from Hokkaido. The rarer introduced chloroplast haplotype found in the introduced range only in Britain, MPH 1, was only found in individuals from Niigata, Honshu.

The low level of resolution and support found with the neighbour joining analysis means conclusive statements about the relationships between the native Japanese and introduced genotypes of *F. sachalinensis* cannot be made. Even so, some observations can be made, and tentative suggestions towards how the current distribution arose can be proposed.

Whether the genotypes found in the introduced *F. sachalinensis* were present in the native range before the plants were collected, or have arisen by sexual reproduction since their introduction is unclear. It is likely that the situation has arisen from a combination of the two factors. A limited number of genotypes were probably introduced from Japan, most likely Hokkaido or the Sakhalin Island, into St. Petersburg. The most plausible explanation is that a minimum of a male-fertile and a male-

sterile clone were sent to Britain from St. Petersburg as established plants rather than seed. These were then distributed throughout Britain to various nursery gardens, and from there to many stately homes and manors, eventually leading to the escapes reflected in the distribution noted by Conolly (1977). Given how easy *F. sachalinensis* is to propagate from the rhizome, there would be little point in the gardeners germinating and growing seed for distribution.

At a similar time, or earlier, plants arising from the same original collection were probably being distributed to Germany, the Czech Republic and other European countries. *Fallopia sachalinensis* was recommended, especially on the continent, as a forage plant for cattle, as well as being introduced as a riverbank stabiliser (Bailey & Conolly 2000). For stabilisation of riverbanks, mature plants were most likely used, which would presumably originate from vegetative reproduction. In addition to its use as a forage plant, *F. sachalinensis* was also used on large estates for scenic plantings and cover for shoots (Bailey & Conolly 2000). As with riverbank stabilising, the plants introduced for scenic plantings were probably introduced as mature plants. However, seed may have been used to produce the plants for forage, which could explain why there was found to be higher levels of genetic variation on the continent, but these plants all cluster together away from the native, possibly indicating that they were produced from the genetically limited original introductions by sexual reproduction. Presumably material either directly from St. Petersburg, or from elsewhere on mainland Europe was sent to the USA.

Three different collections are presumed to have been housed at St. Petersburg: that of Dr H. Weyrich, from Sakhalin in September 1853; that of P. von Glehn in 1861, also from Sakhalin that arrived in St. Petersburg in early 1863; and material of Japanese origin collected by C. J. Maximovicz during 1859–1864 (Bailey & Conolly 2000). Whilst it is not possible, from this study, to determine whether the introduced plants came from Sakhalin or Japan due to a lack of material from the Sakhalin island, data would suggest that if the plants with MPH 6 came from Japan it would have been from the northern island Hokkaido.

The three genotypes found in Britain in plants that have MPH 1 were probably introduced directly from Niigata on Honshu,

Japan. Whilst it is possible that this chloroplast type could be found in non-sampled Japanese sites, a study of chloroplast variation in two hundred and forty Japanese Knotweed *s.l.* accessions from eighty seven sites spanning the four main islands that make up Japan, found this chloroplast type to be restricted to Niigata (Pashley 2003). This could explain why no plants with this chloroplast type have been found anywhere besides Niigata and Britain. The two sites in Britain where these were found were Glasgow and Colchester. The plants (both male-fertile and male-sterile) in Colchester shared MPH 1 and were found growing on the site of an old nursery garden reported to have sold *F. sachalinensis* (Bailey & Conolly 2000). The site in Glasgow where the individual with MPH 1 (B3) was found is close to a botanic garden, and the implication is that the plants at Colchester and the individual B3 from Glasgow came from a common source.

CONCLUSIONS

The majority of British *F. sachalinensis* were found to be one of two widespread genotypes, either a male-fertile or a male-sterile clone. The remaining British genotypes that came from plants that share the chloroplast MPH 6 were presumed to have arisen from the same introduction, as were most of the plants in the other introduced countries included in the study, most likely introduced via St. Petersburg. Only one genotype was found shared between Britain and any of the other countries to which *F. sachalinensis* was introduced. That genotype was the widespread male-sterile clone, and was found in a single accession from the Czech Republic.

The three genotypes found in Britain in plants that have chloroplast MPH 1 were probably introduced straight from Niigata on

Honshu, in Japan, and were not found in any other country included in this study to which *F. sachalinensis* was introduced.

A high level of genetic diversity was found among native *F. sachalinensis*, with each of the sixteen plants analysed having a unique genotype. There was some correlation between genetic relationship and the geographical distribution of these native plants.

There is clearly a higher level of genetic diversity in *F. sachalinensis* than there is in *F. japonica* var. *japonica* (Hollingsworth & Bailey 2000a), however, there is strong evidence that the current British distribution of *F. sachalinensis* has resulted mainly from the spread of two clones rather than via sexual reproduction.

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REFERENCES

- BAILEY, J. P. & CONOLLY, A. P. (2000). Prize-winners to pariahs—A history of Japanese Knotweed *s.l.* (Polygonaceae) in the British Isles. *Watsonia* **23**: 93–110.
- BARRETT, S. C. H. & RICHARDSON, B. J. (1986). Genetic attributes of invading species, in R. H. GROVES & J. J. BURDON eds. *Ecology of Biological Invasions*, pp. 21–33. Australian Academy of Science, Canberra, Australia.
- BARRETT, S. C. H. & SHORE, J. S. (1989). Isozyme variation in colonizing plants, in D. E. SOLTIS & P. S. SOLTIS eds. *Isozymes in Plant Biology*, pp. 106–126. Dioscorides, Portland, Oregon, USA.
- BEERLING, D. J., BAILEY, J. P. & CONOLLY, A. P. (1994). *Fallopia japonica* (Houtt) Ronse, Decraene (*Reynoutria japonica* Houtt, *Polygonum cuspidatum* Sieb. and Zucc.). *Journal of Ecology* **82**: 959–979.

- BÍMOVÁ, K., MANDÁK, B. & PYŠEK, P. (2001). Experimental control of *Reynoutria* congeners: a comparative study of a hybrid and its parents, in G. BRUNDU, J. BROCK, I. CAMARDA, L. CHILD, *et al.* eds. *Plant invasions: Species Ecology and Ecosystem Management*, pp. 283–290. Backhuys Publishers, Leiden, The Netherlands.
- BRABEC, J. & PYŠEK, P. (2000). Establishment and survival of three invasive taxa of the genus *Reynoutria* (Polygonaceae) in mesic mown meadows: A field experimental study. *Folia Geobotanica* **35**: 27–42.
- BROCK, J. H. & WADE, P. M. (1992). Regeneration of *Fallopia japonica*, Japanese Knotweed, from rhizome and stems: Observation from greenhouse trials. *The 9th International Symposium on the biology of weeds*, Dijon, France: 85–94.
- CHILD, L. & WADE, M. (2000). *The Japanese Knotweed Manual*. Packard Publishing Limited, Chichester.
- CONOLLY, A. P. (1977). The distribution and history in the British Isles of some alien species of *Polygonum* and *Reynoutria*. *Watsonia* **11**: 291–311.
- DEMESURE, B., SODZI, N. & PETIT, R. J. (1995). A set of universal primers for amplification of polymorphic noncoding regions of mitochondrial and chloroplast DNA in plants. *Molecular Ecology* **4**: 129–131.
- DUMOLIN-LAPEGUE, S., PEMONGE, M. H. & PETIT, R. J. (1997). An enlarged set of consensus primers for the study of organelle DNA in plants. *Molecular Ecology* **6**: 393–397.
- EXCOFFIER, L. & SMOUSE, P. E. (1994). Using allele frequencies and geographic subdivision to reconstruct gene trees within a species – molecular variance parsimony. *Genetics* **136**: 343–359.
- FELSENSTEIN, J. (2002). PHYLIP (Phylogeny Inference Package). Distributed by the author. Department of Genome Sciences, University of Washington, Seattle.
- FERRIS, C., OLIVER, R. P., DAVY, A. J. & HEWITT, G. M. (1993). Native oak chloroplasts reveal an ancient divide across Europe. *Molecular Ecology* **2**: 337–344.
- HARRIS, S. A. & INGRAM, R. (1992). Molecular systematics of the genus *Senecio*-L. 1. Hybridization in a British polyploid complex. *Heredity* **69**: 1–10.
- HOLLINGSWORTH, M. L. (1998). Clonal growth and hybridisation in some invasive *Fallopia* spp. PhD thesis, University of Leicester, Leicester.
- HOLLINGSWORTH, M. L. & BAILEY, J. P. (2000a). Evidence for massive clonal growth in the invasive weed *Fallopia japonica* (Japanese Knotweed). *Botanical Journal of the Linnean Society* **133**: 463–472.
- HOLLINGSWORTH, M. L. & BAILEY, J. P. (2000b). Hybridisation and clonal diversity in some introduced *Fallopia* species (Polygonaceae). *Watsonia* **23**: 111–121.
- HOLLINGSWORTH, M. L., HOLLINGSWORTH, P. M., JENKINS, G. I., BAILEY, J. P., *et al.* (1998). The use of molecular markers to study patterns of genotypic diversity in some invasive alien *Fallopia* spp. (Polygonaceae). *Molecular Ecology* **7**: 1681–1691.
- PAGE, R. D. M. (1996). TREEVIEW: An application to display phylogenetic trees on personal computers. *Computer Applications in the Biosciences* **12**: 357–358.
- PASHLEY, C. H. (2003). The use of molecular markers in the study of the origin and evolution of Japanese Knotweed *sensu lato*. PhD thesis, University of Leicester, Leicester.
- SAKAI, A. K., ALLENDORF, F. W., HOLT, J. S., LODGE, D. M., *et al.* (2001). The population biology of invasive species. *Annual Review of Ecology and Systematics* **32**: 305–332.
- STUEFER, J. F., ERSCHBAMER, B., HUBER, H. & SUZUKI, J.-I. (2001). The ecology and evolutionary biology of clonal plants: An introduction to the proceedings of Clone-2000. *Evolutionary Ecology* **15**: 223–230.
- SUKOPP, H. & STARFINGER, U. (1995). *Reynoutria sachalinensis* in Europe and in the Far East: a comparison of the species ecology in its native and adventive distribution range, in P. PYŠEK, K. PRACH, M. REJMANEK, & M. WADE eds. *Plant Invasions, general aspects and social problems*, pp. 151–159. SPB Academic Publishing, Amsterdam.
- YAP, I. V. & NELSON, R. J. (1996). WinBoot: A program for performing bootstrap analysis of binary data to determine the confidence limits of UPGMA-based dendrograms. International Rice Research Institute (IRRI), Philippines.

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Introgression between *Plantago major* L. subspecies *major* and subspecies *intermedia* (Gilib.) Lange. in a British population

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ABSTRACT

We measured morphological characters of *Plantago major* from a British population in which subsp. *major* and subsp. *intermedia* both occur, and from 'pure' populations from different parts of Europe as standards, grown in uniform conditions. In the British population, most individuals fall within the variation of subsp. *major*, but individuals resembling ssp. *intermedia* occur as a minority. We attempted to quantify interspecific gene flow between *major* and *intermedia*, and tested the hypotheses that the amount of variation can be explained by minority effects, as functions of the relative frequency or density of the two taxa. The first hypothesis is upheld, but evidence for the effect of density is equivocal. A higher rate of gene flow occurs between these two taxa than expected if they are mostly self-fertilised. We suggest that the taxa do not merit specific rank as no breeding barrier seems to separate the species when they become sympatric.

KEYWORDS: genetic variation, hybridization, introgression, *Plantago*, Greater Plantain, plant speciation, population structure.

INTRODUCTION

Introgressive hybridization has been defined as the repeated backcrossing of a natural hybrid to one or both parental populations and usually occurs in the direction of one parent only (Anderson 1949). It results in the transfer of genes from one parent to another across a partial breeding barrier (Anderson & Hubricht 1938; Anderson 1949, 1953; Harrison 1993). This can result in one of the parents becoming more variable, having incorporated some genes from the other parent, which may allow the introgressed parent to colonise a new environment.

There are some good examples which clearly describe introgression in the literature, where molecular techniques were used to confirm

previously doubtful examples. Abbott *et al.* (1992) used isozymes to confirm that ray-florets in groundsel *Senecio vulgaris* had arisen as a result of introgression from the ray-floreted *Senecio squalidus*. Introgression essentially occurs at the chromosome level. Eshed *et al.* (1992) revealed that when chromosomal segments were recombined into the genome of *Lycopersicon esculentum* (tomato) after hybridization with *L. pennellii*, the new chromosomal inserts survived through repeated recombination and backcrossing although the size of inserts reduced between the first and the sixth backcross generation.

In *Plantago*, maternally inherited chloroplast DNA (cpDNA) was analyzed by comparing DNA fragment patterns produced by seven restriction endonucleases in four species of *Plantago* (Hooglander *et al.* 1993). In this study it was shown that the larger 70bp DNA fragment present in Netherlands *Plantago major* L. subsp. *major* (hereafter referred to as 'major') but absent in subsp. *intermedia* (Gilib.) Lange (hereafter referred to as 'intermedia'), was not observed in a few individuals identified morphologically as *major* from sites where two taxa grow together. Outside the UK, *intermedia* and *major* tend to be separated ecologically, the former taxon being more typical of open saline sites, and has been said to differ biologically, being more often annual or short-lived and self-fertilising than *major* (van Dijk 1989; van Dijk *et al.* 1988). Thus, it is likely that these taxa are usually isolated spatially in countries such as Denmark and the Netherlands, and more often maintain their integrity there.

Nevertheless, Hooglander *et al.* (1993) suggested that natural successive hybridization and backcrossing onto *intermedia* mothers had occurred, with the more outcrossing *major* acting as pollen donors, resulting in introgression from *intermedia* to *major*.

In a population from north-east England (Metrocentre, Gateshead), morphological clustering in the two taxa *major* and *intermedia* is also not clear cut. The aim of the experiments reported in this paper was to investigate the possible occurrence of hybridization and introgression in these mixed populations. We reasoned that the offspring of mothers, some of the seeds of which had been fertilized by pollen from the other taxon or hybrids, would produce offspring that were more variable than those mothers which had not hybridized. By comparing the variability of offspring grown in a standard environment between mothers from different taxa, from areas with differing frequencies of the taxa, and from areas with different densities of adult plants, we were able to investigate parameters which affected rates of hybridisation and introgression.

MATERIALS AND METHODS

MORPHOLOGY

Four separate field populations (45 plants) were collected near the Metrocentre, Gateshead, UK (NZ220630) and taken into cultivation. The four populations were separated by short distances. Population (A) was collected near the River Tyne which is tidal here. The distance between population (A) and population (B) is 35 m; there is 15 m between population (B) and (C), whilst population (C) and (D) are nearly 40 m apart. Habitats in this area are highly ruderal and are dominated by human activities. Each of the four populations appeared to contain some individuals showing characteristics of both *major* and *intermedia*. Although these taxa are reported to differ in up to 12 characters (Hegi 1914, Van Dijk 1984, 1989), average seed number per capsule is the most reliable discriminant, being non-overlapping between the taxa and easily quantifiable (Van Dijk 1984, 1989, Morgan-Richards & Wolff 1999). Individuals were classified primarily on the basis of average seed number per capsule, using a discontinuity in the data distribution as the discriminant (El-Bakatoushi 2004) (*major* ≤ 10.4 , *intermedia* ≥ 10.5). This character, which has also been considered an important discriminant in all earlier studies of these taxa, is strongly correlated with both major principal components of the variation, and with 7 of the 12 other characters employed (Table 2). Pure

populations used for comparison were collected as seed by K. Wolff from districts where only one taxon occurs. These comprised two *intermedia* populations from Denmark (NYA) and the Netherlands (NPZH) and two *major* populations from Italy (Salt.2) and the Netherlands (NPZ) (details in El-Bakatoushi, 2004).

Using the same cultivated material, El-Bakatoushi (2004) compared characters known to vary between the taxa before and after cultivation, and also examined cross-correlation between these characters. As a result of this study, 13 morphological characters were selected which did not change markedly after cultivation and all of which showed some significant character state correlation between individuals (Table 2). These characters were scored after two years growth in standard conditions in pots under glass at Moorbank Gardens (University of Newcastle) (Table 1).

Principal Component Analysis (PCA) was used for the multivariate analysis of the morphological characters, using Minitab V.12.1 (1998). PCA is the most mathematically natural ordination technique (Gauch 1982; Digby & Kempton 1987). The use of PCA enabled us to examine multivariate taxonomic relationships in a manner unbiased by choice of character. It was also possible to combine both continuous and multistate characters in the analysis. By means of cross-correlation between character states and principal components, we were able to examine the relative contribution of each of the 13 characters to these components (Table 2).

EXPERIMENTAL HYBRIDIZATION AND HYBRID FERTILITY

Plantago major is protogynous, and flowering acropetal so that stigmas are exerted from flowers 1–3 days before pollen is shed (El-Bakatoushi 2004). Experimental cross-pollination was achieved by applying dehiscing anthers to stigmas exerted from the lowest flowers on a solitary spike, and then excising the remaining flowers and enclosing the cross-pollinated flowers in a polythene bag. Reciprocal crosses were made between the two taxa using both individuals from the Metrocentre, and the 'pure' control populations. Pollen stainability of samples of 300 grains was examined at $\times 400$ magnification using 45% acetocarmine in experimental hybrids and in mother-daughter lines.

TABLE 1. MORPHOLOGICAL CHARACTERS AND CHARACTER STATES RECORDED FOR *PLANTAGO MAJOR* AND SUBSP. *INTERMEDIA* AFTER TWO YEARS CULTIVATION

1. Leaf blade length / length of leaf blade to base from point of maximum width)
2. Degree of angle at blade / petiole interface (0–180°)
3. Number of main veins in longest leaf (lower surface of leaf)
4. Leaf margin
 0. Teeth well marked (4+)
 1. Teeth slightly apparent (1–4)
 2. Undulate toothed
 3. Entire
5. Leaf indumentum (upper surface, between middle and next vein)
 0. Densely covered with hairs
 1. Somewhat covered with hairs
 2. Slightly covered with hairs
 3. Glabrous
6. Leaf indumentum (Lower surface, between middle and next vein)
 0. Densely covered with hairs
 1. Somewhat covered with hairs
 2. Slightly covered with hairs
 3. Glabrous
7. Width/length of longest leaf.
8. Ratio of flowering spike diameter, 3 mm from bottom of spike/ 3 mm from top.
9. Ratio calyx length/length fruiting pedicle
10. Capsule apex
 0. Obtuse
 1. Intermediate
 2. Acute
11. Capsule length (mm) (lowest flower)
12. Seed number (average from five capsules)
13. Average length of five seeds (mm)

TABLE 2. REGRESSION R^2 BETWEEN FREQUENCY OF *INTERMEDIA*, DENSITY, INDEX, COEFFICIENT VARIATION OF *MAJOR* AND COEFFICIENT VARIATIONS (CV)

	Frequency <i>intermedia</i>	Density both spp.	cv <i>major</i>	cv <i>intermedia</i>
Frequency <i>intermedia</i>	1			
Density both spp.	ns	1		
cv <i>major</i>	0.701***	ns	1	
cv <i>intermedia</i>	0.346*	0.318*	0.341	1

Unstained grains were considered unviable. The proportion of ovules setting apparently viable seed was examined by dissecting the contents of three capsules in a drop of water on a slide under a dissecting microscope. Infertile seeds were dark in colour, shrunken, and lacked mucilage.

VARIATION IN SEED NUMBER AS A MEANS OF QUANTIFYING INTROGRESSION

Thirteen 5 × 5 m areas were selected by eye from near the Metrocentre, and a single fruiting spike from every fruiting plant within each area

was collected. The number of fruiting spikes per 25 m² patch were counted, and the average seed number per capsule calculated for five capsules of each spike. Spikes were described as *intermedia* or *major* on the basis of average seed number per capsule. The discriminants used (*major* ≤10.4, *intermedia* ≥10.5) were based on previous findings in the literature, and a slight discontinuity observed in the distribution of the Metrocentre population data for this attribute. On the basis of this, the frequency of each taxon within the area was calculated.

For each area, two mothers were selected, one *major* and one *intermedia* (but in areas containing only *major*, two *major* mothers were selected) and 20 seedlings of each were grown to maturity (see seed germination) so that the coefficient of variation (cv) of seedling seed number could be calculated for each. This involved the raising of $2 \times 13 \times 20 = 520$ seedlings.

RESULTS

MORPHOLOGY

The first two components of the PCA represented 97.8 % and 1.9% of the total variation respectively. Of the 13 characters used (Table 1), six showed a significant correlation with both major principal components, and 10 showed a significant correlation with at least one. Three characters, all relating to fruits, did not significantly influence principal components, namely character 9 (relative length of fruiting pedicel), 10 (capsule apex shape) and 11 (capsule length), although each of these showed some internal coherence with other characters used. The characters which mostly strongly influenced the two most important components were characters 2 (angle of blade to petiole) and 12 (seed number per capsule), two characters which traditionally have been important in the separation of the two taxa.

Figure 1 represents the first two axes of PCA. The limits of variation in the standard populations are shown. The Metrocentre population encompassed the variation of the four 'pure' populations used as standards, and no less than 40% of individuals (18/45) fell outside the morphological limits of these standards, and can be considered to be morphologically intermediate between the taxa. Only three Metrocentre individuals corresponded clearly to *intermedia*, so that 24 individuals (53%) corresponded to *major*. No clear or distinct morphological clusters could be detected amongst or between Metrocentre populations, although the pure populations show distinct clustering. Most individuals of the intermediate phenotype falling outside the limits of the standard populations tended to resemble *major* more than *intermedia*, perhaps suggesting that most backcrossing occurs to *major*.

HYBRID FERTILITY

No significant difference was found in either seed set or pollen fertility between either parent and the offspring of crosses, or between the offspring of crosses and of selfs. Both the percentage of stainable pollen, and the proportion of ovules set as seed were invariably in excess of 80%. However, there was some evidence for significant matrilineal heritability in pollen stainability for selfed offspring from the Metrocentre population ($r^2 = 11.6^{***}$), and for seed set after crosses in both Metrocentre and 'pure' populations ($r^2 = 15.7^*$ and $r^2 = 46.5^{***}$ respectively).

THE COEFFICIENT OF VARIATION OF *MAJOR* AND *INTERMEDIA* SEED NUMBER IN QUADRATS

The regression between coefficient of variation (cv) of *major* seed number and frequency of *intermedia* per 25 m² quadrat showed that no less than 70.1 % of the variability in seed number in *major* offspring could be attributed to the frequency of *intermedia* in that quadrat (Fig. 2 & Table 2). This suggested that considerable ongoing hybridisation occurred between *major* and *intermedia*. There was no significant effect between the density of fruiting plants per quadrat and offspring seed number cv (Table 2). However, the correlation between cv of *intermedia* offspring seed number and density of plants/quadrat was just significant (Table 2). There was also a positive relationship between the frequency of *intermedia* and cv of seed number in *intermedia* offspring ($r^2 = 0.346^*$) (Table 2). The correlation between coefficient of variation of seed number of *intermedia* and cv of seed number of *major* was also slightly significant ($r^2 = 0.341^*$) (Table 2).

DISCUSSION

Using evidence from a variety of molecular markers, Morgan-Richards & Wolff (1999) suggested that *major* and *intermedia* are sufficiently distinct to warrant specific rank, despite evidence of widespread hybridisation outside the British Isles (Hooglander *et al.* 1993, Wolff & Morgan-Richards 1999). However, the taxa are not so distinct in the British Isles (Kay 2002) and we doubt if morphologically 'pure' populations of *intermedia* often occur here. The scattered and largely ruderal distribution of *intermedia* in the

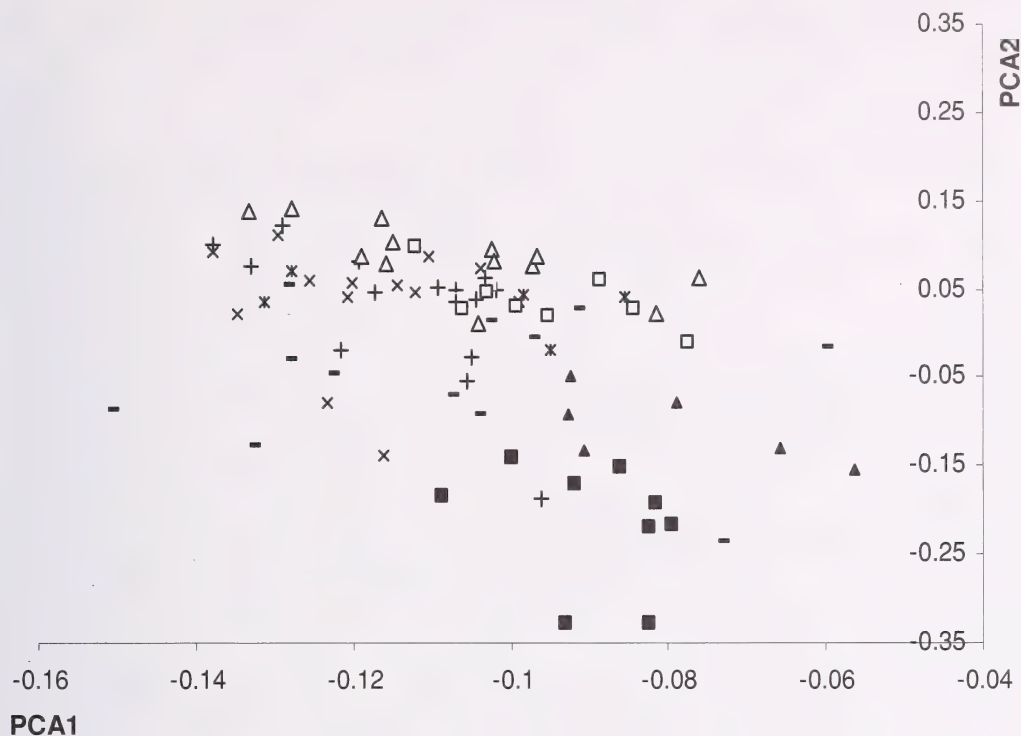


FIGURE 1 The first two axis of PCA for natural populations with four pure populations.

+ population A, * population B, ■ population C, × population D
 ■ standard *intermedia* (NYA), ▲ standard *intermedia* (NPZH)
 △ standard *major* (Salt2), □ standard *major* (NPZ)

British Isles clusters around centres of population such as London, Bristol, Belfast, the west Midlands and the East Midland cities (Kay 2002). We suspect that *intermedia* may be largely of recent and adventive origin in these islands.

There is no evidence of a genetic barrier between the taxa. Both taxa are diploid with $2n = 12$ (Clapham *et al.* 1987) and this number was also obtained from many individuals of both taxa in the Metrocentre population (El-Bakatoushi 2004). All the individuals from the Metrocentre population we investigated had a high level of pollen stainability (>80%), seed set and fertility was high amongst manually made crosses, and the fertility of offspring of these crosses did not vary from that of their parents. Nevertheless, morphological differences between the taxa in British populations persisted after cultivation, suggesting that many characteristics which separate the two

taxa *major* and *intermedia* are genetically controlled (El-Bakatoushi 2004).

In the Metrocentre population, intermediate, putatively hybrid individuals tended to resemble *major* from standard populations more than *intermedia* and this may be an indication that the hybrids have backcrossed to *major* individuals, which dominate in the community. (Another less likely hypothesis, i.e. that *major* characters are overwhelmingly dominant to *intermedia* characteristics was disproved after crosses between the taxa were reported by El-Bakatoushi (2004)).

The highly significant relationship between variability in seed number in *major* offspring and frequency of *intermedia* in the same quadrat suggested that this introgression is ongoing, reflecting a high rate of gene flow between two taxa and helped to confirm that some *major* individuals were introgressed towards *intermedia*. However, we also found a

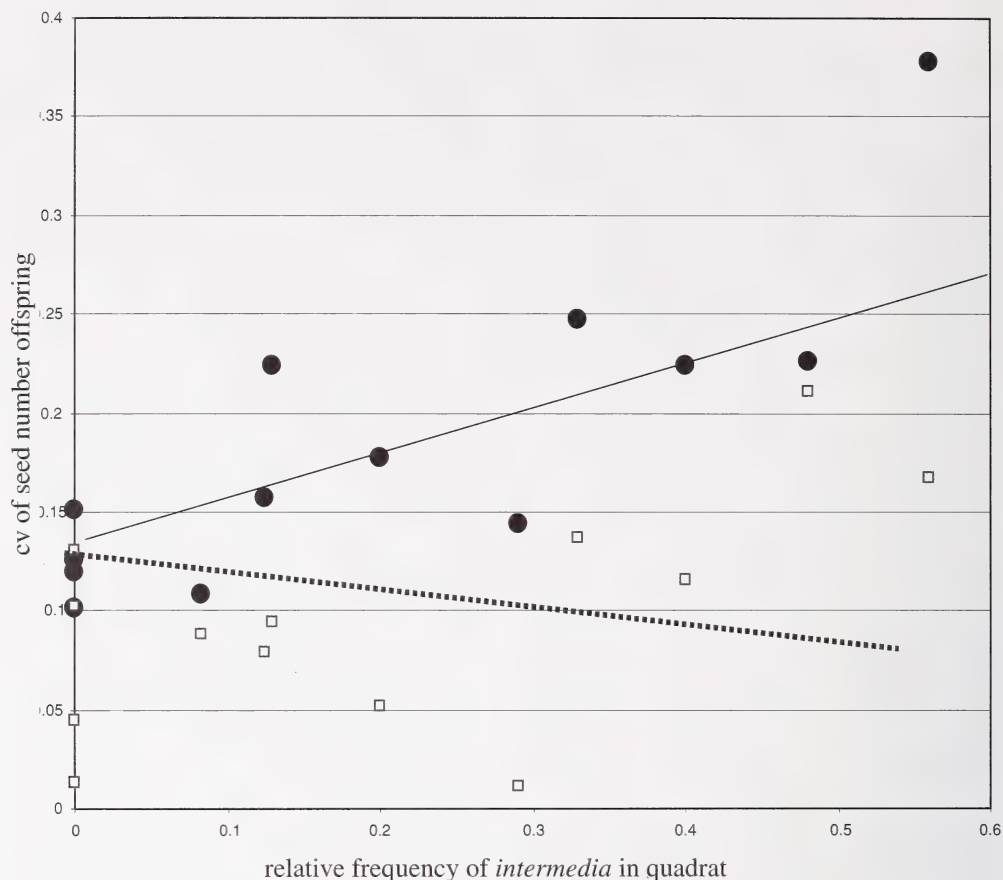


FIGURE 2 Scattergram between relative frequency of *intermedia* in quadrat and coefficient of variation of seed number of *major* ($r^2 = 0.701$), and *intermedia* offspring, showing lines of best fit. ● cv of seed number in *major* offspring, □ cv of seed number in *intermedia* offspring

positive relationship between coefficient of variation of seed number in *intermedia* and frequency of *intermedia* per quadrat. This could have been an artefact caused by a greater variability in seed number in *intermedia* than in *major*.

The variability in *intermedia* seed number in general may have resulted from a greater tendency for *intermedia* individuals to receive outcrossed pollen from the numerically dominant plants of *major*. This suggestion was supported by the slightly positive relationship which occurred between density of plants per quadrat and the coefficient of variation for *intermedia* seed number. Minority effects occur when two potentially interfertile taxa or demes co-occur at very different frequencies, so that pollen arriving on stigmas of the minority taxon will originate overwhelmingly from the dominant taxon (Fowler & Levin 1984).

Individuals of *intermedia* apparently suffered from minority effects at the Metrocentre which were maximised at high density, causing any outcrossed pollen to tend to originate from *major*. Consequently, one would expect immigrant *intermedia* to lose their identity over successive generations, when it occurs, as here, in a minority.

Major and *intermedia* cannot be seen as separate species in the localities from which the mixed UK populations were collected, as it seems that genes of the infrequent and possibly adventive *intermedia* are readily diluted by the native taxon *major*. A high rate of gene flow occurred between these taxa, and both taxa could readily occupy the same open habitat. On this evidence the rank of subspecies is ideal for both taxa, even if the taxa sometimes behave more as one would expect of species in some non-British parts of their range.

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REFERENCES

- ABBOTT, R. J., ASHTON, P. A., & FORBES, D. G. (1992). Introgressive origin of the radiate groundsels, *Senecio vulgaris* L. var *hibernicus* Syme; Aat-3 evidence. *Heredity* **68**: 425–435.
- ANDERSON, E. (1949). *Introgressive Hybridization*. Wiley, New York.
- ANDERSON, E. (1953). Introgressive Hybridization. *Biological Reviews* **28**: 280–307.
- ANDERSON, E. & HUBRICHT, L. (1938). Hybridisation in *Tradescantia*. III. The evidence for introgressive hybridization. *American Journal of Botany* **25**: 396–402.
- CLAPHAM, A. R., TUTIN, T. G. & MOORE, D. M. (1987). *Flora of the British Isles*, 3rd edition. Cambridge University Press, Cambridge.
- EL-BAKATOUSHI, R. (2004). *Population genetics and evolution of the Plantago major group*. Ph. D. thesis, University of Newcastle, UK.
- ESHED, Y. M., ABU-ABIED, Y. & ZAMIR, D. (1992). *Lycopersicon esculentum* lines containing small overlapping introgressions from *L. pennellii*. *Theoretical and Applied Genetics* **83**: 1027–1034.
- FARRIS, M. A. & MITTON, J. B. (1984). Population density, outcrossing rate, and heterozygote superiority in Ponderosa pine. *Evolution* **38**: 1151–1154.
- FOWLER, N. L. & LEVIN, D. A. (1984). Ecological constraints on the establishment of a novel polyploid in competition with its diploid progenitor. *American Naturalist* **124**: 705–711.
- HARRISON, R. G. (1993). Hybrids and hybrid zones: a historical perspective, in R. G. HARRISON ed. *Hybrid Zones and the Evolutionary Process*, pp. 3–12. Oxford University Press, Oxford.
- HEGEL, G. (1914). *Illustrierte Flora von Mitteleuropa*. Vol. **6** (1) ed. 1. Munich.
- HOOGLANDER, N., LUMARET, R. & BOS, M. (1993). Inter- and intraspecific variation of chloroplast DNA of European *Plantago* spp. *Heredity* **70**: 322–334.
- KAY, G. M. (2002). *Plantago major* subsp. *intermedia*, in C. D. PRESTON, D. A. PEARMAN & T. D. DINES eds. *New Atlas of the British Flora*, p. 535. Oxford University Press, Oxford.
- MORGAN-RICHARDS, M. & WOLFF, K. (1999). Genetic structure and differentiation of *Plantago major* reveals a pair of sympatric sister species. *Molecular Ecology* **8**: 1027–1036.
- NEALE, D. B. & ADAMS, W. T. (1985). The mating system in natural and shelterwood stands of Douglas-Fir. *Theoretical and Applied Genetics* **71**: 201–207.
- VAN DIJK, H. (1984). Genetic variability in *Plantago* species in relation to their ecology. 2. Quantitative characters and allozyme loci in *P. major*. *Theoretical and Applied Genetics* **68**: 43–52.
- VAN DIJK, H. (1989). Genetic variability in *Plantago* species in relation to their ecology. 4. Ecotypic differentiation in *P. major*. *Theoretical and Applied Genetics* **77**: 749–759.
- VAN DIJK, H., WOLFF, K. & DE VRIES, A. (1988). Genetic variability in *Plantago* species in relation to their ecology. 3. Genetic structure of populations of *P. major*, *P. lanceolata*, and *P. coronopus*. *Theoretical and Applied Genetics* **75**: 518–528.
- WOLFF, K. (1991). Analysis of allozyme variability in three *Plantago* species and a comparison to morphological variability. *Theoretical and Applied Genetics* **81**: 119–126.
- WOLFF, K., FRISO, B. & VAN DAMME, J. M. M. (1988). Outcrossing rates and male sterility in natural populations of *Plantago coronopus*. *Theoretical and Applied Genetics* **76**: 191–196.
- WOLFF, K. & MORGAN-RICHARDS, M. (1999). The use of RAPD data in the analysis of population genetic structure: case studies of *Alkanna* (Boraginaceae) and *Plantago* (Plantaginaceae), in P. M. HOLLINGSWORTH, R. M. BATEMAN & R. J. GORNALL eds. *Molecular systematics and plant evolution*, pp. 51–73. Taylor & Francis, London.

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Names and diagnoses for three willow (*Salix* L.) hybrids discovered recently in Scotland

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ABSTRACT

Binomials and diagnoses are provided for three distinctive willow (*Salix* L.) hybrids found in recent years in the Scottish Highlands: *Salix myrsinifolia* × *S. phylicifolia* × *S. repens* = ***S. ×lochsiensis***; *Salix arbuscula* × *S. repens* = ***S. ×lyonensis***; and *Salix caprea* × *S. myrsinifolia* × *S. phylicifolia* = ***S. ×meikleana***.

INTRODUCTION

Binomials and diagnoses are provided for three distinctive willow (*Salix* L.) hybrids which were discovered in recent years during field surveys of British montane willows, as summarised by Tennant (2001, 2004); full descriptions were provided by Tennant (2004). All three were discovered in montane habitats in the Scottish Highlands, but one of them (*S. ×meikleana*) has also been found in Mid-West Yorkshire (v.c. 64) (Tennant 2001, Wilcox 2001). They were all found growing near their parents and were all local and very scarce. *S. ×tetrapla* Walker (*S. myrsinifolia* × *S. phylicifolia*) was probably one parent of *S. ×lochsiensis* and of *S. ×meikleana*). Only two plants of *S. ×lochsiensis* were found in Glenshee; one plant of *S. ×lyonensis* was found on Meall Ghaordaidh, and two more near Creag Roro in 2002; and at least four plants of *S. ×meikleana* were found near Creag Roro.

THREE NEW HYBRIDS

***Salix ×lochsiensis* D. J. Tennant, hybrida nova**

HOLOTYPUS: On stream-bank north-west of the Spittal of Glenshee, East Perthshire, v.c 89, GR NO07, 5.8.1997, D. J. Tennant no. GSB 2H/97 (BM).

Hybrida inter *Salicem myrsinifoliam* Salisb. et *S. phylicifoliam* L. et *S. repentem* L.

A *Salice myrsinifolia* et *S. phylicifolia* et *S. ×tetrapla* Walker (*S. myrsinifolia* × *S. phylicifolia*) habitu fruticis prostrati vel

decumbentis nanissimi, ramos longos graciles gemmasque minores ferentis; foliis multo minoribus, marginibus revolutis undulatisque, primo dense sericeis, postea rarius sericeis, denique abaxialiter subglabris; petiolis saepe rubellis; amentis numerosioribus, minoribus, flores prorsum spectantes ferentibus, in pedunculis brevibus lateralibus portatis; amentorum squamis angustioribus, involventibus, omnino viridibus vel nonnunquam dilute brunneis; ovariis capsulisque brevioribus distinguitur. Praeterea a *S. myrsinifolia* stipulis paucissimis vel absentibus et ovariis pubescentibus; a *S. phylicifolia* foliis serratis, dentes rubellos saepe ferentibus, abaxialiter venationem prominentem praebentibus, abaxialiter fere persistente sericeis minusque glaucis, et pedicellis longioribus et stylis brevioribus distinguitur.

A *Salice repenti* foliis magis undulatis, distinctissime serratis, dentes saepe curvatos acutos rubellos ferentibus, abaxialiter venationem prominentem praebentibus; amentorum squamis hirsutioribus, saepe anguste obovatis; stigmatibus longioribus distinguitur.

A *Salice ×schraderiana* Willd. (*S. phylicifolia* × *S. repenti*) foliis angustius obovatis (minus anguste ellipticis), obtusioribus, magis serratis, magis undulatis, dilute viridibus vel minus glaucis, abaxialiter venationem magis prominentem praebentibus; stipulis paucis nonnunquam praesentibus distinguitur.

Hybrid between *Salix myrsinifolia* Salisb., *S. phylicifolia* L. and *S. repens* L.

Distinguished from *S. myrsinifolia*, *S. phylicifolia* and *S. ×tetrapla* Walker (*S. myrsinifolia* × *S. phylicifolia*) by being a prostrate or decumbent, very dwarf shrub with long, slender branches and smaller buds; by its leaves much smaller with revolute, undulate margins, initially densely sericeous, later more thinly sericeous, eventually subglabrous abaxially; by its petioles often reddish; by its catkins more numerous, smaller, with forward-directed

flowers, and on short, lateral peduncles; by its catkin-scales narrower, involvent and wholly green or sometimes pale brown; and by its ovaries and capsules shorter. It is further distinguished from *S. myrsinifolia* by its stipules very few or absent and by its ovaries pubescent and from *S. phylicifolia* by its leaves serrate, often with reddish teeth, with prominent raised venation abaxially, almost persistently sericeous and less glaucous abaxially, by its pedicels longer, and by its styles shorter.

Distinguished from *S. repens* by its more undulate leaves very distinctly serrate, with often curved, acute, reddish teeth and with prominent raised venation abaxially; by its catkin-scales more hairy and often narrowly obovate; and by its stigmas longer.

Distinguished from *S. xschradariana* Willd. (*S. phylicifolia* $\times$ *S. repens*) by its leaves more narrowly obovate (less narrowly elliptic), more obtuse, more serrate, more undulate, and pale green or less glaucous with more prominent venation abaxially; and a few stipules sometimes present.

***Salix xlyonensis* D. J. Tennant, hybrida nova**

HOLOTYPUS: On rock-ledge, Meall Ghaordaidh in Glen Lyon, Mid Perthshire, v.c. 88, GR NN54, 1.9.1994, D. J. Tennant no. MG 2C/94 (BM).

Hybrida inter *Salicem arbusculam* L. et *S. repentem* L.

A *Salice arbuscula* foliis minoribus, hebetioribus, abaxialiter minus glaucis, margines magis revolutos praebentibus, dentes pauciores minores ferentibus, adaxialiter persistentius appresso-pubescentibus, abaxialiter persistente vel dense sericeis; amentis squamas longiores ferentibus distinguitur.

A *Salice repenti* foliis distincte serratis vel glanduloso-serratis, in sicco non nigrescentibus; amentis magis compactis, breviter pedunculatis, cum foliis primum visis, flores patentes (non prorsum spectantes) squamasque latiores, ad apicem brunneas, densius pubescentes, ferentibus; ovariis densius pubescentibus, pedicello brevioribus, capsulam minorem parientibus, distinguitur.

A *Salice xpseudoglauc*a Andersson (*S. arbuscula* $\times$ *S. lapponum* L.) foliis minoribus, saturatius viridibus, nitidioribus, distinctius serratis, margines magis revolutos

praebentibus, adaxialiter glabrioribus, abaxialiter pilos non nisi breves sericeos (non tomentosos) ferentibus; amentis minoribus, ovaria capsulasque minores ferentibus, distinguitur.

Hybrid between *Salix arbuscula* L. and *S. repens* L.

Distinguished from *S. arbuscula* by its leaves smaller, duller, less glaucous abaxially, with more revolute margins, with fewer smaller teeth, more persistently appressed-pubescent adaxially, persistently sericeous to densely so abaxially; and by its catkins with longer catkin-scales.

Distinguished from *S. repens* by its leaves distinctly serrate or glandular-serrate, not blackening when dried; by its catkins more compact, shortly pedunculate, appearing with the leaves, with patent (not forward-directed) flowers, with wider, brown-tipped, more densely pubescent catkin-scales; and by its ovaries more densely pubescent, with a shorter pedicel and producing a smaller capsule.

Distinguished from *S. xpseudoglauc*a Andersson (*S. arbuscula* $\times$ *S. lapponum*) by its leaves smaller, deeper green, glossier, more distinctly serrate, with more revolute margins, more glabrous adaxially, with only short sericeous (not tomentose) hairs abaxially; and by its catkins smaller, with smaller ovaries and capsules.

***Salix xmeikleana* D. J. Tennant, hybrida nova**

HOLOTYPUS: On stream-bank, Allt a' Chobhair, Creag Roro, Glen Lyon, Mid Perthshire, v.c. 88, 7.7.2000, D. J. Tennant no. CR 9/00 (E).

Hybrida inter *Salicem capream* L. et *S. myrsinifoliam* Salisb. et *S. phylicifoliam* L.

A *Salice caprea* foliis adaxialiter vividius nitidiusque saturatiusque viridibus, abaxialiter plerumque glabris; ovariis brevioribus, pro ratione latioribus, stylum distinctum et stigmata vix longiora ferentibus, distinguitur.

A *Salice myrsinifolia* fruticis plerumque excelsioris habitu; foliis latioribus, magis coriaceis, adaxialiter vividius nitidiusque plerumque saturatius viridibus, minus pubescentibus, in sicco non nigrescentibus; ovariis uniformiter pubescentibus, stigmata vix longiora ferentibus, distinguitur.

A *Salice phylicifolia* ramunculis lentius glabrescentibus; foliis magis serratis (quorum

maxima ad apicem basinque latius rotundata sunt), apicem versus et adaxialiter in costa persistente sed tenuiter pubescentibus, abaxialiter venationem magis prominentem praebentibus; stipulis plerumque bene effectis; pedicellis longioribus ubi capsulae effectae sunt; stylis paulo brevioribus distinguitur.

A *Salice* $\times$ *latifolia* Forbes (*S. caprea* $\times$ *S. myrsinifolia*) foliis maximis plerumque latoribus, ad apicem obtusioribus, magis coriaceis, adaxialiter vividius nitidiusque saturatiusque viridibus, abaxialiter plerumque glabris, in sicco non nigrescentibus, distinguitur.

Ab hybrida *Salice caprea* $\times$ *S. phylicifolia* foliis apicem versus et adaxialiter in costa persistentius sed tenuiter pubescentibus, abaxialiter plerumque glabris; stipulis saepe majoribus distinguitur.

A *Salice* $\times$ *tetrapla* Walker (*S. myrsinifolia* $\times$ *S. phylicifolia*) praecipue gemmis majoribus, luteolis; foliis maximis pro ratione latoribus, ad apicem basinque latius rotundatis, in sicco non partim nigrescentibus; stipulis saepe magis effectis distinguitur.

Hybrid between *Salix caprea* L., *S. myrsinifolia* Salisb. and *S. phylicifolia* L.

Distinguished from *S. caprea* by its leaves brighter, glossier, deeper green adaxially and usually glabrous abaxially; and by its ovaries shorter and relatively broader, with a distinct style and marginally longer stigmas.

Distinguished from *S. myrsinifolia* by being a usually taller bush; by its leaves wider, more coriaceous and brighter, glossier, usually deeper green adaxially, less pubescent, and not blackening when dried; and by its ovaries uniformly pubescent with marginally longer stigmas.

Distinguished from *S. phylicifolia* by its twigs more slowly becoming glabrous; by its leaves more serrate and persistently but thinly pubescent near the apex and on the midrib adaxially, with more prominent venation abaxially, the largest leaves more broadly rounded at the apex and base; by its stipules usually well developed; by its pedicels longer when capsules have developed; and by its styles slightly shorter.

Distinguished from *S. $\times$ latifolia* Forbes (*S. caprea* $\times$ *S. myrsinifolia*) by its largest leaves usually broader, more obtuse at the apex, more coriaceous, brighter, glossier, deeper green adaxially, usually glabrous abaxially, and not blackening when dried.

Distinguished from *S. caprea* $\times$ *S. phylicifolia* by its leaves more persistently but thinly pubescent near the apex and on the midrib adaxially and usually glabrous abaxially; and by its often larger stipules.

Distinguished from *S. $\times$ tetrapla* Walker (*S. myrsinifolia* $\times$ *S. phylicifolia*) mainly by its buds larger and yellowish; by its largest leaves relatively broader, more broadly rounded at the apex and base, and not blackening in parts when dried; and by its stipules often more developed.

This hybrid is named after Robert Desmond Meikle in recognition of his long service and considerable contribution to the study of British willows.

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REFERENCES

- TENNANT, D. J. (2001). *Salix caprea* L. $\times$ *S. myrsinifolia* Salisb. $\times$ *S. phylicifolia* L. in Perthshire. *Watsonia* **23**: 547–549.
 TENNANT, D. J. (2004). A re-assessment of montane willow (*Salix* L., Salicaceae) hybrids in Scotland. *Watsonia* **25**: 65–82.
 WILCOX, M. (2001). Two triple hybrid willows in the Yorkshire Dales. *BSBI News* **86**: 28–29.

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Notes

THE GUNNA (V.C. 103) RECORD FOR *CAREX APPROPINQUATA* SCHUM. (CYPERACEAE)

Many of the late 1930s and 1940s records of J. W. Heslop Harrison from the Isle of Rhum (v.c. 103) and elsewhere in the Hebrides are now widely considered to result from the deliberate introduction of plants in an attempt to provide evidence to support his theory for survival of elements of the flora from pre-glacial times (Sabagh 2001, Preston 2004, Pearman & Walker 2004). Several such records are for *Carex* species, some of them purporting to be the first for the British Isles. Perhaps the most surprising were *Carex bicolor* and *C. glacialis* both known from Europe and elsewhere but not from the British Isles. Understandably, these have been treated with considerable scepticism, both at the time and since.

There is, however, a most interesting Heslop Harrison record for *Carex appropinquata* from the islet of Gunna (v.c. 103) in the Inner Hebrides which lies between Coll and Tiree. This record was first published under the name *C. paradoxa* Willd. in *The Flora of the Isles of Coll, Tiree and Gunna* (Heslop Harrison *et al.* 1941) with the statement: "Rare in Gunna, and only recorded once previously from a Scottish locality. This was in Peebles". If correct, this would represent a considerable extension of range since the stronghold for *C. appropinquata* in the British Isles is in East Anglia; elsewhere it is only known locally in Yorkshire, the Scottish Borders and Ireland.

Whilst examining Carices in the Edinburgh herbarium (E), it was surprising to find a previously overlooked voucher specimen which supports this record. The specimen is of a rather immature plant but which, by its general facies and its narrow leaves (to a maximum width of 2mm) and black fibrous basal leaf sheaths, is undoubtedly *C. appropinquata*. Indeed there is an added determination slip to that effect signed by Ernest Nelmès, the Kew specialist, to whom Heslop Harrison often sent material for confirmation. The specimen has been in the Edinburgh herbarium for over twenty years and was formerly in the collection of Robert Mackechnie, a colleague of Heslop Harrison who was invited by the latter to botanise with him on Rhum in 1949

(Mackechnie *in litt.* to A. C. Jermy). This specimen, along with others, was bequeathed to the Edinburgh herbarium shortly after Mackechnie died in 1978.

The label states "Carex appropinquata. Island of Gunna, between Coll & Tiree. June 1940. Prof. J. W. Heslop Harrison". However, the label is not in Heslop Harrison's hand but was directly transcribed by the curator from the wrapping covering the specimen (which also contained Nelmès' original signed determination slip) when received for incorporation (D. R. McKean pers. comm. 2006). The curator feels confident that this was done accurately.

There are certain facts which support this record and others which cast doubt upon it. Perhaps the most favourable is that it is a published record supported by a voucher specimen, albeit on a re-labelled sheet. Also, a Hebridean record for *C. appropinquata* is unlikely to have been of value in support of Heslop Harrison's theory relating to pre-glacial survival and, therefore, to have been deliberately planted by him (or even by an associate).

Although there had been an old unconfirmed record from Innerleithen, Peeblesshire (v.c. 78), by Lyell in the 1850s (David 1990), subsequent to the 1940 Gunna record, *C. appropinquata* was not re-found in that general (Borders) area of Scotland until found in Roxburghshire (v.c. 80) in 1967 (Corner 1969). Heslop Harrison was obviously aware of the old record (Heslop Harrison *et al.* 1941) but it seems very unlikely that his specimen could have originated from there.

In the British Isles, *C. appropinquata* has a rather disjunct distribution pattern, so that its occurrence in the Inner Hebrides is quite possible. Also, *C. paniculata* and *C. diandra*, two closely related species, the latter especially being a close ecological associate of *C. appropinquata* as at Malham Tarn (v.c. 64), both occur on neighbouring Tiree (Pearman & Preston 2000). It is also known that Heslop Harrison's party explored Gunna in the summer of 1940 and it was in June of that year that the specimen was collected. Due to the suspicion surrounding many of Heslop Harrison's

records, it is tempting to dismiss anything unusual as being of dubious worth but this is perhaps unfair since there are some of his Hebridean rarities which have been subsequently confirmed, e.g. *Spiranthes romanzoffiana*. There is also his collection of the Asiatic *Carex brunnea* Thunb. from the grounds of Kinloch Castle (Rhum), again confirmed by Nelmes, which he readily conceded (Heslop Harrison 1945 and *in sched.*) as having been almost certainly introduced accidentally with planted bamboo. The voucher specimen for this is also in the Edinburgh herbarium (E) and again originated via Mackechnie in the same way as that of the Gunna specimen of *C. appropinquata*. An annotation on the *C. brunnea* sheet in Heslop Harrison's hand states that it was collected on August 12, 1944.

On the other hand certain factors cast doubt on the Gunna record. Firstly, it is surprising that it is unmentioned by Heslop Harrison (1948) in his later review of his own records of noteworthy sedges from the Inner and Outer Hebrides, although he does include its close associate *C. paniculata* for neighbouring Tiree. In addition, Pearman & Preston (2000) discount the record of *C. appropinquata* on ecological grounds stating that "There is no suitable habitat on Gunna for this species". It is also possible that the collection may not have been made by Heslop Harrison in person since

he states (Heslop Harrison *et al* 1941) that in the years 1939 and 1940, the co-authors of that paper (although perhaps not necessarily always present himself) spent three long periods on Coll and Tiree. On the second of these periods (whether 1939 or 1940 is not clear) whilst based on Tiree they also explored Gunna. However in 1939 a party of his students also camped on Coll and "broke new ground on the Isle of Gunna". Perhaps it was the students who were thought, or claimed, to have collected the *C. appropinquata* or, dare one suggest, attempted to deceive by introducing it there?

Unless *C. appropinquata* is re-discovered on Gunna, the record is likely to remain a mystery. Despite suspicion over Heslop Harrison's more unusual records, it is difficult to see how a falsification would have any relevance in furthering his theory of Hebridean plant survival from pre-glacial times. The alternative conclusion is that there has been a mislabelling of the specimen or other mix-up when collecting.

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REFERENCES

- CORNER, R. W. M. (1969). *Carex appropinquata* Schumach. – In Scotland. Plant Notes. *Proceedings of the Botanical Society of the British Isles*, 7: 562.
- DAVID, R. W. (1990). The distribution of *Carex appropinquata* Schumacher (*C. paradoxa* Willd.) in Great Britain and Ireland. *Watsonia* 18: 201–204.
- HESLOP HARRISON, J. W. (1941). The Flora of the Isles of Coll, Tiree and Gunna (v.c. 110B). *Proceedings of the University of Durham Philosophical Society*, 10(4): 301–304.
- HESLOP HARRISON, J. W. (1945). Noteworthy Sedges from the Inner and Outer Hebrides, with an Account of Two Species New to the British Isles. *Transactions and Proceedings of the Botanical Society of Edinburgh*, 270–277.
- PEARMAN, D. A. & PRESTON, C. D. (2000). *A Flora of Tiree, Gunna & Coll*, p. 68. Dorchester.
- PEARMAN, D. A. & WALKER, K. J. (2004). An examination of J. W. Heslop Harrison's unconfirmed plant records from Rum. *Watsonia* 25: 45–63.
- PRESTON, C. D. (ed.) (2004). John Raven's Report on his visit to the Hebrides, 1948. *Watsonia*, 25: 17–44.
- SABBAGH, K. (2001). *A Rum Affair. A True Story of Botanical Fraud*. 1–276. Da Capo Press.

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VALERIANELLA ERIOCARPA DESV. AS A PRESUMED NATIVE IN BRITAIN
– AN UPDATE

In our paper in *Watsonia* (Pearman & Edwards 2002), we suggested that *V. eriocarpa* was a native member of an annual early flowering cliff-edge community on the limestones of Dorset and the hard chalk of the Isle of Wight. We had also looked, without success, on the South Devon limestone at Berry Head, and felt ambivalent about the status of the relatively persistent Cornish records, which are on sand.

Since then there have been several interesting developments, with records from completely new areas.

VC3, SOUTH DEVON.

Ilsham Marine drive, Torquay. SX941632. A. J. Byfield. 2002. A few plants in short therophyte turf on steep S facing road verge bank.

Headland north of Whitsand Beach, Maidencombe. SX927676. D. Buckingham. <1995. A few plants in a relict fragment of unimproved cliff-top grassland. Not searched for again.

VC49, CAERNARVONSHIRE.

Great Orme, Llandudno. SH773824, (c. 20 plants in 2003), SH772827, (c. 30 plants in 2003), SH776827, (c. 45 plants in 2003). W. McCarthy. 1992 and every year since.

On very thin soils over outcropping limestone, south-facing, with a range of species including *Aphanes arvensis*, *Arenaria serpyllifolia*, *Carex caryophylla*, *Cerastium pumilum*, *C. semidecandrum*, *Erophila glabrescens*, *Festuca ovina*, *F. rubra*, *Galium verum*, *Sherardia arvensis*, *Thymus polytrichus*, *Veronica arvensis*.

These new sites then are limestone headlands, with broadly similar communities to the Dorset sites. In addition, one of us (DAP) searched the Gower limestones for two days in

May 2005 without any success, finding only *V. locusta*, and that only in very small quantity. This means that of all the coastal limestone areas in southern England and Wales, only those at Weston-super-Mare and Brean Down (VC6) remain to be searched.

Elsewhere Ted Pratt and David Leadbetter have added some new sites in Dorset, slightly further inland on the Purbeck limestone and at Corfe Castle on the chalk. These are from permanent grassland, albeit over rock and with open areas. Conversely new areas of arable there have produced *Euphorbia platyphyllos* and *V. dentata* but no *V. eriocarpa*. DAP has visited the two Cornish sites mentioned in the *Watsonia* article (Pearman & Edwards 2002). At the Constantine site (SW8675) the sandy wall had become over-grown (though it has just been cleared), and no plants have been seen there for 15 years, but at the second site, at Phillack Towans, near Hayle (SW5538) there are plenty of patches. But here it looks so ruderal, growing on walls, waste lots and around buildings, that it is difficult to see it as a native. A further and more natural site has been discovered by Ian Bennallick below the coast path at Harbour cove, Padstow (SW9177) where it grows on rocks just by the beach with *V. rimosa* nearby! The coastal footpath separates this site from arable fields above, with *Vicia bithynica* on the edge, so the site has more of the flavour of an arable weed refugium.

We still feel uncertain of the status of the Cornish sites, though we tend even more to considering them as persistent aliens, but the records from the new limestone sites are potentially very interesting indeed.

We are very grateful to those named above for the new records and details.

REFERENCE

- PEARMAN, D. A. & EDWARDS, B. (2002). *Valerianella eriocarpa* Desv. in Dorset, and a reassessment of its status as a presumed introduction in Britain. *Watsonia* 24: 81–89.

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RUBUS MILESIANUS WHOLLY A GARDEN ESCAPE IN BRITAIN?

Certain members of the *Rubus fruticosus* aggregate characterised by fruit of a kind holding a special appeal to growers have probably long been liable to be taken into cultivation from the wild and in some cases marketed commercially. Unfortunately, it has not been the practice in the past for examples of what nurseries had on offer to be preserved in herbaria: field botanists have collected cultivated taxa only when those have chanced to occur outside the confines of gardens sufficiently to be claimable as 'wild'.

A rare documented exception is *R. bartonii* Newton, a member of Series *Vestiti* widespread as an unquestioned native in Wales and western parts of England with a marked peak of abundance in Cardiganshire, v.c. 46 (in which it is the commonest bramble). Cultivated at the former Long Ashton Research Station, near Bristol, and some years ago placed on the market under the trade name 'Ashton Cross' (Edees & Newton 1988: 127 fn.), this has won favour comparatively widely by reason of its heavy cropping despite rather acidic fruit. Isolated occurrences of it well outside its presumptive natural range, as on Barnes Common in Surrey, v.c. 17 (Norman 1999), can be credibly attributed to garden outcasts or dispersal by birds from cultivated sources; elsewhere, though, some supposedly native populations of the species may be more suspect in status than is at first sight apparent. In the Isle of Man, for example, in the one place in which it occurs in quantity, in a shady ravine opening on to the sea, a habitat which seemed good grounds for regarding it as a member of the native flora (Allen 1986), the population has subsequently been found to extend into an adjacent garden, the owner of which turns out to have long prized this particular bramble for the very qualities for which it has been promoted commercially. In the light of this finding, the status of this species in the island as a whole has come into question.

A more extreme possibility is that some supposedly native species are garden escapes in Britain (and Ireland too, for that matter) in their entirety. One of those, it has belatedly become apparent, could well be the recently-described *R. milesianus*. Robust and distinctive enough to have gained a place in the herbaria of *Rubus* specialists since as early as 1867 (Watson 1958: 194), its recorded occurrences all lie

along an arc of some 235 km in length extending across the far south-east corner of England, from Bournemouth to Canterbury. Most of these appear to have taken the form of solitary bushes only, a pattern especially characteristic of larger-fruited species such as this that are consequently more than ordinarily prone to dispersal by birds – though in two instances secondary spread by tip-rooting has clearly taken place on an extensive scale.

In addition to their large size the mature fruits of *R. milesianus* are also notably delicious. It is thus a species particularly likely to have been taken into cultivation from the wild. The possibility that is may have occurred as a garden escape has nevertheless been raised hitherto only in the case of one anomalous-looking urban record (Allen 2004: 170). Subsequent scrutiny of all the recorded occurrences, however, has revealed a suggestive association with areas notable for a concentration, at least by the mid-nineteenth century, of large detached houses standing in grounds spacious enough to have contained a sizeable kitchen-garden extending to a range of soft fruit. Even one of the two populations of considerable extent, that on Southampton Common, v.c.11, is suspiciously confined to the neighbourhood of the Common's north margin, the part adjacent to that city's leafy, late-developing suburb of Bassett.

At first sight the other substantial population, by far the larger of the two in extending across 3 × 2 km of wooded countryside in north-east Hampshire, v.c.12, has no comparably suspect character. Although that area has its south end as the type locality – the extensive grounds of a mansion, Tylney House (now a hotel) – the readiest assumption is that the plant owes its presence in those to overspill from the adjoining woodland. Equally, however, the reverse could be the case. Given the impressively rapid rate of spread by tip-rooting of which *Rubus* species are well-known to be capable, it would not have been difficult for one as robust as this to have colonised that large tract of country within a relatively short span of years. The more or less continuous character of the population could be seen as providing support for that alternative interpretation.

But if the status of *R. milesianus* in Britain is wholly that of a naturalised escape, there remains the question of from where it

originated. Did it arise in cultivation (as the widely-grown *R. laciniatus* Willd. is supposed to have done, in the absence of contrary evidence) or does it exist somewhere as a native? After a century and a half in which Britain has been explored increasingly intensively by *Rubus* specialists, it is hard to believe that so conspicuous a species still lies undiscovered in such situations here. Mainland Europe accordingly seems much likelier as the source. And to where more precisely that might have been, the recent surfacing in **BM** of an unmounted gathering from southern France of what has every appearance of being a weak example of this same taxon provides a clue. These specimens were collected in 1925 by a then leading Swedish botanologist, C. E. Gustafsson, in or near Carmaux, a town in the north of *dép.* Tarn, in the south-western foothills of the Massif Central. They are accompanied by a label in the handwriting of the collector with a determination that he probably arrived at by himself from the keys and descriptions in *Rubi Europae* (Sudre 1908–

1913): *R. micans* subsp. *heterochrous* var. *nitidipilus* Sudre, a taxon described in that work from another locality in that same *département*. As no authentic material of that has been located, it is impossible to say whether that determination is correct (which could have nomenclatural implications, if it is). The specimen does, however, provide a possible homeland for *R. milesianus* – assuming that the plant found by Gustafsson was not an escape there as well. In addition it reopens the possibility that Watson (1958) may have been correct after all in identifying the British plant with *R. koehleri* subsp. *lapeyrousianus* Sudre, a taxon described (and known only) from *dép.* Ariège, at the east end of the Pyrenees. Though Ariège is two *départements* distant from Tarn and situated alongside a different mountain range, the separating distance is not so great as to make such an identification geographically altogether unlikely. However, that question too cannot be settled for similar lack of an authentic specimen (Allen 2004).

REFERENCES

- ALLEN, D. E. (2004). Five new species of *Rubus* L. (Rosaceae) mostly from Central South England. *Watsonia* **25**: 157–174.
- EDEES, E. S. & NEWTON, A. (1988). *Brambles of the British Isles*. Ray Society, London.
- NORMAN, E. (1999). The flora of Barnes Common. *London Naturalist* **78**: 65–80.
- SUDRE, H. (1902–1913). *Rubi Europae*. Librairie des Sciences naturelles, Paris.
- WATSON, W. C. R. (1958). *Handbook of the Rubi of Great Britain and Ireland*, ed. P. D. SELL & J. E. WOODHEAD. Cambridge University Press, Cambridge.

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Plant Records

Records for publication must be submitted to the appropriate Vice-county Recorder (see *BSBI Year Book* 2005), and not to the Editors. Following publication of the *New Atlas of the British & Irish Flora* and the *Vice-county Census Catalogue*, new criteria have been drawn up for the inclusion of records in *Plant Records*. (See *BSBI News* no. 95, January 2004 pp10 & 11). These are outlined below:

- First records of **all** taxa (species, subspecies and hybrids) included in the VCCC, designated as native, archaeophyte, neophyte or casual.
- First record since 1970 of the taxa above, except in the case of *Rubus*, *Hieracium* and *Taraxacum*.
- Records demonstrating the rediscovery of all taxa published as extinct in the VCCC or subsequently.
- Newly reported definite extinctions.
- Deletions from the VCCC (e.g. through the discovery of errors, the redetermination of specimens etc.) **NB** – only those errors affecting VCCC entry.
- New 10km square records for Rare and Scarce plants, defined as those species in the *New Atlas* mapped in the British Isles in 100 10km squares or fewer. (See *BSBI News* no. 95, January 2004 pp 36-43).

Records for the subdivisions of vice-counties will not be treated separately; they must therefore be records for the vice-county as a whole. However, records will be accepted for the major islands in v.cc. 102–104, 110 and 113.

In the following list, records are arranged in the order given in the *List of Vascular Plants of the British Isles* and its supplements by D. H. Kent (1992), from which the species' numbers, taxonomy and nomenclature are taken. The Ordnance Survey national grid reference follows the habitat and locality. With the exception of collectors' initials, herbarium abbreviations are those used in *British and Irish Herbaria* by D. H. Kent & D. E. Allen (1984). Records are field records if no other source is stated. For all records 'det.' or 'conf.' appear after the herbarium if the determination was based on material already in an institutional herbarium, otherwise before the herbarium.

The following signs are used:

* before the vice-county number: to indicate a new vice-county record.

† before the species number: to indicate that the plant is an archaeophyte.

‡ before the species number: to indicate that the plant is a neophyte.

© before the species number: to indicate that the plant is a casual.

The above 3 signs may also be used before the vice-county number to indicate the status of the plant in that vice-county.

® before the vice-county number: to indicate that this is an additional hectad for a Rare or Scarce plant.

Ø at end of entry: established taxon not in Vice-County Census Catalogue.

[] enclosing a previously published record: to indicate that that record should be deleted or changed.

The following list contains the second set of records up to and including the year 2005. Records up to and including the year 2006 will be published in the next issue of *Watsonia*.

1/3.1. **Lycopodium clavatum** 110, Outer Hebrides: Lingara, South Harris, NG0585, R. J. Pankhurst, R. A. H. Smith & E. Pilling, 1997. 1st record since 1970.

4/1.2. **Equisetum ramosissimum** *35, Mons.: in rough grass, a brownfield site, NW of Spytty Pill, Newport, ST323874, R. P. Kilshaw, 2005, conf. T. G. Evans, A. C. Jermy, P. J. Acock & F. J. Rumsey. 1st Welsh record. Translocation is being considered.

4/1.3. **Equisetum variegatum** 106, E. Ross: forested dunes, Morrich More, NH802833, B. R. & C. B. Ballinger, 2005, **herb. B.B.** 1st record since 1970.

4/1.4×8. **Equisetum ×dycei** (*E. fluviatile* × *E. palustre*) *93, N. Aberdeen: flush, Scad Hill, NJ428245, P. J. Acock, F. J. Rumsey & D. Welch, 2003, **herb. D. Welch**. Known in Scad Hill - Silverford flushes since c. 1980, but identity uncertain.

4/1.6. **Equisetum pratense** 110, Outer Hebrides: Rodel, Harris, NG041845, C. N. Page, 1972, **E.** 1st record since 1970.

4/1.6×7. **Equisetum ×mildeanum** (*E. pratense* × *E. sylvaticum*) *93, N. Aberdeen: flush in gorge, White Hill of Bogs, NJ438253, P. J. Acock, F. J. Rumsey & D. Welch, 2005, **herb. D. Welch**. *E. ×mildeanum* suspected in 2003, confirmed at same position in 2005.

6/1.1. **Osmunda regalis** 95, Moray: one plant in damp area under pine trees, Lossie Forest, NJ314658, I. P. Green, 2005. 1st record since 1955.

‡8/1.nip. **Pteris nipponica** Shich *29, Cambs.: a single naturalised plant near base of wall, Essex Building, Queens' College, Silver Street, Cambridge, TL446581, P. H. Oswald, 2000. Ø

11/1.1×2. **Polypodium ×mantoniae** (*P. vulgare* × *P. interjectum*) *110, Outer Hebrides: Abhainn Gheurasdail, South Harris, NG107969, P. A. Smith, 2005, conf. G. Hutchinson, NMW.

14/1.1. **Thelypteris palustris** @28, W. Norfolk: fen, Sculthorpe, TF902300, R. A. Yaxley, 2001. @28, W. Norfolk: fen, Sculthorpe, TF901297, R. A. Yaxley, 2001. @28, W. Norfolk: fen grassland, East Walton Common, TF734166, Norfolk Flora Group & R. W. Ellis, 2002.

14/3.1. **Oreopteris limbosperma** 32, Northants.: one plant only growing near patch of ling by old railway tunnel, Charwelton, SP533569, J. Atkinson, 2004, conf. I. A. Denholm, **herb. Gill Gent**. Rediscovered having been presumed extinct (*Flora of Northamptonshire*, 1995).

15/2.5b. **Asplenium trichomanes** subsp. **quadrivalens** *91, Kincardines.: roadside dyke, Banchory, NO693959, D. Welch, 2005, **herb. D. Welch**. Site long known but VCCC recorded only the species, not the subspecies.

15/2.7. **Asplenium ruta-muraria** 106, E. Ross: urban site, Muir of Ord, NH5250, M. J. Crawley, 1998. 1st record since 1970. Still present in Muir of Ord 2001.

16/5.1. **Cystopteris fragilis** ‡32, Northants.: wall, Brockhall, SP632626, B. J. Laney, 2005, conf. P. Stanley, **herb. Gill Gent**. Rediscovered having been presumed extinct (*Flora of Northamptonshire*, 1995).

17/1.1. **Polystichum setiferum** 104, N. Ebeudes (Skye): cliff base, S of Holm, NG519507, S. J. Bungard, 2004, conf. M. H. Rickard. 1st record for Skye. ‡‡110, Outer Hebrides: old woodland garden, Northbay, Barra, NF705036, R. J. Pankhurst, 2004, det. H. McHaffie, **E.**

17/1.2. **Polystichum aculeatum** 110, Outer Hebrides: ravine NE of Clett an Duin, Taransay, NB037003, E. Pilling, 1997, **E.** 1st record since 1970.

17/3.1. **Dryopteris oreades** *110, Outer Hebrides: ravine of Abhainn a'Mhuill, NB188130, R. J. Pankhurst, 1996, det. S. Lindsay, **E.** 1st confirmed record.

17/3.2×3. **Dryopteris ×complexa** (*D. filix-mas* × *D. affinis*) *8, S. Wilts.: woodland, Great Bedwyn, SU283626, Wiltshire Botanical Society, 2003.

17/3.2×3. **Dryopteris ×complexa** nothosubsp. **critica** (*D. filix-mas* × *D. affinis* subsp. **borreri**) *46, Cards.: wooded ravine, Llyfnant Valley, 300m SW of Cwmrhaidr, SN752960, T. D. Dines & A. O. Chater, 1997, det. K. Trewren, NMW.

17/3.3con. **Dryopteris affinis** morphotype **convexa** *44, Carms.: acid boundary bank, Glandy Farm, SN167287, BSBI meeting, 2005, det. A. O. Chater & S. J. Thomas. 1st record of morphotype.

17/3.3pal. **Dryopteris affinis** morphotype **paleaceo-lobata** *44, Carms.: hedgebank, Tireithin, Bancffosfelen, SN493127, BSBI meeting, 2003, det. A. O. Chater & S. J. Thomas. 1st record of morphotype.

‡20/7.mug. **Pinus mugo** 110, Outer Hebrides: Glen Coishletter, South Harris, NF998885, R. J. Pankhurst, 2002. 1st record since 1970.

‡20A/CRY.jap. **Cryptomeria japonica** *7, N. Wilts.: two seedlings progressing to saplings in woodland, Chisbury Wood, SU275655, J. E. Oliver, 2004.

‡21/1×2/1×noo. **×Cupressocyparis leylandii** (*Cupressus macrocarpa* × *Chamaecyparis nootkatensis*) *110, Outer Hebrides: Scotasay, NG188972, R. J. & A. F. Pankhurst, 2005.

@28/3.3. **Helleborus orientalis** *7, N. Wilts.: established on dumped soil, Clatford, SU160688, J. E. Oliver, 2003.

‡28/3.arg. **Helleborus argutifolius** *©5, S. Somerset: self-sown at base of pavement, Witcombe, ST476214, P. R. Green, 2005.

‡28/12.4. **Clematis montana** *©29, Cambs.: one self sown plant in paving crack below Elizabeth Way bridge, Cambridge, TL461591, A. C. Leslie, 2005.

28/13.4. **Ranunculus sardous** 32, Northants.: field edge, SP663658, B. J. Laney, 2005, det. E. J. Clement. 1st record since 1970.

28/13.13×14. **Ranunculus ×levenensis (R. flammula × R. reptans)** *108, W. Sutherland: at 553m, Coir a' Ghallaich, Ben Hope, NC486505, G. P. Rothero, 2004, conf. R. J. Gornall.

28/13.23. **Ranunculus aquaticus** 106, E. Ross: farm pond near Rockfield, NH930838, B. R. & C. B. Ballinger, 2005. 1st record since 1970, confirming *Atlas* record for NH98, M. J. Crawley, 1995.

©29/1.7. **Berberis julianae** *7, N. Wilts.: roadside, Marlborough, SU192695, J. E. Oliver, 2004. Recent garden escape.

‡29/1.9. **Berberis darwinii** *7, N. Wilts.: five self-seeded young plants on stonework, Chippenham, ST920735, J. E. Oliver & M. Blake, 2003. *51, Flints.: on established coastal dunes away from houses, Talacre, SJ1285, J. Phillips, 2005.

‡30/1.3. **Papaver somniferum** *‡110, Outer Hebrides: Eorpie, NB519649, R. J. Pankhurst, 2005.

‡30/1.6. **Papaver hybridum** 32, Northants.: arable field edge, Spanhoe, SP945987, A. Wilson, 1999, det. R. J. Wilson. Rediscovered having been presumed extinct (*Flora of Northamptonshire*, 1995) and 1st record since Druce 1930.

‡31/3.1. **Pseudofumaria lutea** 106, E. Ross: wall, Rosemarkie, NH736577, B. R. & C. B. Ballinger, 2005. 1st record since 1970.

31/4.1. **Ceratocapnos claviculata** *32, Northants.: very well established in conifer plantation, Harlestone Firs, SP718640, K. Taylor, 1996, conf. G. M. Gent, **herb. Gill Gent**.

31/5.1. **Fumaria capreolata** 50, Denbs.: footpath, Colwyn Bay, SH875787, J. A. Green, 2005. 1st record since 1960.

‡31/5.10. **Fumaria vaillantii** ©28, W. Norfolk: urban area, Dereham, TF999131, D. & B. Mathias, 2004.

‡32/1.occxori. **Platanus ×hispanica (P. occidentalis × P. orientalis)** *50, Denbs.: streamside, Alyn Waters County Park, Wrexham, SJ319549, BSBI group, 2005, NMW.

‡36/1.1b. **Urtica dioica** subsp. **galeopsifolia** *44, Carms.: rubbish tip, old quarry north of Beacon Bog, SN31N, C. Cheffings, M. Godfrey & A. R. Vickery, 2005. 1st Welsh record for subspecies

40/1.2b. **Betula pubescens** subsp. **tortuosa** *110, Outer Hebrides: Molinginish, NB2200, J. W. Heslop Harrison, 1956. Heslop Harrison *et al* in *Proc. Unic. Durh. Phil. Soc.* 12: 141-149 (1956).

40/1.3. **Betula nana** *86, Stirlings.: Craigend Muir, Strathblane, NS581774, J. Mitchell & D. C. Shenton, 2002, E.

‡40/1.uti×1. **Betula utilis × B. pendula** *29, Cambs.: one self sown tree, apparently of this parentage, on a grave at the southern end of Mill Road cemetery, Cambridge, TL461561, A. C. Leslie, 2001, **CGE**. First seen in 2001 when 6ft tall. Still there (2005) and now 15ft tall. Ø Apparently 1st record for the British Isles.

‡40/2.1×2. **Alnus ×hybrida (A. glutinosa × A. incana)** *44, Carms.: self sown, with both parents in vicinity, amongst shrub plantings, Wildfowl & Wetlands Trust Centre, Penclacwydd, Llanelli, SS533986, Llanelli Naturalists, 1999, det. I. K. Morgan. *©57, Derbyshire: amenity tree planting, near Grin Low car park, SK049719, A. Willmot & J. Bland, 2004. Probably planted, and with both parents which were planted.

‡40/2.3. **Alnus cordata** *7, N. Wilts.: seedlings and 3 saplings on canalside, Swindon, SU135836, J. E. Oliver, 2004.

‡40/2.rub. **Alnus rubra** *42, Brecks.: Glasfynydd Plantation, SN82, R. G. Woods, 2004.

‡43/1.12. **Chenopodium murale** ©46, Cards.: several plants on waste ground, Ynys-las boatbuilding yard, SN616932, A. O. Chater, 2005, NMW. 1st record since 1932.

©43/1.gig. **Chenopodium giganteum** *29, Cambs.: one plant on a low ridge of waste soil, Jeavons Lane, Cambridge, TL320588, N. P. Millar, 2005, **CGE**.

43/3.3×4. **Atriplex ×taschereaui (A. glabriuscula × A. longipes)** *95, Moray: several plants in saltmarsh on the edge of Lossie Forest, Lossiemouth, NJ253689, I. P. Green, 2005.

43/3.6. *Atriplex litoralis* *©32, Northants.: one plant only on wall, Oundle, TL035880, F. H. Perring, 2001, **herb. Gill Gent.**

43/6.2. *Salicornia ramosissima* 110, Outer Hebrides: north of Lochboisdale, NF7819, E. Pilling, 2000, det. R. J. Pankhurst, **E.** 1st record since 1970.

43/6.6. *Salicornia fragilis* *106, E. Ross: intertidal zone of muddy shore, Inver, NH860825, B. R. & C. B. Ballinger, 2005, det. I. K. Ferguson.

‡44/1.1×4. *Amaranthus retroflexus* × *A. bouchonii* *29, Cambs.: several plants scattered amongst numerous plants of both parents in beet field, Cross Drove, Littleport, TL584868, A. C. Leslie, 2005, **CGE.** Ø

45/3.1. *Montia fontana* 32, Northants.: recently cleared area of relict heathland, Harlestone Firs, SP719639, B. J. Laney, 2004, conf. P. Stanley, **herb. Gill Gent.** Rediscovered having been presumed extinct (*Flora of Northamptonshire*, 1995).

45/3.1a. *Montia fontana* subsp. *fontana* 110, Outer Hebrides: Cliuthar, South Harris, NG19K, R. J. Pankhurst & P. A. Smith, 2004. 1st record since 1970.

45/3.1b. *Montia fontana* subsp. *variabilis* 110, Outer Hebrides: wet peaty pool near sea, Husinis, NA91W, R. J. Pankhurst & P. A. Smith, 2004, det. A. O. Chater. 1st record since 1970.

46/1.2. *Arenaria norvegica* *106, E. Ross: rock outcrop, Breabag Tharsuinn, NC302190, G.P. Rotho, 1998. Still present 2005.

46/17.3. *Spergularia marina* *‡32, Northants.: three of four large patches on road verge, Wellingborough, SP870666, S. L. M. Karley, 2004, **herb. S.L.M. Karley.**

‡46/20.7. *Silene armeria* *©29, Cambs.: one plant on disturbed ground, south of the new Cutter Ferry Bridge, Midsummer Common, Cambridge, TL459590, A. C. Leslie, 2005.

46/20.10. *Silene dioica* 110, Outer Hebrides: Northbay area, Barra, NF70, D. Dupree, L. Gaskell, C. Velandar, G. Orledge, 1998. 1st record since 1970.

‡46/20.11. *Silene gallica* ®28, W. Norfolk: arable field edge, Snettisham, TF667335, N. Harris, 2001.

‡46/25.6. *Dianthus barbatus* *42, Brecks.: waste ground, Bwlch, SO146223, W. J. H. Price & M. Porter, 2005.

‡46/GYP.mur. *Gypsophila muralis* *70, Cumberland: dumped earth in field, Glasson Moss, NY240610, F. J. Roberts, 2005, det. G. Halliday, **LANC.**

47/1.12. *Persicaria lapathifolia* 110, Outer Hebrides: Loch an Duin, NB189408, N. F. Stewart & J. J. Day, 1995. 1st record since 1970.

47/1.16. *Persicaria minor* *86, Stirlings.: Shore of Loch Lomond, between Balmaha and Endrick Mouth, NS4290, A. J. Silverside, 1978.

‡47/3.1. *Fagopyrum esculentum* *©42, Brecks.: road verge, 1km E of Bronllys, SO149355, M. & C. Porter, 2005. 50, Denbs.: bare ground, Gresford, SJ346536, B. Formstone, 2005. 1st record since 1930.

47/4.5. *Polygonum boreale* *106, E. Ross: coast, Munlochy, NH640525, J. K. Butler, 1992.

47/8.8×13. *Rumex* ×*propinquus* (*R. longifolius* × *R. crispus*) *108, W. Sutherland: sea cliff, Oldshore, NC1959, P. Merler, 1948, det. J. E. Lousley, **E. Ex. herb. Nat. Con. Council.**

47/8.13×19. *Rumex* ×*pratensis* (*R. crispus* × *R. obtusifolius*) *108, W. Sutherland: Inchnadampf, NC250215, I. P. Green, 2005. Also found by I. P. Green at Achmelvich and Durness.

47/8.14×15. *Rumex* ×*ruhmeri* (*R. conglomeratus* × *R. sanguineus*) *44, Carms.: growing with both parents in disturbed dunes in vicinity of new pond near the inland control tower, RAF. Pembrey Sands, Tywyn Burrows, SN375049, BSBI meeting, 2005, det. A. O. Chater & H. J. Killick.

48/2.1. *Armeria maritima* ‡29, Cambs.: four plants scattered along the east side of the central reservation of the M11, north-west of Whittlesford, TL457486 - 457488, P. H. Oswald, 2005. 1st record since 1930 when it was seen along the tidal R. Nene at Foul Anchor.

51/1.3. *Hypericum androsaemum* *91, Kincardines.: wooded roadside, Strachan, NO685932, D. Welch, 2005.

‡51/l.for. *Hypericum forrestii* *70, Cumberland: lakeshore gravel bank, Derwentwater, SE side, NY266202, F. J. Roberts, 2005, **LANC.**

‡53/1.2. *Malva alcea* *©44, Carms.: three plants, Shidenyn farmyard and road verge between Felin Newydd and Penygader Farm, SN352231, C. Cheffings, M. Godfrey & A. R. Vickery, 2005.

53/2.olb×thu. **Lavatera ×clementii** (*L. olbia* × *L. thuringiaca*) *51, Flints.: established garden throw-out on waste ground, Mold, SJ238644, J. Phillips, 1997.

©53/4.1. **Alcea rosea** *49, Caerns.: one plant in concrete sea-wall, near Little Orme, Penrhyn Bay, SH8281, W. McCarthy, 2005.

57/1.1. **Viola odorata** ‡106, E. Ross: damp woodland, outside wall of Contin churchyard, NH455557, B. R. & C. B. Ballinger, 2005. 1st record since 1970.

57/1.4×5. **Viola ×bavarica** (*V. riviniana* × *V. reichenbachiana*) *32, Northants.: many plants, well established on woodland bank, Wild Wood, Silverstone, SP672430, C. Christie, 2001, **herb. Gill Gent.**

57/1.4×6. **Viola ×intersita** (*V. riviniana* × *V. canina*) *93, N. Aberdeen: grassland on fixed dunes, Sands of Forvie, NK019265, I. P. Green & D. Welch, 2005, **ABD.**

‡57/1.12×13. **Viola ×contempta** (*V. tricolor* × *V. arvensis*) *80, Roxburghs.: with both parents in barley stubble field, south-east of Clarilaw, Hawick, NT530180, M. E. Braithwaite, 2005, **herb. R.W.M.C.**

‡57/1/13. **Viola arvensis** 104, N. Ebudes (Raasay): disturbed soil, West Suisnish, NG553355, S. J. Bungard, 2004. 1st record since 1970.

61/2.11×15. **Salix ×laurina** (*S. cinerea* × *S. phylicifolia*) *93, N. Aberdeen: sea cliff, Whinnfold, NK083335, D. Welch, 2003, det. R. D. Meikle, **herb. D. Welch.**

61/2.11×16. **Salix ×subsericea** (*S. cinerea* × *S. repens*) *91, Kincardines.: wooded roadside, Lochton, Banchory, NO708973, D. Welch, 2005, det. R. D. Meikle, **herb. D. Welch.**

61/2.12×15. **Salix ×ludificans** (*S. aurita* × *S. phylicifolia*) 69, Westmorland: edge of Skelsmergh Tarn, SD533966, N. F. Stewart & J. Lambert, 2005, det. R. D. Meikle, **LANC.** 1st record since 1970.

62/10.2. **Matthiola sinuata** *44, Carms.: one plant (in flower) on yellow dunes, Ginst Point, Laugharne, c.SN3208, J. & C. Rees, 2005.

62/12.3. **Rorippa islandica** *‡48, Merioneth: occasional to locally frequent on rough ground beside river and concrete footpath all way down to footbridge, on E bank of Afon Glaslyn below Ynys-Ileian, Beddgelert, SH54, S. P. Chambers, 2005, conf. A. O. Chater. 1st record in N. Wales. P. M. Benoit describes *R. islandica* as a classic example of a neophyte - a spreading weed of artificial habitats, suddenly appearing where it has never been before.

‡62/14.qui. **Cardamine quinquefolia** (Bieb.) Schmalh. *35, Mons.: one small clump on bank of R. Usk, Abergavenny, SO292139, J. S. Rees, 2005, det. T. G. Evans. Ø Apparently 1st record for British Isles.

62/15.2. **Arabis glabra** @28, W. Norfolk: forest ride, Foulden, TF783004, J. E. Gaffney, 2002.

62/21.4. **Draba muralis** *©32, Northants.: a few scattered plants on railway bank near Great Oxenden, SP737828, B. J. Laney, 2005, conf. E. J. Clement, **herb. Gill Gent.**

‡62/25.2. **Capsella rubella** 23, Oxon: towpath of Oxford Canal, SP5006, J. Edgington, 2005, **OXF.** 1st record since 1962.

62/27.1. **Teesdalia nudicaulis** 91, Kincardines.: dry grassland close-grazed by rabbits, Crathes, NO747962, D. Welch, 2005. 1st record since 1970. 106, E. Ross: shingle by river, Dunglass Island, NH535547, Inverness Botany Group, 2001. 1st record since 1970.

62/30.6. **Lepidium latifolium** @28, W. Norfolk: roadside, Dereham, TF997123, D. & B. Mathias, 2001.

‡62/35.2. **Sinapis alba** 69, Westmorland: upland kale field, north side of Ninezergh Lane, Levens, SD495849, J. H. Clarke, 2005, **LANC.** 1st record since 1970.

62/41.1. **Crambe maritima** *93, N. Aberdeen: rocky shore, Peterhead, NK125455, M. Innes, 2005, conf. D. Welch. Very probably a recent colonisation - small plants first noticed 2003.

©62/CAL.irr. **Calepina irregularis** Thell. *29, Cambs.: several plants growing on discarded rootballs of trees on waste ground, Cambourne, TL313599, N. P. Millar, 2005, det. A. C. Leslie, **CGE.** Ø

‡65/2.2. **Rhododendron luteum** *80, Roxburghs.: pine woodland, The Moor, Monteviot, NT639260, J. Mercer, 2000, det. D. McKean, **E, herb. R.W.M.C.** Naturalised in quantity with *R. ponticum*.

65/13.2. **Vaccinium microcarpum** @106, E. Ross: damp meadow near Alladale Lodge, NH440894, C. Sandom, B. R. & C. B. Ballinger, 2005.

69/1.3. **Primula veris** 106, E. Ross: riverside grassland, Brahan, NH509539, S. Cohen, 1999. 1st record since 1970. Seen in 2005 in NH66.

‡70/1.2. **Pittosporum tenuifolium** *49, Caerns.: established in wood above track to Menai Strait, Bangor, SH5873, S. P. Chambers, 2005.

‡71/HYD.mac. **Hydrangea macrophylla** *©44, Carms.: one plant in fly-tipped rubbish on vacant ground, WDA development site, Delta Lake, Machynys, SS508986, G. Hutchinson, I. K. Morgan & R. D. Pryce, 2004.

72/2.6. **Ribes alpinum** ‡29, Cambs.: one large shrub on an old earth tip beside field hedge, Oakington Road, Cottenham, TL431661, J. L. Sharman, 2004. 1st record since C19.

73/1.1. **Crassula tillaea** ®28, W. Norfolk: roadside, Hoe, TF988162, K. A. & G. Beckett, 2001.

‡73/5.3. **Sedum confusum** *5, S. Somerset: small patch at base of wooded slope on margin of wood, Dunster, SS989433, P. R. Green, 2005.

©74/1.1×chixros. **Astilbe ×arendsii** (**A. japonica** × **A. chinensis** × **A. rosea**) *44, Carms.: several flowering plants in disused silica quarry, Mynydd-y-Garreg, Kidwelly, SN435085, V. & A. Lewis, 2005.

74/9.1. **Chrysosplenium oppositifolium** 110, Outer Hebrides: Stornoway Castle, NB43, R. J. Pankhurst & W. A. J. Cunningham, 1997. 1st record since 1970.

‡75/3.2×3. **Spiraea ×billardii** (**S. alba** × **S. douglasii**) *42, Brecks.: bank of R. Wye, Bultth Wells, SO035513, M. & C. Porter, 2005.

‡75/6.3. **Filipendula camtschatica** *106, E. Ross: roadside, A835, Monadh More, NH582523, J. O. Mountfield, 2003. Still present 2005.

‡75/8.2. **Rubus tricolor** *42, Brecks.: beside track in open woodland, 1.5km SW Penderyn, SN935072, M. & C. Porter, 2005.

75/8.32. **Rubus vigorosus** *44, Carms.: edge of *Molinia* dominated grassland, Penygraig Goch, near Myddfai, SN743225, BSBI meeting, 2005, det. M. Porter. Occasional at this farm

75/8.60. **Rubus lindleianus** *91, Kincardines.: roadside, Cammachmore, NO901948, D. Welch, 2004, det. A. Newton, **herb. D. Welch**.

75/8.81. **Rubus sciocharis** *93, N. Aberdeen: abandoned railway, Maud, NJ930481, D. Welch, 2004, **herb. D. Welch**.

75/8.112. **Rubus nemoralis** *91, Kincardines.: roadside, St Cyrus, NO742649, D. Welch, 2004, conf. A. Newton, **herb. D. Welch**.

75/8.254. **Rubus rufescens** *86, Stirlings.: wood margin, Island of Clarinsh, Loch Lomond NNR, NS4189, A. McG. Stirling, 1980, det. A. Newton, **E**.

‡75/9.7. **Potentilla recta** *44, Carms.: one plant at base of hedge, Ty'r-waun, Pwll, Llanelli, SN470013, I. K. Morgan, 2005. *46, Cards.: streambank by level crossing, Llanbadarn Fawr, SN599807, A. O. Chater, 2005, **NMW**.

75/9.16. **Potentilla sterilis** 106, E. Ross: woodland, River Alness, NH644714, P. Wortham, 1998. 1st record since 1970. Still present 2005.

‡75/13.3. **Geum macrophyllum** *©5, S. Somerset: garden weed, not originally planted, Wellington, ST140200, S. J. Parker, 2005. May have come in with birdseed.

75/15.1. **Agrimonia eupatoria** 106, E. Ross: coast, Shandwick, NH856738, H. McHaffie, B. R. & C. B. Ballinger, 2005. 1st record since 1970. Also recorded for *Atlas* by BSBI group in NH98 in 1999.

75/19.12. **Alchemilla glomerulans** *70, Cumberland: herb-rich meadow at 400 m, Garrigill, NY762385, F. J. Roberts, 2005. ®106, E. Ross: cliff, Loch Luchd Coire, Seanna Braigh, NH283878, V. Halcrow, 2004.

®106, E. Ross: cliff, Coire Lochain, Ben Wyvis, NH767708, B. R. & C. B. Ballinger, 2005, **herb. B.B.**

75/21.4×16. **Rosa arvensis** × **R. sherardii** *50, Denbs.: hedge, small lane, St George, Abergele, SH967757, M. Stead, 2005, det. R. Maskew, **NMW**.

75/21.13b×16. **Rosa caesia** subsp. **vosagiaca** (female) × **R. sherardii** (male) *110, Outer Hebrides: top of low sea cliff, Glendale, NF792146, R. J. Pankhurst, 2003, det. R. Maskew, **E**. 1st record with subsp. of *R. caesia* identified.

‡75/21.bru. **Rosa brunonii** Lindl. *29, Cambs.: at least four large plants, some climbing 30-40 ft into trees and shrubs, southern end of Coe Fen, Cambridge, TL450571, A. C. Leslie, 2005, **CGE**. Ø Apparently 1st record for British Isles.

75/22.4×5. **Prunus ×fruticans** (**P. spinosa** × **P. domestica**) *48, Merioneth: by track on edge of sand dunes, near Coleg Harlech, SH53, N. E. & R. Sherlock, 1998, conf. K. W. Page.

75/27.1. **Malus sylvestris** *106, E. Ross: Aultgowrie, NH45, L. Garrard, G. Hogg, S. Hogg, T. C. G. Rich, 1987. Also at east end Loch Achilty, NH43795691, 2004.

‡75/28.7. **Sorbus intermedia** s.s. 110, Outer Hebrides: Stornoway Castle, NB43, R. J. Pankhurst & W. A. J. Cunningham, 1997. 1st record since 1970.

‡75/28.hup. **Sorbus hupehensis** *95, Moray: five self-sown trees on edge of Balnacoul Wood, Mosstodloch, NJ322600, I. P. Green, 2005, det. E. J. Clement.

‡75/31.1. **Photinia davidiana** *95, Moray: twenty-four self-sown bushes in Balnacoul Wood, Mosstodloch, NJ3259, I. P. Green, 2005.

‡75/32.10. **Cotoneaster salicifolius** *7, N. Wilts.: bird-sown on wall-top, Marlborough, SU186689, J. E. Oliver, 2003.

‡75/32.16. **Cotoneaster integrifolius** 7, N. Wilts.: bird-sown on stonework, Coate Water, Swindon, SU177826, J. E. Oliver, 2003. 1st record since 1970. *91, Kincardines.: dyke by stream, Maryculter, NJ894009, D. Welch, 2005.

‡75/32.17. **Cotoneaster linearifolius** *7, N. Wilts.: bird-sown seedling on stonework, Coate Water, Swindon, SU177826, J. E. Oliver, 2003. Parents cultivated nearby.

[‡75/32.25. **Cotoneaster nanshan** 77, Lanarks.: error in VCCC. No known record. Delete.]

‡75/32.34. **Cotoneaster bullatus** *91, Kincardines.: riverside woodland, Banchory, NO710957, D. Welch, 2005. Self-seeded from nearby landscaping.

‡75/32.40. **Cotoneaster sternianus** *50, Denbs.: quarry, Llandulas, SH912777, W. McCarthy, 2003.

[‡75/32.ind. **Cotoneaster induratus** 77, Lanarks.: error in VCCC. No known record. Delete.]

[‡75/32.lid. **Cotoneaster lidjiangensis** 77, Lanarks.: error in VCCC. No known record. Delete.]

‡77/3.1×ori. **Colutea ×media** (**C. arborescens** × **C. orientalis**) *5, S. Somerset: flowering, at edge of car park, Porlock Weir, SS864478, C. J. Giddens, 2005.

77/10.3. **Ornithopus perpusillus** 106, E. Ross: by forest track, West Kinkardine Hill, NH588872, B. R. & C. B. Ballinger, 2005. 1st record since 1970.

77/14.13. **Vicia lutea** 91, Kincardines.: embankment of abandoned railway, St Cyrus, NO737635, B. Hogarth, 2005. 1st record since 1970.

©77/14.fab. **Vicia faba** *7, N. Wilts.: spoil, Bradford-on-Avon, ST823632, J. Presland, 2003. *49, Caerns.: disturbed ground near new superstore, Porthmadog, SH5638, Caerns. Recording Group, 2005.

‡77/15.9. **Lathyrus latifolius** *106, E. Ross: dune by sea, Shandwick, NH859750, B. R. & C. B. Ballinger, 2004. Confirms M. J. Crawley *Atlas* record for NH87 in 1999.

77/16.3. **Ononis spinosa** *‡44, Carm's.: sparsely vegetated opencast spoil, Ffos-las former opencast site, Trimsaran, SN453062, I. K. Morgan, 1999. ?Introduced in seed mix.

77/16.4. **Ononis repens** 106, E. Ross: urban site, Muir of Ord, NH5348, P. Wortham, 1995. 1st record since 1970. Still present, Muir of Ord station, 2005.

77/18.3. **Medicago minima** ®29, Cambs.: many fine plants on a dry, open, SW facing bank above pond, Cambridge Science Park, Milton, TL464617, A. C. Leslie, 2005, CGE.

77/19.8. **Trifolium fragiferum** 50, Denbs.: grassland, Pentre Mawr Parc, Abergele, SH943786, J. A. Green, 2005. 1st record since 1970.

‡77/21.1×2. **Lupinus ×regalis** (**L. arboreus** × **L. polyphyllus**) *106, E. Ross: by shore, Barbaraville, NH749721, B. R. & C. B. Ballinger, 2005. Garden escape. Confirms M. J. Crawley *Atlas* record for NH77 in 1999.

77/25.4. **Genista anglica** 106, E. Ross: Hillockhead, NH747603, Inverness Botany Group, 1997. 1st record since 1970. Still present 2005.

‡77/25.ten. **Genista tenera** (Jacq.) Kuntze *17, Surrey: one large shrub and several smaller ones self-seeded from nearby gardens, Turf Hill, Bagshot, SU932617, G. Hounscome, 2005, det. E. J. Clement. Ø

77/26.3. **Ulex minor** 32, Northants.: recently cleared area of relict heathland, Harlestone Firs, SP718639, G. M. Gent, 1999. Rediscovered having been presumed extinct (*Flora of Northamptonshire*, 1995).

‡77/PHA.vul. **Phaseolus vulgaris** *42, Brecon.: canal verge, Brecon, SO047282, A. & V. Lewis, 2005.

©77/PIS.sat. **Pisum sativum** *49, Caerns.: disturbed ground near new superstore, Porthmadog, SH5638, Caerns. Recording Group, 2005.

‡78/1.1. **Hippophae rhamnoides** 110, Outer Hebrides: Berneray, NF909813, R. J. & A. F. Pankhurst, 2004. 1st record since 1970.

†81/1.2. **Lythrum hyssopifolium** @29, Cambs.: in gravel scrape by Elney Lake, Fen Drayton gravel pits, TL336693, S. Brown, 2005, det. N. P. Millar. Considered native in v.c.29.

81/1.3. **Lythrum portula** 32, Northants.: recently cleared area of relict heathland, Harlestone Firs, SP718689, G. M. Gent, 2005, **herb. Gill Gent**. Rediscovered having been presumed extinct (*Flora of Northamptonshire*, 1995).

81/1.3b. **Lythrum portula** subsp. **longidentatum** *110, Outer Hebrides: ditches west side of North Uist, NF76, W. A. Shoolbred, 1898, NMW, det. D. E. Allen (as var. *longidentata*), in Allen *Watsonia* 3: 85-91 (1954).

‡83/2.gun. **Eucalyptus gunnii** *5, S. Somerset: self-sown on side of passageway as street weed, Wellington, ST135195, S. J. Parker, 2005.

84/1.2. **Epilobium parviflorum** 106, E. Ross: dunes, lochan south-east of control tower, Morrich More, NH8482, BSBI group, 1999. 1st record since 1970.

[84/1.2×6. **Epilobium ×dacicum** (*E. parviflorum* × *E. obscurum*) *52, Anglesey: damp ground by track, Ty Mawr, Paradwys, SH416708, I. R. Bonner, 2004, **herb. I.R.B.** In *Watsonia* 26: 82 (2006). Delete - plant re-determined as *Epilobium ×floridulum* (*E. parviflorum* × *E. ciliatum*) by G. D. Kitchener.]

84/1.2×7. **Epilobium ×persenicum** (*E. parviflorum* × *E. roseum*) *29, Cambs.: several plants with both parents at edge of pavement bordering the Cherry Hinton Brook, Burnside, Cambridge, TL475574, A. C. Leslie & C. D. Preston, 2005, CGE.

84/1.2×8. **Epilobium ×floridulum** (*E. parviflorum* × *E. ciliatum*) *44, Carms.: working limestone quarry, Cilyrychen Quarry, Llandybie, SN616166, A. O. Chater, K. A. Cottingham & R. D. Pryce, 2001, det. A. O. Chater. *52, Anglesey: damp ground by track, Ty Mawr, Paradwys, SH416708, I. R. Bonner, 2004, **herb. I.R.B.** det. G. D. Kitchener. Originally determined as *Epilobium ×dacicum* (*E. parviflorum* × *E. obscurum*).

84/1.3×6. **Epilobium ×aggregatum** (*E. montanum* × *E. obscurum*) *44, Carms.: one plant at woodland edge, Penygraig Goch, near Myddfai, SN743225, BSBI meeting, 2005, det. A. O. Chater.

84/1.7. **Epilobium roseum** *50, Denbs.: roadside, Pwllglas, SJ126554, J. A. Green, 2005.

84/1.7×8. **Epilobium ×nutantiflorum** (*E. roseum* × *E. ciliatum*) *29, Cambs.: one plant with both parents at edge of pavement bordering the Cherry Hinton Brook, Burnside, Cambridge, TL475574, A. C. Leslie & C. D. Preston, 2005, CGE.

‡84/1.8. **Epilobium ciliatum** 104, N. Ebudes (Raasay): waste ground, Clachan, NG549364, S. J. Bungard, 2002, det. T. D. Pennington. 1st record for Raasay. Also known as garden weed, West Suisnish.

84/1.8×9. **Epilobium ×fossicola** (*E. ciliatum* × *E. palustre*) *44, Carms.: rushy area in field, Cwrtbrynnybeirdd, near Trapp, SN665178, BSBI meeting, 2005, det. A. O. Chater.

‡84/5.1. **Fuchsia magellanica** *70, Cumberland: two bushes on bank of R. Cocker, Cockermouth, NY122306, D. Broughton, 2005.

‡85/1.3. **Cornus alba** *42, Brecks.: roadside scrub, Bronllys, SO151345, A. & V. Lewis, 2005.

85/1.5. **Cornus suecica** *70, Cumberland: 10 - 15 sterile shoots on ledge in gully at 800m on Great End, NY227085, S. Webb, 2005, LANC.

‡91/2.3. **Euphorbia corallioides** *29, Cambs.: numerous plants naturalised both on and beside grass track along field margin at the western end of village, Barton, TL402560, A. C. Leslie, 2005, CGE.

‡91/2.obl. **Euphorbia oblongata** *7, N. Wilts.: urban structures, Malmesbury, ST936871, J. E. Oliver & J. Wall, 2004. Declining here. Known for several years.

94/2.1. **Radiola linoides** 91, Kincardines.: wet floor of abandoned quarry, Maryculter, NO880993, D. Welch, 2005. 1st record since 1970.

95/1.1. **Polygala vulgaris** 106, E. Ross: coast, Shandwick, NH856738, C. Dixon, J. W. McIntosh, G. P. Rothero, 1998. 1st record since 1970. Still present 2005.

‡99/1.mac. **Acer macrophyllum** *8, S. Wilts.: numbers of seedlings from two planted trees, Rushmore Estate, ST958194, J. E. Oliver, 2003.

‡100/1.1. **Rhus typhina** 47, Monts.: one young stem coming up through soil-mound, farm sales outlet S of Welshpool, SJ222056, S. P. Chambers, 2005.

©101/1.1. **Ailanthus altissima** *7, N. Wilts.: seedlings on riverside and roadside, Chippenham, ST920735, M. Waters, 2003.

‡102/1.8. **Oxalis articulata** 50, Denbs.: garden escape, St George, SH973758, J. A. Green, 2005.

‡102/1.14. **Oxalis incarnata** *49, Caerns.: woodland edge, Marl Woods, SH8078, NWWT group, 2005.

‡103/1.8. **Geranium himalayense** *5, S. Somerset: single clump on edge of track to garages, Taunton, ST235245, S. J. Leach, 2003.

103/1.9. **Geranium sanguineum** ©7, N. Wilts.: roadside, Kingsdown, ST817671, J. Presland, 2003. 1st record since 1970.

‡103/1.13xpla. **Geranium ×magnificum (G. ibericum × G. platypetalum)** 106, E. Ross: by track, Strathgarve Lodge. NH404612, M. Dean, B. R. & C. B. Ballinger, 2005, **herb. B.B.** 1st record since 1970.

©103/2.tri. **Erodium triflorum** Cav. *29, Cambs.: two plants self sown at base of fence in front of 320 Coldham's Lane (and several more at base of hedge in front of number 314), Cambridge, TL474580, A. C. Leslie, 2005. Naturalised. Ø

©104/1.maj. **Tropaeolum majus** *‡110, Outer Hebrides: by shore, Brevig, Barra, NL694985, R. J. Pankhurst, 2004.

‡106/1.1. **Hedera colchica** *42, Brecks.: road bank, 2km S of Llangattock, SO204166, S. P. Chambers, 2005.

‡107/1.ran. **Hydrocotyle ranunculoides** *29, Cambs.: Soham Lode, first seen 2003 and by 2004 was dominating the mill pond and extending downstream to railway line, Soham, TL589730 - 585730, R. Torrens, 2003. *32, Northants.: very well established in large pond, Higham Ferrers A45 Road, SP950687, Environment Agency, 2003, **herb. Gill Gent.** *49, Caerns.: organic farm pond and surrounding land, Llangybi, SH4340, D. Thorpe, 2005.

107/5.3. **Chaerophyllum temulum** 106, E. Ross: roadside, west end of Loch Achilty, NH435571, J. Muscott, 1996. 1st record since 1970. Still present here 2005.

107/15.1. **Sium latifolium** ®28, W. Norfolk: dike by pasture, West Harling, TL967853, Norfolk Flora Group & R. W. Ellis, 2002.

107/19.5. **Oenanthe crocata** 32, Northants.: well established and spreading on shaded river bank, Bluebell Walk, Peterborough, TL1999, D. Broughton, 2005, conf. B. Partridge. Rediscovered having been presumed extinct (*Flora of Northamptonshire*, 1995).

107/20.1. **Aethusa cynapium** ‡106, E. Ross: by track near shore, Tain, NH785824, B. R. & C. B. Ballinger, 2005, **herb. B.B.** 1st record since 1970.

107/31.1. **Cicuta virosa** ®28, W. Norfolk: waterside, Cockley Cley, TF787037, J. E. Gaffney, 2004.

107/39.2. **Peucedanum palustre** ®28, W. Norfolk: pool in pasture, Oxburgh Hythe, TF732000, Norfolk Flora Group & K. A. & G. Beckett, 2004.

107/40.1. **Pastinaca sativa** ‡106, E. Ross: waste ground by shore, Inver, NH864828, B. R. & C. B. Ballinger, 2005, **herb. B.B.** 1st record since 1970.

107/44.1a. **Daucus carota** subsp. **carota** 110, Outer Hebrides: Uig sands, NB050328, 1971. 1st record since 1970.

108/3.3. **Centaurium littorale** 106, E. Ross: widespread on short turf at top side of saltmarsh, Morrich More, NH846842, S. Smyth, B. R. & C. B. Ballinger, 2005, **herb. B.B.** 1st record since 1970.

©111/IPO.pur. **Ipomoea purpurea** *5, S. Somerset: single self-sown plant in pavement crack, Dunster, SS989435, P. R. Green, 2005.

‡113/2.1. **Nymphoides peltata** *91, Kincardines.: fishery pool created c. 1998, Raemoir, Banchory, NO696977, D. Welch, 2005.

114/1.1. **Polemonium caeruleum** *‡110, Outer Hebrides: rough ground near football pitch, Stornoway, NB432334, E. Pratt, 1999.

‡116/4.2. **Symphytum asperum** *95, Moray: one plant growing on bank of the River Spey, under road bridge of the A941, Craigellachie, NJ286452, I. P. Green, 2005.

116/4.3. *Symphytum tuberosum* *‡110, Outer Hebrides: waste ground by sports centre, Coll, NB463386, R. J. Pankhurst, 2003, E. Previously reported from Scarastavore, South Harris by Heslop Harrison *et al.* in *Journal of Botany* 79:164-169 (1941), but without a voucher. This is the first confirmed record.

‡116/10.1. *Trachystemon orientalis* *69, Westmorland: copse by road junction, Slackhead, Beetham, SD493787, J. H. Clarke, 2005.

116/15.9. *Myosotis ramosissima* 106, E. Ross: coast, North Sutor, Nigg, NH806688, P. Wortham, 1997. 1st record since 1970. Still present 2005.

‡116/16.1. *Omphalodes verna* 70, Cumberland: near fisherman's hut, R. Eden, Coombs Wood, Armathwaite, NY506446, G. Lines, 2005. 1st record since 1970.

©117/1.hyb. *Verbena xhybrida* *5, S. Somerset: single self-sown plant in pavement crack, Dunster, SS990435, P. R. Green, 2005.

©117/CAR.inc x mon. *Caryopteris xclandonensis* (*C. incana* x *C. mongholica*) A. Simmonds ex Rehder *29, Cambs.: one young flowering plant, self sown on low brick wall in front of Sherlock Court, Cambridge, TL436599, A. C. Leslie, 2005, CGE. Ø

‡118/1.2. *Stachys byzantina* *49, Caerns.: on dumped soil in field, Pydew, SH8179, W. McCarthy, 2005.

‡118/2.1a. *Ballota nigra* subsp. *meridionalis* 44, Carms.: at edge of disused, vegetating tarmac car-park, Pembrey Burrows Local Nature Reserve, SS414993, BSBI AGM field meeting, 2005. 1st record since 1970.

‡118/6.2. *Galeopsis angustifolia* ©8, S. Wilts.: on edge of arable field margin, farmland, DTE Salisbury Plain, SU247494, J. Moon, 2004.

118/11.3. *Teucrium scordium* *52, Anglesey: pool margin, Bryngwran, SH349768, R. Birch, 2005. 1st Welsh record. Status unknown - ?native, as probably introduced by wildfowl.

118/12.2. *Ajuga pyramidalis* ©108, W. Sutherland: hazel scrub, River Laxford, NC254457, P. A. & I. M. Evans, 2005. Other plants in the vicinity.

‡118/23.3. *Mentha spicata* 110, Outer Hebrides: East Pabbay, NL68, R. J. Pankhurst & J. Swindells, 1998. 1st record since 1970.

‡118/23.3x4. *Mentha xvillosa* (*M. spicata* x *M. suaveolens*) 110, Outer Hebrides: Castlebay, Barra, NL6698, R. J. Pankhurst, 1998. 1st record since 1970.

120/1.pal. *Callitriche palustris* *86, Stirlings.: sandy shore of Endrick Mouth, Crom Mhin Bay, Loch Lomond NNR, NS426901, J. Mitchell, 2005, det. R. Lansdown, E, NMW. 2nd record for British Isles.

121/1.1. *Plantago coronopus* 32, Northants.: well established on verge of A6, Corby, SP8888, R. D. Cleaver, 1999, conf. G. M. Gent, herb. Gill Gent. Rediscovered having been presumed extinct (*Flora of Northamptonshire*, 1995). 106, E. Ross: coast, Nigg ferry, NH805689, P. Wortham, 1997. 1st record since 1970. Still present 2005.

121/1.3b. *Plantago major* subsp. *intermedia* *95, Moray: frequent on tracks in Lossie Forest, NJ280677, I. P. Green, 2005. *110, Outer Hebrides: Ceann Iar, Monach Islands NNR, NF60526200, P. A. Smith, 2005, det. T. C. G. Rich, NMW. Cult. T. C. G. Rich.

‡122/1.3. *Buddleja globosa* *©7, N. Wilts.: hedgerow, NW of Bromham, ST983679, J. Presland, 2003. *51, Flints.: naturalised, Leete path, 1.6km SW of Rhydymwyn, SJ195657, G. Wynne, 2003.

‡124/1.1. *Verbascum blattaria* 35, Mons.: one plant on the edge of a pile of stony earth, N of Millbrook Garden Centre and Trothy Brook, SO501112, T. G. Evans & C. Titcombe, 2005. 1st record since 1970.

‡124/1.10. *Verbascum speciosum* *‡42, Brecks.: road verge, Brecon, SO033284, A. & V. Lewis, 2004.

124/1.11. *Verbascum pulverulentum* ©28, W. Norfolk: disused sand pit, Blackborough End, TF680143, Norfolk Flora Group & R. M. Leaney, 2005.

‡124/1.pho. *Verbascum phoeniceum* *69, Westmorland: overgrown dump of soil, Ninezergh Lane, Levens, SD494849, G. Halliday, 2005, LANC.

124/2.1. *Scrophularia nodosa* 110, Outer Hebrides: foot of wall, Willowglen Road, Stornoway, NB434340, R. J. Pankhurst, 2001, E. 1st record since 1970.

‡124/4.2. *Mimulus guttatus* *29, Cambs.: margin of pond, Cambridge Science Park, Milton, TL466617, D. Barden, 2004. Probably deliberately introduced but now well established.

124/5.1. **Limosella aquatica** *69, Westmorland: shallow muddy pool, Tarn Syke, Sunbiggin, NY667076, G. Quartly-Bishop, 2005, LANC.

©124/13.mar. **Linaria maroccana** *44, Carms.: waste ground, Burry Port Harbour, SN443003, V. & A. Lewis, 2005. With *Centaurea cyanus*, *Viola tricolor* subsp. *tricolor*, *Sedum album* and *S. rupestre*.

‡124/16.18. **Veronica peregrina** 29, Cambs.: one plant as a weed on Monksilver Nursery, Oakington Road, Cottenham, TL436663, J. L. Sharman, 2005, CGE. 3rd v.c. record and 1st since 1958.

†124/16.24. **Veronica hederifolia** 106, E. Ross: coast, Portmahomack/Rockfield, NH98, BSBI group, 1999. 1st record since 1970.

‡124/17.elixspec. **Hebe** × **franciscana** (**H. elliptica** × **H. speciosa**) *29, Cambs.: one self sown plant at base of wall, Coveney, TL487820, A. C. Leslie, 2005.

124/20.5x1. **Euphrasia arctica** × **E. rostkoviana** *46, Cards.: horse-grazed pasture with bracken at 240 m, below road 1km SE of Devil's Bridge, SN747763, A. O. Chater, 2003, det. A. J. Silverside, NMW.

124/20.5b×19. **Euphrasia** × **venusta** (**E. arctica** subsp. **borealis** × **E. scottica**) *46, Cards.: flush on S-facing grassy slope at 370m, 200m W of Nant-llwyd, Soar y Mynydd, SN781524, A. O. Chater, 2003, det. A. J. Silverside, NMW.

124/20.5×20. **Euphrasia arctica** × **E. heslop-harrisonii** *110, Outer Hebrides: above salt marsh, Seilebost, NG082965, A. F. Pankhurst, 2005, det. A. J. Silverside, E.

124/20.7×1a. **Euphrasia nemorosa** × **E. rostkoviana** subsp. **rostkoviana** *46, Cards.: grassy working area in conifer forest at 430m, Bryn Du-bach, 3km SSE of Llanddewi-Brefi, SN678527, A. O. Chater, 2003, det. A. J. Silverside, NMW.

124/20.7×8. **Euphrasia nemorosa** × **E. pseudokernerii** *46, Cards.: gravelly verge of FC road by lead mine at 270m, with both parents growing nearby, Mynach Vale, 3km E of Devil's Bridge, SN772775, A. O. Chater, 2003, det. A. J. Silverside, NMW.

124/20.7×9. **Euphrasia nemorosa** × **E. confusa** *79, Selkirks.: locally common in basic pasture at 540m, Red Scar, Hopetown Craig, Ettrick, NT185071, R. W. M. Corner, 2005, det. A. J. Silverside, **herb. R.W.M.C.** 110, Outer Hebrides: short turf, Hellisay, Sound of Barra, NF764036, P. A. Smith, 2003, det. A. J. Silverside, E. 1st record since 1970.

124/20.8. **Euphrasia pseudokernerii** @28, W. Norfolk: chalk grassland, Cockthorpe Common, TF984430, Norfolk Flora Group & R. W. Ellis, 2000. @28, W. Norfolk: chalk grassland, Grimes Graves, TL817899, S. R. J. Woodell, 2000.

124/20.11. **Euphrasia frigida** 110, Outer Hebrides: at 450m on stony hilltop, Caiteshal, NB240046, R. J. Pankhurst & P. A. Smith, 2002. 1st record since 1970.

124/20.12. **Euphrasia foulaensis** 106, E. Ross: top end of saltmarsh, Morrich More, NH8483, P. A. Evans, 1998. 1st record since 1970. Still present and abundant 2005 (B. R. & C. B. Ballinger), confirmed A. J. Silverside. @110, Outer Hebrides: Linciate, Benbecula, NF7849, E. Pilling, 2000, det. A. J. Silverside, E.

124/20.12×14. **Euphrasia foulaensis** × **E. ostenfeldii** *110, Outer Hebrides: turf at cliff edge, Scotasay, NG182927, R. J. Pankhurst, 2005, det. A. J. Silverside.

124/20.19. **Euphrasia scottica** 106, E. Ross: damp woodland, Loch Luichart, NH385580, B. Goater, S. Erskine, M. Godfrey, 1999. 1st record since 1970.

©124/21.1. **Odontites jaubertianus** *32, Northants.: short unimproved calcareous grassland on edge of disused WW2 airfield, Spanhoe, SP940978, R. Mileto, 2005, conf. E. J. Clement, **herb. E.J.C.**

124/23.1. **Parentucellia viscosa** *29, Cambs.: two plants on disturbed ground near Fen Causeway, Coe Fen, Cambridge, TL448574, J. Shanklin, 2005.

124/25.2. **Pedicularis sylvatica** 32, Northants.: wet field, Yardley Chase MOD area (SSSI), SP836556, M. Coleman, 1997. Rediscovered having been presumed extinct (*Flora of Northamptonshire*, 1995) and 1st record since Druce 1930.

‡124/DIA.int. **Diascia integerrima** E. Mey. ex Benth. *©42, Brecks.: waste ground, Penderyn, SN939087, M. & C. Porter, 2005. 1st Welsh record. Ø Apparently 1st record for British Isles.

‡124/SUT.cor. **Sutera cordata** Kuntze *©42, Brecks.: river bank, 3km W of Hay-on-Wye, SO198408, M. & C. Porter, 2005, det. G. M. Kay. Ø

‡125/1.2. **Lathraea clandestina** *110, Outer Hebrides: Askernish, South Uist, NF738238, W. Neill, 2005. Probably introduced with *Salix* trees.

‡127B/CAT.big. **Catalpa bignonioides** Walter *29, Cambs.: two self sown young plants at base of wall in car park behind shops, Norfolk Street, Cambridge, TL461584, A. C. Leslie, 2005. Ø

128/2.6. **Utricularia minor** 106, E. Ross: Corriehallie Forest, NH396488, P. Wortham, 1999. 1st record since 1970. Still present in this locality 2004.

‡129/1.3. **Campanula lactiflora** *91, Kincardines.: shingle by R. Dee, Kingcausie Island, Maryculter, NJ867012, D. Welch, 2005, ABD.

©129/9.1. **Downingia elegans** *32, Northants.: two or three plants found in recently seeded area in marshy field, Weston Favell Mill, SP792608, R. Moore, 1997, det. M. Mullin, **herb. Gill Gent.**

130/3.1. **Sherardia arvensis** 91, Kincardines.: unsprayed turnip field, Crathes, NO750960, D. Welch, 2005, ABD. 1st record since 1970.

130/7.1. **Cruciata laevipes** ‡106, E. Ross: coast, Kiltarn, NH615652, P. Wortham, 1997. 1st record since 1970. Still present 2005.

‡131/1.1. **Sambucus racemosa** *48, Merioneth: edge of plantation, beside the Bala – Llangynog road near Llandderfel, SH981352, D. O. Elias, 2005. Known here for 2 or 3 years.

‡131/3.orb×mic. **Symphoricarpos ×chenaultii** (S. **orbiculatus** × S. **microphyllus**) *7, N. Wilts.: two clumps on old canal towpath, Swindon, SU136835, J. E. Oliver, 2004.

‡131/5.1. **Leycesteria formosa** *91, Kincardines.: shore by policies, Johnshaven, NO804675, D. Welch, 1997.

‡131/6.1. **Lonicera pileata** *7, N. Wilts.: one self-seeded young plant on stonework, Chippenham, ST920735, J. E. Oliver & G. Yerrington, 2003. *69, Westmorland: wall-top, Kendal, SD517930, C. E. Wild, 2005, LANC.

‡131/6.4. **Lonicera xylosteum** *‡80, Roxburghs.: old hedge, east of Clarilaw, Hawick, NT530180, M. E. Braithwaite, 1990. Status unchanged in 2006.

‡133/1.2. **Valerianella carianata** *32, Northants.: waste ground, Sibbertoft, SP6882, F. Pearson, 1998, conf. G. M. Gent, **herb. Gill Gent.**

‡134/2.1. **Cephalaria gigantea** *8, S. Wilts.: seeding heads on plants on derelict site, Jockey Green, SU285639, J. E. Oliver, 2004.

‡135/1.3. **Echinops bannaticus** *44, Carms.: on SW facing sandy bank, Pembrey Country Park, SN406010, I. K. Morgan, 1998, det. G. Hutchinson, NMW. Still present in 2005. The original record was published in error as *E. sphaerocephalus* (*Welsh Bulletin* 76: 33 (2005)). A throw-out or deliberate planting? *©46, Cards.: one plant in alleyway, self-sown from nearby garden, N of High Street, Lampeter, SN576481, C. M. Overton, 2005, det. A. O. Chater, NMW.

135/5.3. **Carduus crispus** 93, N. Aberdeen: arable grassland, Rattray, NK087581, I. P. Green, 2005. 1st record since 1970.

‡135/11.3. **Centaurea cyanus** *©110, Outer Hebrides: bank opposite Cuddy Point, Stornoway Castle, NB418328, R. J. Pankhurst, 2005, E. Apparently introduced with seed mixture.

‡135/17.1. **Picris echioides** *©104, N. Ebudes (Skye): single plant on roadside, S of Sconser, NG534293, S. J. Bungard, 2004. Site later tarred.

‡135/22.1. **Lactuca serriola** 42, Brecks.: industrial estate road verge, Brynmawr, SO199114, M. & C. Porter, 2005. 1st record since 1970. *49, Caerns.: roadside bank, Penrhyn Bay, SH8181, M. Stead, 2005. *52, Anglesey: roadside gravel, Valley, SH286789, R. Birch, 2005. Second plant at SH289786.

135/25.58. **Taraxacum cambricum** *69, Westmorland: meadow by canal, Stainton, SD523853, A. M. Boucher, 2005, det. A. J. Richards, **herb. A.M.B.**

135/25.100. **Taraxacum spiculatum** *69, Westmorland: pavement weed, Natland, SD521891, A. M. Boucher, 2005, conf. A. J. Richards, LANC, **herb. A.M.B.**

‡135/25.104. **Taraxacum acutifidum** *69, Westmorland: grassland, Rinkfield Road, Kendal, SD519912, A. M. Boucher, 2005, det. A. J. Richards, LANC, **herb. A.M.B.**

135/25.120. **Taraxacum cophocentrum** *69, Westmorland: footpath border, Natland, SD519890, A. M. Boucher, 2005, conf. A. J. Richards, **herb. A.M.B.**

‡135/25.122. **Taraxacum corynodes** *69, Westmorland: verge near church, Natland, SD521892, A. M. Boucher, 2005, det. A. J. Richards, **herb. A.M.B.**

‡135/25.127. **Taraxacum densilobum** *69, Westmorland: coastal grassland, Milnthorpe, SD488815, A. M. Boucher, 2005, det. A. J. Richards, **herb. A.M.B.**

‡135/25.138. **Taraxacum adiantifrons** *86, Stirlings.: waste ground by old lemonade factory, Milngavie, NS552748, R. J. Pankhurst, 2003, det. A. J. Richards, E, **herb. R.J.P.**

‡135/25.149. **Taraxacum laeticolor** *69, Westmorland: roadside verge, B6385, Crooklands, SD533826, A. M. Boucher, 2005, det. A. J. Richards, **herb. A.M.B.**

135/25.155. **Taraxacum leucopodium** *44, Carms.: moderately fertile and well drained grazing/hay field with some winter grazing and no record of recent ploughing, Waunygwail Fach Farm, Four Roads, SN447086, A. Stevens, 2004, det. A. J. Richards, **NMW**. Good material of this scarce plant.

135/25.172. **Taraxacum oblongatum** *‡110, Outer Hebrides: Harris Hotel, Tarbert, NB152000, P. A. Smith, 2005, det. A. J. Richards, **E**.

135/25.217. **Taraxacum undulatum** *69, Westmorland: coastal grassland, Milnthorpe, SD483823, A. M. Boucher, 2005, det. A. J. Richards, **LANC, herb. A.M.B.**

‡135/25.coa. **Taraxacum coartatum** *110, Outer Hebrides: Harris Hotel, Tarbert, NB152000, P. A. Smith, 2005, det. A. J. Richards, **E**.

‡135/27.6b. **Pilosella aurantiaca** subsp. **carpathicola** *108, W. Sutherland: rough ground between path and backs of gardens, Lochinver, NC095230, I. M. Evans, 2005.

135/28.29. **Hieracium placherophylloides** *46, Cards.: ungrazed rocky river bank at 285m, Afon Pysgotwr Fawr, 300m SE of Bryn-glas, SN738511, A. O. Chater, 1995, det. D. J. McCosh, **NMW**.

135/28.111. **Hieracium pollinarioides** *110, Outer Hebrides: Glen Skeaudale, NB140034, R. J. Pankhurst & P. A. Smith, 1996, det. D. J. McCosh, **E**.

‡135/28.115. **Hieracium scotostictum** *46, Cards.: roadside banks, Derwen-fach, Llandygwydd, SN242436, A. O. Chater & P. A. Smith, 1998, det. D. J. McCosh, **NMW**. Escaped from cultivation in adjacent garden.

135/28.167. **Hieracium schmidtii** 110, Outer Hebrides: Beinn na h'Aire, North Uist, NF901590, P. A. Smith, 1997, det. D. J. McCosh, **E**. 1st record since 1970.

‡135/28.asp. **Hieracium asperatum** Jord. ex Boreau *46, Cards.: ballast of disused railway in cutting, behind Penyrangor, Aberystwyth, SN581808, A. O. Chater, 1993, det. D. J. McCosh, **NMW**. Previously det. as *H. pollichiae* by P. D. Sell in 1994. Site now destroyed. Ø

135/28.avi. **Hieracium aviicola** Jord. ex Boreau *46, Cards.: roadside hedgebank at 275m, 600m WSW of chapel, Trefenter, SN601685, A. O. Chater, 1998, det. D. J. McCosh, **NMW**. Ø

135/28.con. **Hieracium consociatum** Jord. ex Boreau *46, Cards.: ballast of disused railway, Aberbachnog, 2km E of Llandysul, SN373403, A. O. Chater, 1985, det. D. J. McCosh, **NMW**. Ø

135/28.deg. **Hieracium deganwyense** Pugsley *46, Cards.: mortared walls of wheelpit of ruined lead mine at 370m, Nantycreuau mine, 4km E of Ponterwyd, SN789802, A. O. Chater, 1991, det. D. J. McCosh, **NMW**. Previously det. as *H. scoticum* by P. D. Sell in 1994. Ø

135/28.rio. **Hieracium rionii** Gremli *29, Cambs.: one plant by side of School Lane, Histon, TL441630, P. D. Sell, 2004, **CGE**. Ø

‡135/29.1. **Gazania rigens** *©49, Caerns.: pavement edge near beach café, Penrhyn Bay, SH8281, W. McCarthy, 2005.

135/30.4. **Filago minima** 32, Northants.: recently cleared area of relict heathland, Harlestone Firs, SP718638, B. J. Laney, 2004, conf. P. Stanley, **herb. Gill Gent**. Rediscovered having been presumed extinct (*Flora of Northamptonshire*, 1995).

135/33.2. **Gnaphalium sylvaticum** 7, N. Wilts.: woodland path, Cobham Frith, SU255669, J. Newton, 2003. 1st record since 1970.

©135/34.ita. **Helichrysum italicum** *29, Cambs.: one self sown plant at base of wall, Front Court, Emmanuel College, Cambridge, TL452583, A. C. Leslie, 2005.

[‡135/35.1. **Inula helenium** *91, Kincardines.: alder wood on island in R. Dee, Maryculter, NJ866009, D. Welch, 1995. Misidentification of *Telekia speciosa* (*Watsonia* 21: 397 (1997)). Delete from VCCC.]

‡135/38.1. **Telekia speciosa** *91, Kincardines.: alder woodland on island in R. Dee, Kingcausie Island, Maryculter, NJ866009, D. Welch, 2005, **ABD**. Original 1995 record called *Inula helenium* in error. *93, N. Aberdeen: streamside in gorge, Craig, NJ477245, D. Welch, 2005, **herb. D. Welch**. The original 1987 record for this site (the 2nd record for v.c. 93) was erroneously called *Inula helenium* (*Watsonia* 17: 478 (1989)).

‡135/44.1 **Conyza canadensis** *93, N. Aberdeen: flower bed, Invervrie, NJ775216, I. P. Green, 2005.

‡135/50.2. **Artemisia verlotiorum** *32, Northants.: many plants, well established on road verge, Middleton Cheney, SP509413, C. Christie, 2001, conf. G. Hansen, **herb. Gill Gent**.

- ‡135/55.2. **Anthemis arvensis** *©110, Outer Hebrides: bank opposite Cuddy Point, Stornoway Castle, NB418328, R. J. Pankhurst, 2005. Apparently introduced with seed mixture.
- ‡135/55.4. **Anthemis tinctoria** *©110, Outer Hebrides: path by west harbour, Tarbert, NB148002, R. J. Pankhurst, 2005.
- ©135/55.aus. **Anthemis austriaca** Jacq. *29, Cambs.: several plants on old soil heap, Pembroke College sports field, Grantchester Road, Cambridge, TL438570, A. C. Leslie, 2005, CGE. Ø
- ‡135/62.3. **Senecio inaequidens** *©32, Northants.: drained pond, Woodford Halse, SP505505, M. Atkins, 2003, conf. B. Partridge, **herb. Gill Gent.** *44, Carms.: about 3 large plants in disturbed ground at east end of Burry Port Southern Distributor Road construction site, SN453004, I. K. Morgan, 2005, NMW. *©46, Cards.: eight plants on waste ground, Ynys-las boatbuilding yard, SN616932, A. O. Chater, 2005, NMW. *50, Denbs.: garage forecourt, Denbigh, SJ054669, J. A. Green, 2005.
- ‡135/67.1. **Sinacalia tangutica** *29, Cambs.: apparently self sown at base of wall in narrow, concreted basement area beside Emmanuel College, Parker Street, Cambridge, TL454583, A. C. Leslie, 2003.
- ‡135/68.1. **Ligularia dentata** *69, Westmorland: south-west margin of pond, Witherslack, SD434862, J. Adams & W. Nelson, 2005.
- ‡135/71.2. **Petasites japonicus** *106, E. Ross: damp ground by river, Evanton, NH617654, B. R. & C. B. Ballinger, 2005, **herb. B.B.**
- ‡135/71.3. **Petasites albus** 110, Outer Hebrides: Stornoway Castle, NB43, R. J. Pankhurst & W. A. J. Cunningham, 1997. 1st record since 1970.
- ‡135/74.1. **Ambrosia artemisiifolia** *108, W. Sutherland: four plants in garden near bird feeders, Craggan Glas, Clashnessie, NC053308, E. King, 2005, det. P. A. & I. M. Evans, **herb. I.M. Evans.**
- ©135/76.2. **Xanthium spinosum** *‡32, Northants.: garden, Hunsbury, Northampton, SP727579, B. J. Laney, 2005, conf. E. J. Clement, **herb. Gill Gent.**
- ‡135/78.1. **Rudbeckia hirta** *95, Moray: one plant only on rubbish tip, Elgin, NJ236631, I. P. Green, 2005.
- ‡135/79.2. **Helianthus tuberosus** *44, Carms.: one large plant, c.2m across, in derelict ground used as council ash tip in 1960s, near Pemberton, Llanelli, SS530999, I. K. Morgan, 2005, NMW.
- 142/1.1×2. **Potamogeton ×gessnacensis (P. natans × P. polygonifolius)** *69, Westmorland: in 3m of water, Little Langdale Tarn, NY309033, C. Newbold, 1999, det. C. D. Preston, **LANC.** 1st English and 3rd British record.
- 142/1.7. **Potamogeton alpinus** 32, Northants.: pond, Yardley Chase MOD area (SSSI), SP839559, M. Wade, 1996. Rediscovered having been presumed extinct (*Flora of Northamptonshire*, 1995) and 1st record since Druce 1930.
- 142/1.17. **Potamogeton compressus** 29, Cambs.: one plant immediately west of the sluice on north side of Moreton's Leam, Stanground Sluice, just E of Peterborough, TL209974, P. Kirby, 2004. 1st record since 1912.
- 146/1.1. **Zostera marina** ®106, E. Ross: intertidal zone, Portmahomack, NH915846, B. R. & C. B. Ballinger, J. O. & S. A. Mason, 2005, **herb. B.B.**
- ‡147/2.1. **Lysichiton americanus** *93, N. Aberdeen: ditch in policies, Pitcaple Castle, NJ726262, D. Welch, 2005. Escape from garden.
- ‡147/5.2b. **Arum italicum** subsp. **italicum** *106, E. Ross: woodland edge, Rosemarkie, NH734578, B. R. & C. B. Ballinger, 2005, **herb. B.B.** Garden escape.
- ‡147/7.1. **Arisarum proboscideum** ‡42, Brecks.: shaded rough ground, Gurnos, SN778094, A. & V. Lewis, 2005.
- ©147/PIS.str. **Pistia stratiotes** L. *4, N. Devon: two small rosettes, Grand Western Canal, SS9812, J. Ison, 2005. Ø
- 151/1.6. **Juncus foliosus** 104, N. Ebudes (Raasay): mud by burn, Arnish, NG596482, S. J. Bungard, 2003. 1st record for Raasay and 1st for v.c.104 since 1970.
- 151/1.8. **Juncus ambiguus** 104, N. Ebudes (Rona): shore, Big Harbour, NG616565, S. J. Bungard, 2003. 1st record for Rona and 1st for v.c.104 since 1970. 104, N. Ebudes (Raasay): shore, Oskaig, NG547377, S. J. Bungard, 2003. 1st record for Raasay.

151/1.13×14. **Juncus ×surrejanus** (**J. articulatus** × **J. acutiflorus**) *44, Carms.: frequent in rushy field (with both parents), Cwrtbrynnybeirdd near Trapp, SN665180, BSBI meeting, 2005, det. A. O. Chater.

151/1.20. **Juncus maritimus** *104, N. Ebudes (Skye): tidal river, Camasunary, NG510191, A. M. B. Averis & A. M. Averis, 1996. Seen by S. J. Bungard 2006.

152/4.1. **Bolboschoenus maritimus** *‡32, Northants.: old fishing lake, Heyford, SP657624, T. Balbi, 1997, conf. G. M. Gent.

‡152/11.1. **Cyperus longus** *70, Cumberland: one large clump on S bank of R. Derwent, Cockermouth, NY120308, D. Broughton, 2005.

‡152/11.2. **Cyperus eragrostis** *29, Cambs.: self sown seedlings from plants presumably deliberately introduced, Lake Lambert, Cambourne, TL319598, N. P. Millar & A. C. Leslie, 2005.

152/14.1. **Cladium mariscus** 108, W. Sutherland: patch 20 × 20m in shallow pool, saddle mire, Mullach na Creige Deirge, NC165473, P. A. & I. M. Evans, 2005. 1st record since 1970.

152/16.32. **Carex sylvatica** 106, E. Ross: Craig Wood, Dingwall, NH556600, Dundee Naturalists Society, 2005. 1st record since 1970. Previous *Atlas* record, M. J. Crawley in NH55, 1999.

152/16.57. **Carex limosa** 106, E. Ross: bog, Scardroy Burn, NH180533, P. Wortham, 2003. 1st record since 1970. Still present 2005.

152/16.60. **Carex atrata** *86, Stirlings.: Ben Lomond, NN30, L. Watt, 1888, Noted by A. McG. Stirling in *Scottish Naturalist* IV.

152/16.65×67. **Carex ×elytroides** (**C. acuta** × **C. nigra**) *69, Westmorland: with both parents in marsh west of Roman camp, Ambleside, NY371034, M. S. Porter, 2005, conf. A. O. Chater, **LANC**.

152/16.65×68. **Carex ×prolixa** (**C. acuta** × **C. elata**) *52, Anglesey: fen, Cors Castell, SH4980, R. H. Roberts, 1982?, det. A. C. Jermy, **NMW**. From an un-named herbarium sheet passed on by Mrs Roberts.

152/16.67×69. **Carex ×decolorans** (**C. nigra** × **C. bigelowii**) 50, Denbs.: grassy summit, Cadair Bronwen, SJ078346, S. Stille, 2005, det. A. O. Chater, M. S. Porter & R. W. M. Corner, **NMW**. 1st Welsh record.

153/12.2×3. **Festuca ×fleischeri** (**F. arundinacea** × **F. gigantea**) *70, Cumberland: at least 2 plants on sandy W bank of R. Eden, Wetheral, NY467549, F. J. Roberts, 2005, det. A. Copping & T. A. Cope, **LANC**. One of three sites.

153/12.7a. **Festuca rubra** subsp. **rubra** 110, Outer Hebrides: Allt Volagir, South Uist, NF799295, R. J. Pankhurst, 2000, det. C. A. Stace, **E**. 1st record since 1970.

153/12.8. **Festuca ovina** 106, E. Ross: dunes, Morrich More, NH88, BSBI group, 1998. 1st record since 1970. Widespread here 2005.

153/12×14/7×1. **×Festulpia hubbardii** (**Festuca rubra** × **Vulpia fasciculata**) *95, Moray: growing on sand dunes with both parents, Findhorn, NJ037649, I. P. Green, 2005, conf. A. Copping.

‡153/14.3. **Vulpia myuros** *©110, Outer Hebrides: car park, Tarbert, NB150002, R. J. Pankhurst, 2005, det. C. A. Stace, **E**.

153/14.4b. **Vulpia ciliata** subsp. **ambigua** *32, Northants.: two or three large patches in open rough ground, Polebrook Airfield, TL099871, R. D. Cleaver, 1997, det. C. A. Stace, **herb. Gill Gent**.

‡153/18.10. **Poa palustris** *95, Moray: one plant on edge of small pond in Lossie Forest, NJ296665, I. P. Green, 2005, conf. T. A. Cope.

©153/25.cil. **Melica ciliata** var. **atropurpurea** L. *44, Carms.: several plants, self-sown from cultivated plants nearby, in cobbled/gravelled farmyard, Glynhir Mansion, Llandybie, SN639152, BSBI meeting, 2004, det. G. M. Kay. Ø

153/26.1. **Helictotrichon pubescens** 106, E. Ross: dunes, Morrich More, NH852835, BSBI group, 1998. 1st record since 1970. Still present 2005.

153/26.2. **Helictotrichon pratense**. 106, E. Ross: coast, Shandwick, NH856738, C. Dixon, J. W. McIntosh, G. P. Rothero, 1998. 1st record since 1970. Still present here 2005.

‡153/44.1. **Apera spica-venti** *©32, Northants.: found during survey of farmland, Sacrewell Farm, TL080998, T. C. E. Wells, 1999, **herb. T.C.E. Wells**. *©44, Carms.: one plant only in disturbed, sparsely vegetated ground, Dyfatty, Burry Port, SN460096, BSBI meeting, 2005, det. G. M. Kay, **NMW**.

†153/50.7. **Bromus secalinus** 28, W. Norfolk: arable field, Bradenham, TF916105, K. A. & G. Beckett, 2002. 1st record since 1970.

153/56.1×3. **Elytrigia ×laxa** (**E. repens** × **E. juncea**) 106, E. Ross: sandy shore, Nigg near ferry terminal. NH796687, B. R. & C. B. Ballinger, 2005, **herb. B.B.** 1st record since 1970.

153/58.1. **Hordelymus europaeus** 32, Northants.: recently cleared area in woodland, large area of over 100 plants, Short Wood, TL0191, A. Colston, 1998, conf. F. H. Perring, **herb. Gill Gent.** 1st record since 1970.

‡153/62.ric. **Cortaderia richardii** *5, S. Somerset: single self-sown clump on side of woodland ride, Pendomer, ST521089, P. R. Green, 2005, det. I. P. Green.

153/67.2. **Spartina anglica** *‡106, E. Ross: muddy shore, Dingwall, NH557590, B. R. & C. B. Ballinger, 2004, det. T. A. Cope, **herb. B.B.** Previously recorded as *Spartina alterniflora* var. *glabra*.

‡153/68.1. **Echinochloa crus-galli** *©51, Flints.: reclaimed industrial site, Rhydymwyn, SJ205668, G. Wynne, 2003.

‡153/70.pum. **Setaria pumila** ©51, Flints.: reclaimed industrial site, Rhydymwyn, SJ205668, G. Wynne, 2003. 1st record since 1917.

‡153/70.ver. **Setaria verticillata** *69, Westmorland: pavement weed, Finkle St, Kendal, SD515926, A. M. Boucher, 2005, **LANC, herb. A.M.B.**

‡153/71.san. **Digitaria sanguinalis** *69, Westmorland: pavement weed, Finkle St, Kendal, SD515926, A. M. Boucher, 2005, **LANC, herb. A.M.B.**

‡153/FAR.mul. **Fargesia murielae** (Gamble) T. P. Yi *44, Carms.: originally planted, now naturalised and spreading on bank clothed in tall herb and bramble to west of larger of two ponds, Penarth Ganol, Pumsaint, SN649401, K. A. & R. D. Pryce, 2005, det. G. Hutchinson, **NMW.** 1st record for naturalised plant away from coastal amenity plantings. Ø

154/1.1c. **Sparganium erectum** subsp. **neglectum** 50, Denbs.: riverside, Llandulas, SH909787, J. A. Green, 2005. 1st record since 1911.

154/1.2. **Sparganium emersum** 106, E. Ross: small loch, Black Loch, NH792756, Loch Survey, 1994. 1st record since 1970. Still present 2005.

‡158/10.1. **Tulipa sylvestris** *93, N. Aberdeen: roadside, Pitcaple, NJ734254, I. P. Green, 2005.

‡158/12.1. **Lilium martagon** *93, N. Aberdeen: roadside, Bourtie, NJ783244, I. P. Green, 2005.

‡158/18.2. **Ornithogalum angustifolium** *110, Outer Hebrides: graveyard, Eriskay, NF784116, R. J. & A. F. Pankhurst, 2004.

‡158/19.1. **Scilla bifolia** *©110, Outer Hebrides: rough grassland near Ormiclate, South Uist, NF73, D. L. Smith, 1956, **GLAM.**

158/19.4. **Scilla verna** 44, Carms.: two plants, one with c.25 and the other with 2 flowering stems, on crest of cliff in limestone grassland, Dolwen Point, Pendine, SN233078, I. K. Morgan & R. N. Stringer, 2005, **NMW.** 1st record since E. B. G. Jones' c.1950 record from Llanstephan.

‡158/22.1. **Chionodoxa forbesii** *69, Westmorland: by copse at road junction, Slackhead, Beetham, SD493787, J. H. Clarke, 2005.

‡158/24.5. **Allium subhirsutum** *44, Carms.: three clumps associated with *A. vineale* in disturbed ground at edge of platform, Ferryside railway station, SN366104, G. Hutchinson, 2005, **NMW.** 2nd Welsh record

158/24.11. **Allium oleraceum** 91, Kincardines.: steep deciduous woodland, Morpie, NO717620, D. Welch, 2005, **ABD.** 1st record since 1970.

©158/24.cep. **Allium cepa** *‡42, Brecks.: shingle along R.Usk, near Scethrog, SO106244, M. & C. Porter, 2005.

©158/24.tub. **Allium tuberosum** Rottl. Ex Spreng *29, Cambs.: several plants, apparently self-sown on steps of 45 Panton Street, Cambridge, TL453574, P. H. Oswald, 2005, det. A. C. Leslie. Ø

‡159/2.5. **Sisyrinchium striatum** *44, Carms.: established on colliery tip, south of Y Garth, near Ammanford, SN619133, I. K. Morgan, 2005, det. G. Hutchinson, **NMW.**

‡159/5.4. **Iris versicolor** 110, Outer Hebrides: shore, Benbecula, NF847553, S. J. Bungard, 1998. 1st record since 1970.

- ‡159/13.1. **Crocoshia paniculata** *93, N. Aberdeen: trackside, Strichen, NJ957563, D. Welch, 2005.
- 162/3.7. **Epipactis phyllanthos** ®28, W. Norfolk: fen edge, Dereham, Lolly Moor, TF992103, D. & B. Mathias, 2002.
- 162/11.1. **Corallorhiza trifida** ®106, E. Ross: vegetated dunes, in 4 locations under birch and willow, Morrich More, NH852834, B. R. & C. B. Ballinger, 2005.
- 162/15×18/1×2. ×**Pseudorhiza bruniana** (**Pseudorchis albida** × **Dactylorhiza maculata**) *104, N. Ebudes (Skye): coastal grassland, Ullinish, NG319368, B. Allen, 1994.
- 162/17×18/1×1. ×**Dactyloglossum mixtum** (**Coeloglossum viride** × **Dactylorhiza fuchsii**) 110, Outer Hebrides: Luskentyre, NG072987, R. S. C. Ferreira, 1990. 1st record since 1970.
- 162/18.1×2. **Dactylorhiza** ×**transiens** (**D. fuchsii** × **D. maculata**) 110, Outer Hebrides: Fuday, NF7308, R. Waterston, 1980, E. 1st record since 1970.
- 162/18.1×5. **Dactylorhiza** ×**venusta** (**D. fuchsii** × **D. purpurella**) 110, Outer Hebrides: North Uist, NF845766, S. J. Bungard, 1998. 1st record since 1970.
- 162/18.3b. **Dactylorhiza incarnata** subsp. **coccinea** 104, N. Ebudes (Raasay): moorland, South Fearn, NG5835, S. J. Bungard, 1997, det. R. M. Bateman. 1st record since 1970.
- 162/18.5×6. **Dactylorhiza purpurella** × **D. majalis** 110, Outer Hebrides: Clachan, Trumisgarry, North Uist, NF867749, R. J. Pankhurst, 1979. 1st record since 1970.
- 162/18.7. **Dactylorhiza traunsteineri** ®28, W. Norfolk: part alkaline mire, Roydon, TF686227, R. A. Yaxley, 2000. ®28, W. Norfolk: alkaline mire, Castle Acre, TF806152, H. E. Williamson, 2000.

Book Reviews

Change in the British Flora 1987-2004 (A report on the BSBI Local Change survey). M. E. Braithwaite, R. W. Ellis & C. D. Preston. Pp. iv + 382. Botanical Society of the British Isles, London. 2006. £12. ISBN 0-901158-34-8.

Botanists have always been fascinated by the distribution of species, as witnessed by the Herculean efforts of B.S.B.I. members in gathering records for the two Atlases, and the plethora of county Floras complete with lists of localities and dot maps at tetrad or 1-km square resolution. Although we might get weary of it at times, square-bashing remains something of a national pastime.

Make no mistake; the end-products of all this recording activity (the Red Data Books, Atlases and County Rare Plant Registers) are absolutely vital to those of us working to *conserve* the British flora. But while dot maps tell us a great deal about the distribution of each species, they say rather less about how that distribution is changing through time, and next to nothing about the environmental factors ‘driving’ those changes.

Desirable as it may be, the scope for developing a botanical equivalent to the Breeding Bird Survey or Butterfly Monitoring Scheme is extremely limited. Counting birds and butterflies is much easier, on the whole, than counting plants. Many plants are simply ‘uncountable’ – without digging them up you can’t tell where one individual ends and the next begins, and taking account of the seed-bank is practically impossible. Multiply these problems by the sheer numbers of species involved and you begin to see why botanists have generally opted to record presence/absence within sample plots and grid-squares to generate distribution and *frequency* data – rather than attempting direct counts to give *abundance* data of the sort favoured by zoologists.

But there is a great deal that can be gleaned from dot-map frequency data, as demonstrated by the *New Atlas*, which included a quantitative analysis of changes in the British flora between the periods 1930-69 and 1987-99, along with a ‘change index’ for those taxa mapped in the 1962 Atlas and again in the *New Atlas*. The *New Atlas* analysis was a real eye-opener, with species like *Chrysanthemum segetum*, *Gnaphalium sylvaticum*, *Ranunculus arvensis*, *Pedicularis sylvatica*, *Scleranthus annuus* and *Spergula arvensis* being listed in the ‘top 100’

species showing the greatest relative decrease between the two recording periods. This paved the way for a root-and-branch revision of the *Red Data List* for Great Britain in 2005.

The analyses of change in the *New Atlas* and the *Red List* were based on 10-km square data; yet there has always been a suspicion that data at this scale could be masking (or under-estimating) some of the changes taking place – after all, within a 10-km square a common species occurring in 25 tetrads could, in theory, be lost from all but one tetrad (a *colossal* decline) without having any effect on either its 10-km dot distribution or its frequency at 10-km scale. This is a problem, of course, with dots at *any* scale, and indicates the need for a variety of surveys at different spatial scales. It also suggests that declines in more widespread species may be more readily discernible by examining presence/absence data from smaller sampling units such as tetrads or 1-km squares. A difficulty with smaller units, of course, is that blanket coverage of the country becomes impossible, so one therefore has to adopt some kind of sampling approach – which is where the B.S.B.I.’s ‘Local Change’ project, and the volume under review, makes its entrance onto the stage.

On the face of it, ‘Local Change’ has moved us to another level: the change indices are derived from *tetrad* data, and the time interval between the first (1987-88) and second (2003-04) surveys is just 18 years, covering the most recent date-class in the *New Atlas* (1987-99) and the five years following. This is a colourful and attractively produced book, well written, with lots of colour photographs and clearly set-out tables; but it is a *technical report*, and beneath its apparent accessibility there lurks a degree of complexity that many readers will find hard to penetrate. The data analyses, in particular, are bewildering, and even those with a reasonable grasp of mathematics are likely to struggle to make sense of the statistical methods (and underlying assumptions) employed, although – to be fair to the authors – these are fully explained in an Appendix. Great care has been taken to point out the limitations of both the data and the analytical methods

being used. Throughout the report there are caveats and 'cautionary notes', and readers need to bear these in mind when interpreting and using the results. In particular, for any measure of % change there is also a measure of the *confidence* that can be attached to it, and all too often the 90% confidence limits point to considerable uncertainty as to the reliability and extent of the changes being reported.

Species are grouped according to Broad Habitats, then divided into subgroups by means of a TWINSPAN analysis of their British distributions as given in the *New Atlas*. Grouping species in this way has certain advantages, of course, in that one can then look at changes across a whole *suite* of species having similar national distributions and habitat requirements; but, to be honest, I found the TWINSPAN groups really rather unhelpful, and would have preferred a simpler analysis (as in the *New Atlas*), with species examined individually first, and then *en bloc* to discern those ecological, phytogeographical, morphological (etc.) attributes particularly associated with 'stable', 'decreasing' or 'increasing' species. You can, of course, pick your way through the report in search of the ecologically (and statistically) significant – and tabulated results for all species, in alphabetical order, are helpfully given in an Appendix – but at times it is a bit like searching haystacks for needles.

Nevertheless, there is much in this report to quicken the pulse, and much, too, of relevance not just to conservationists 'on the ground' but also to those working in policy areas like climate change and sustainable land-use. For example, as hinted at in the *New Atlas*, it seems clear that quite a few species are now increasing markedly in response to climate change, or at any rate the recent run of warmer temperatures, including 'southern' or Mediterranean plants like *Geranium rotundifolium*, *Medicago arabica*, *Oenanthe pimpinelloides*, *Ranunculus parviflorus*, *Ophrys apifera* and *Anacamptis pyramidalis*. Many increasing neophyte taxa have their origins in warm-temperate or subtropical regions, e.g. *Campanula poscharskyana*, *Conyza sumatrensis*, *Allium triquetrum* and *Geranium pyrenaicum*, and it is likely that these, too, are benefiting from the milder weather.

Declining species are predominantly those associated with nutrient-poor (infertile) habitats such as calcareous grasslands and heather moorland: species like *Alchemilla xanthochlora*, *Briza media*, *Centaurea scabiosa*,

Cirsium acaule, *Pedicularis sylvatica*, *Rhinanthus minor* and *Viola lutea*. This agrees with the general findings in the *New Atlas* but, interestingly, the 'Local Change' survey has thrown up a number of species which, while 'stable' or showing only slight decline at 10-km square scale, have apparently undergone significant recent declines at tetrad scale. Some species of arable/horticultural land continue to decline, including *Chrysanthemum segetum*, *Galeopsis speciosa* and *Silene noctiflora*, but others are apparently increasing, possibly benefiting from agri-environment schemes introduced since the original survey (e.g. set-aside, arable field margins, etc.).

Many declining species, as one would expect, seem to have been mostly lost from tetrads away from their core areas, usually in parts of the country where they were already pretty thin on the ground. Are 'nature conservation' activities making a difference to these species? Certainly, it would be interesting to know whether 'edge-of-range'/outlying populations are becoming increasingly restricted to 'protected sites' – SSSIs, County Wildlife Sites, Protected Road Verges, etc. – or agri-environment land. That many rare/scarcely plants are now found mainly on protected sites has been well demonstrated in some areas (see, for example, the entries in the Dorset Rare Plants Register), but for more widespread 'decliners' the relationship has yet to be investigated – a worthwhile subject for future study, perhaps?

The 'Local Change' survey came hard on the heels of 'Atlas 2000', and to many B.S.B.I. foot soldiers there seemed to be little time for recuperation between the end of one campaign and the start of the next. But the effort has surely been worth it. The authors do their best to tease out the main conclusions of the survey, while being honest and up-front about its limitations. The results seem to raise as many questions as they answer, but there is much here to inform and provoke, and anyone interested in Britain's flora and how it is changing should get hold of a copy. One thing is clear: change happens simultaneously at a range of spatial scales, and if we are to document and understand it we need to have a whole batch of projects working at different scales and employing different recording methods and analytical techniques – of which the 'Atlas' is one, and 'Local Change' is another. No rest for the square-bashers, then?

S. J. LEACH

The Botanist. The botanical diary of Eleanor Vachell (1879-1948). Edited by M. Forty & T. Rich. Pp. 227. National Museum of Wales. 2006. Softback. £19.50. ISBN 0-7200-0565-5.

Eleanor Vachell's diary has long been known to the happy few from a typescript in the National Museum of Wales, and now, thanks to the diligence of Michelle Forty and Tim Rich, this incomparable document of some 200,000 words is available to the wider botanical public. I am not aware of any other writing that so vividly communicates the enjoyment, the excitements and the detailed mechanics of plant-hunting in Britain and Ireland, except perhaps parts of the generally rather more sober New Naturalist book *Mountain Flowers* by John Raven and Max Walters. Eleanor Vachell was the daughter of a distinguished Cardiff physician and amateur botanist with whom she started, at the age of twelve, compiling what was to become an outstanding private herbarium. She began a diary at the same time. The work under review is not so much daily entries as a series of narratives written up in the third person, mostly apparently after the event. Her driving forces were a passionate desire to see every British plant, an ambition to colour in her illustrated "Bentham" (in fact Fitch's *Illustrations of the British Flora*, and Butcher & Strudwick's *Further Illustrations*), and above all her friendship and good-natured rivalry with other botanists. She was a serious investigator, corresponding with and sending specimens to experts on many difficult groups, including *Potamogeton*, *Rosa*, *Fumaria*, *Centaureum*, *Rhinanthus*, *Callitriche* and *Limosella*.

The diary covers most of the country, and Vachell's most regular companions on the innumerable, often successful, often disastrous, but always high-spirited expeditions were four other lady enthusiasts who constituted themselves as the Trudgeleers (a term of expressive but obscure Irish origin). Others who figure prominently include Francis Druce, T. J. Foggitt and his wife, A. J. Wilmott, N. D. Simpson and R. W. Butcher, and many of the other botanists of the period, from the aged J. E. Griffith to the young Paul Richards, appear at some time or other. Various Botanical Exchange Club events, the International Botanical Congress at Cambridge and a BSBI meeting in Merioneth are vividly described. G. C. Druce makes many appearances, none more memorable than on a wet and unsuccessful outing to see *Potentilla rupestris* on the Wye when he behaved with singularly poor grace. Vachell was short of funds until an inheritance from an uncle in 1938, but by 1927 she had saved up enough from writing regular botanical

notes for the *Western Mail* (which she did from 1921 to 1948) and from wireless talks to buy a third-hand Clyno car. She changed to a second-hand Swift Coupé in 1932, and then to a Morris later the same year. As an account of the perils and joys of early motoring alone the book is worth reading.

Predictably, hunts for familiar rarities such as *Cypripedium* (one of the few plants she never saw in spite of the most extreme efforts) and *Trichomanes* (at Killarney the party was expensively tricked into being taken on horseback to see planted-out specimens by a noisy group of predatory locals including a trumpeter and a photographer) figure prominently. But more interesting and less fashionable taxa such as the splits of *Thalictrum minus* and the upland *Deschampsia* species get equal attention. Repeated expeditions to most of the chief localities for rarities, such as Lochnager, which she climbed seven times, and Ben Lawers, are described in great detail. It is a measure of the sheer gusto of the writing that the 1921 account of a catastrophic climb up Lawers in appalling weather, when no plants were seen and the author was reduced at one point to crawling up to the summit cairn in thick mist carrying her vasculum in her teeth, is even more vicariously enjoyable than the account of the successful expedition two days later when virtually all the rarities were seen. The circumstantial detail of sites and populations makes many of the entries of real historical interest.

The editors have provided an index that includes genera, personal names and, especially helpfully, the main counties visited. The personal names understandably lead one sometimes to just a name rather than a particular person, for example "Mr Taylor" refers to Peter as well as Sir George Taylor. A few interesting names are missing, such as E. H. T. Bible of Aberdyfi on p.125, and Robert Dick, deceased but touchingly apostrophised on p.107. In the text "The botanical nomenclature has largely been updated to modern genera, though sometimes where the historical context might be lost ... the original names have been retained", but it is not indicated where this updating, which to some extent applies to species as well as genera, has or has not been done; it would have been more helpful, and editorially correct, to have retained the original names and given the modern ones in brackets.

A. O. CHATER

A Natural History of Nettles. Keith G. R. Wheeler. Pp. x + 300 plus CD-ROM with 143 colour plates. Trafford Publishing, Victoria, Canada. 2004. Softback. ISBN 1-4120-2694-6.

This is a monograph on the genus *Urtica* and its relatives on an epic scale. The author says that he has 'tried to produce a book for naturalists [and] scientists ... with a large number of photographs and illustrations [that] would appeal to the general public.' Thus, it combines the enthusiasm and polymath expansiveness of a Victorian natural historian with the latest techniques in microscopy and scientific enquiry. The author has explored an enormously diverse range of topics, often introducing a topic in one chapter and returning to it in more detail later. This is not a book to read straight through, therefore, but, rather, one to browse and dip into for sections of particular interest. It will, perhaps, be of special interest to teachers who will find a great wealth of fascinating facts and ideas for students of all ages.

On the botanical side, the author starts with the classification of the Urticales and descriptions of the floral structures and pollination mechanisms in *Urtica*, with wonderful illustrations. This is followed by a brief account of *Urtica dioica*, *U. urens* and *U. pilulifera* in Europe with an interesting section on var. *dodartii*; this was once thought to be a different species but it does not breed true and breeding experiments in the early 20th century showed that the pellitory-like leaf characters were controlled by a single recessive gene. Roman nettle is thought to be extinct now in Britain, apart, perhaps, from botanic gardens: in the 1970s I saw a small colony that was maintained in a corner of Pembroke College garden, Cambridge. Chapters 14 and 15 cover the worldwide and British distribution of *U. dioica*, its nutritional requirements, establishment, growth and general ecology. The book concludes with two chapters on the 'sex life' and breeding systems in *Urtica* spp., and an appendix on the other British 'nettleworts', *Parietaria judaica* and *Soleirolia soleirolii*, again with superb illustrations.

Three whole chapters are devoted to the micromorphology and functioning of stinging trichomes, and the composition and effects of the toxins in the Urticaceae and in other, quite unrelated, families. The microscopic details of trichomes are illustrated in six full page photographs and drawings but the colour illustrations on the CD-ROM must be viewed to appreciate them fully. As a child in south

India, I was shown and warned against 'elephant nettle', *Girardinia diversifolia*, and having seen it again while trekking through rainforest in Tamil Nadu in 2000, I was particularly fascinated to read the account of 'tropical tormentors' in chapter 7. The New Zealand nettle tree, *Urtica ferox*, which I have also seen, is clearly not in the same league for size and fierce stinging properties as the giant stinging trees, *Dendrocnide* spp., of Australia. Horses can even die from contact with these plants. On the other hand, many invertebrates are unaffected by the stinging hairs. The description of the way in which a caterpillar overcomes the defences of *Cnidioscolus urens* (Euphorbiaceae) is another fascinating story.

Other chapters describe the place of nettles in folklore and literature and the use of nettles for food and fibre. Nettle fibre is stronger than flax fibre and its use from early historical times is well known but its production in Germany during the First World War may not be so well known. In 1915, apparently, ten million acres in Austria were thought to be 'splendidly adapted to the cultivation of the nettle', twice that needed to replace cotton imports, but 2.7 million kg were harvested without any special cultivation.

Chapter 11 describes the life history, distribution and field studies on associated species such as Greater Dodder, *Cuscuta europaea* and fungal rusts. This is followed by two chapters on the insects associated with *Urtica*, again with several full page plates, which can only be fully appreciated in colour on the CD-ROM. The painting of the leaf hopper *Eupteryx aurata* is especially beautiful. In this field again the author contributes interesting first hand accounts of territorial and courtship behaviour among vanessid butterflies and unusual oviposition on nettles by Painted lady butterflies, *Cynthia cardui*, during a particularly large invasion in 1996.

There is a very large reference list and a good subject index. Critical readers may, however, be rather surprised by the inconsistent use of italics for scientific names. This seems almost random except in the case of *Urtica* and relatives, which are generally printed in Roman font. There are also quite a lot of typographical errors, some of which have been corrected by hand. Among authors' names quoted in the text, Perrin should be

Perring, for example, and Rackman should be Rackham. Since this book is available through 'on-demand publishing', it may be possible to correct some of these minor faults in future productions. The author says that this book 'has been much maligned by the conventional

book publishers'. It does, indeed, fall outside the norm in today's economy-conscious and specialist publishing world but I hope others will, like me, obtain 'pleasure from entering the world of the nettle patch.'

B. N. K. DAVIS

Atlas Florae Europaeae. Distribution of Vascular Plants in Europe. Volume 13. Rosaceae (Spiraea to Fragaria, excl. Rubus). Edited by A. Kurtto, R. Lampinen & L. Junikka. Pp. 320. The Committee for Mapping the Flora of Europe and Societas Biologica Fennica Vanamo, Helsinki. 2004. Softback. 120 euros. ISBN 951-9108-14-9.

Atlas Florae Europaeae issued its first volume in 1972 and reached the end of the first volume of *Flora Europaea* with volume 12 in 1999. There has now been a further long pause, occasioned partly by the death of Jaakko Jalas and the retirement of Juha Suominen, who were the founding editors.

The commencement of maps covering volume 2 of *Flora Europaea* has allowed a new look and small modifications to the layout. These include an amended grid system (principally for the purpose of fitting in with atlases of other groups and largely affecting areas of sea) and very useful coverage map of all the taxa covered in this part – which allows one to see straight away likely lacunae – together with the customary list of deviations from *Flora Europaea*. The territory divisions and the acronyms tie up with the Euro+Med PlantBase, newly set up in 2000. The maps themselves have, at last, totals of the dots under the various date and status categories.

This volume is the first of four for the Rosaceae, a family made deeply complicated by apomixis; indeed two of the next three parts are to be devoted solely to *Alchemilla* and *Rubus*. That will leave *Sorbus*, *Cotoneaster* and the *Pyrus/Malus* complex for the last volume. This first part has 286 maps of which 54 are of *Rosa* and 150 of *Potentilla*. All other genera are small. The coverage of most genera is introduced by a general map for all the taxa covered, which allows one to see both the richness of that genus in each country and how well each has covered it – particularly relevant for critical groups.

After *Spiraea* and *Filipendula* comes *Rosa*, and for readers from Britain and Ireland, a treatment very difficult to get to grips with, particularly under Section *Canina*. The treatment here broadly follows *Flora Europaea* and thus fundamentally differs from that in Stace's *New Flora* and Graham & Primavesi's B.S.B.I. Handbook. To add to our complications, the

general map that prefaces the account shows that France, our nearest neighbour, has little enthusiasm for the genus other than a very broad treatment.

Up to the *Canina* group there are no problems, other than the interesting point that the widely naturalised *R. rugosa* is barely recorded for France, which must be just recording bias. After the *Canina* group the synonymy is more or less comparable with ours and there is little to comment on other than perhaps the non-recording of *R. sherardii* from France. I do not think this review is the place (even assuming I had the skill) to provide a detailed comparison for the two treatments of the *Canina* group. Suffice it to say that each species or aggregate has a detailed (I was tempted to say bewildering) section on taxonomy, through which the skilled or patient could trace the treatment of the species concepts more familiar to us. Thus their *R. dumalis* is our *R. caesia* subsp. *glauca* and their *R. subcanina* is our *R. caesia* subsp. *glauca* × *canina* (*R. ×dumalis* sensu Graham & Primavesi pro parte).

Next come smaller genera including *Sanguisorba* and *Geum*. Nothing particular to say there, but they are followed by the large *Potentilla* genus prefaced by *P. fruticosa*, *P. palustris* and *P. rupestris* split off into *Dasiphora*, *Comarum* and *Drymocallis* respectively. These alterations date from 1990 but do not seem to have been even discussed here. *Potentilla argentea* is split into *P. argentea* and *P. neglecta*, with the latter reaching W & S France and Scandinavia but not (yet) here. The native range of our alien species *P. norvegica*, *P. intermedia* and *P. recta* is well shown. *P. tabernaemontani* is mapped as our Spring Cinquefoil and *P. neumanniana* is shown only as a local apomict in Germany and Scandinavia. Interestingly, *P. anglica* is shown in France as very rare with many extinctions.

Perhaps one has to be grateful for this magnificent work of scholarship – in many ways much more full and satisfactory than the original written Flora – and ignore the fact that on current progress it might be complete by 2120. Personally I find the current progress deeply unsatisfying. I would much prefer a statement now of as many species as can be easily dealt with, leaving the critical groups as aggregates if necessary. Though there have been other distribution atlases for Northern Europe and Scandinavia it is a real bore that these do not cover around 40% of our flora,

and even if they do, they are often based on data that are very old.

Finally, the price. I am sure that it can be justified for the scientific work involved and the limited market. But it is totally out of court for anybody with

other than the deepest pocket, especially as British natural history booksellers cite prices between £110 and £145, and this does not help dissemination of the valuable distribution and taxonomic work contained in this Atlas.

D. A. PEARMAN

The Wild Flower Key, revised and expanded edition. F. Rose & C. O'Reilly. Pp. 576. Frederick Warne. 2006. Softback. £19.99. ISBN 0-7232-5175-0.

Since its publication in 1981 *The Wild Flower Key* has become one of the most popular field guides to the British flora. By combining taxonomic keys with illustrations of diagnostic features, 'Rose', as it is affectionately known, has helped a generation of British botanists to develop the critical skills required for field identification. This new edition incorporates much new information on the distribution, conservation and taxonomy of British species including many aliens which are now well established in the wild in the UK.

Much of the work for the new edition has been carried out by Clare O'Reilly (née Coleman), a freelance botanist who abandoned a career in environmental law to complete it. Clare has edited and expanded many of the species accounts and, with the help of leading botanists, improved the keys to difficult genera. In addition, there are new chapters on 'Plant Status', 'Ancient Woodland Indicators', 'Wild Plants and the Law' and 'Finding and Recording Wild Plants' as well as useful lists of botanical references and websites for beginners.

Although the introductory keys remain unaltered, the nomenclature and family orders have been revised to follow Stace (1997), only diverging where the authors disagree (e.g. *Gymnadenia*) or where recent taxonomic changes have been large (e.g. *Anacamptis*). This is a great improvement on the rather inconsistent taxonomic treatment of the first edition. However, most of the diagnostic characters are still based on CTW (second edition) and are therefore woefully out of date. This is a shame given the wealth of new information recently made available. The keys to families, genera and species were one of the

best features of the first edition and these have remained largely unaltered (although see Primavesi 2006). More controversial will be the removal of north-west European species not present in the UK, such as *Arnica montana* and *Digitalis lutea*, although surprisingly two British neophytes have also been removed (*Holosteum umbellatum*, *Legousia speculum-veneris*). The line drawings of common native grasses have also been dropped, presumably because the wonderful companion volume to grasses is now available (Rose 1989). These deletions have made way for over 50 aliens which have become widely naturalised over the last fifty years (e.g. *Buddleja davidii*, *Fallopia japonica*, *Hirschfeldia incana*, *Hyacinthoides × massartiana*, *Persicaria wallichii*, *Solidago canadensis*) and illustrations of 20 native montane species that were omitted from the first edition (e.g. *Betula nana*, *Diapensia lapponica*, *Koenigia islandica*, *Linnaea borealis*, *Loiseleuria procumbens*, *Moneses uniflora*, *Oxyria digyna*, *Silene acaulis*). The coverage of the new edition is therefore less biased to the south and more reflective of the British flora at the start of the twenty-first century, including all natives and long-established introductions, all non-natives in over 300 10-km squares and non-natives in 50–299 10-km squares if they are invasive or easily confused with natives.

Substantial changes to the layout have made the book much easier to use in the field. The illustrations are more spaced out on the page and some poor quality pictures have been reproduced more accurately (e.g. *Viola* spp.) although one or two have suffered from enlargement (e.g. *Myrica gale*, *Thesium humifusum*). Virtually all the line drawings

have been redrawn and are now much clearer (see *Fumaria* spp.) and the 'ID Tip' boxes which provide handy hints and illustrated glossaries to diagnostic features for around twenty large families will no doubt prove popular with beginners. The design is refreshingly modern whilst retaining much of the original format and, if you treat your books as badly as I do, you'll appreciate the plastic cover which appears to come as standard.

Some of the deficiencies of the first edition remain although most are only minor drawbacks. The tone of the new introduction is rather immodest and I'm sure less energetic colleagues will resent the increase in size (it is considerably heavier than Clive Stace's (1999) *Field Flora*, for example). Unfortunately there are still many typographic errors, some of which were not corrected by the publisher in order to meet the publication deadline (these are listed in Coleman (2006)). Many illustrations are on separate pages to the accompanying text, which can prove irritating, and some users may find the plethora of abbreviations (e.g. in describing distribution, habitats, status etc.) a little bewildering. The selection of illustrated species remains frustratingly incomplete and many taxa will still be too poorly covered for more

experienced botanists, in particular infra-specific and critical taxa (e.g. *Alchemilla* spp., *Erophila* spp., *Montia fontana*). One wonders whether these could have been better covered at the expense of very rare species such as *Orchis laxiflora* or the vegetative keys to flora of specific habitats that, although being one of the best features of the original, are probably rarely used. Also a simple table of ecological attributes (e.g. soil pH, moisture, fertility, life-form, etc.) would have been more informative for beginners than a bald list of Ancient Woodland Indicators ('AWIs').

Although this edition of 'Rose' is neither entirely suitable for the beginner nor for the advanced student it will be warmly welcomed by both amateur and professional botanists alike. Its combination of dichotomous keys and illustrations of diagnostic features bridges the gap between more elementary pictorial guides and more serious taxonomic works which can be so off-putting to botanists with little or no formal taxonomic training. This new edition is more comprehensive, stylish, and user-friendly than the original and is therefore likely to be the most popular field guide on the market for many years to come.

K. J. WALKER

REFERENCES

- COLEMAN, C. (2006). Wild Flower Key 2nd Edition: corrigenda and addenda, March 2006. *BSBI News* **102**:71.
- PRIMAVESI, A. (2006). Don't blame me. I never said it. *BSBI News* **103**: 49-50.
- ROSE, F. (1989). *Colour identification guide to grasses, sedges, rushes and ferns of the British Isles and north-western Europe*. Viking, London.
- STACE, C. A. (1997). *New flora of the British Isles* 2nd ed. Cambridge University Press, Cambridge.
- STACE, C. A. (1999). *Field flora of the British Isles*. Cambridge University Press, Cambridge.

Obituary

LARCH SYLVIA GARRAD
(1936–2005)

With the death of Larch Garrad on 7 July 2005 the Society has lost its long-serving Recorder for Vice-county 71 and the Isle of Man, an authority of exceptional breadth on both its natural and local history.

An only child, born in 1936 Larch's closeness to her civil servant father ensured that from an early age she acquired both his voraciousness for reading and a keen interest in the details of the countryside, to the latter of which her enrolment in the Wild Flower Society gave a botanical slant. Brought up in Somerset, she attended the Grammar School for Girls in Weston-super-Mare before going on to Birmingham University to read Archaeology and Ancient History. One of her archaeology lecturers happened to hail from the Isle of Man and it was through working on a student excavation there under his direction that she came to be acquainted with the Island.

Meanwhile, excavation had taken her also to Greece, where the study of pottery styles appealed to her taxonomic bent and in due course became the subject of postgraduate research that culminated in the award of a doctorate. However, the career as an archaeologist that ought to have followed turned out to be elusive: posts in the subject were then still very few and fiercely competed for, and eventually she had to settle for one as a librarian in Gloucestershire, the great distance of which from the Isle of Man involved fearfully arduous and complicated journeys whenever she returned to see her parents, who were now living there in retirement.

Providentially, a vacancy arose not long afterwards on the staff of the Manx Museum in Douglas – though for someone to take special responsibility for natural history, not in archaeology (which was well covered already). However, small museums necessarily prize broad interests and versatility above deep knowledge in one special field and she was able to gain the job on the basis of her reasonable familiarity with the Island's natural history and its flora in particular.

By that time, the compiling of a much-needed book-length account of the Island's vascular plants had been under way for thirteen years, but one by one the few resident

contributors of records had been dropping away through death, incapacity or removal 'across', and intensive fieldwork had largely fallen to occasional irruptions by visiting botanists that were all too brief. The arrival of a resident one at last who brought to this project personal enthusiasm as well as professional commitment was thus providential. Within two years, what is more, Larch struck up a friendship at evening class with a local schoolteacher nearing retirement who fancied using her impending greater leisure to pursue a long-existing interest in plants with greater seriousness. Marjorie Devereau supplied not only an extra pair of eyes, but two exceptionally sharp ones, which were to produce a string of increasingly startling discoveries in the years that followed; her better sight also enabled her to master sections of the flora, most notably *Carex*, that were unavoidably barred to Larch. As a car-owner, moreover, she rescued the bus-dependent Larch from over-localised exploration. The innumerable additional records that arose from their joint efforts put paid to what had threatened to be indefinite deferment of the intended published volume, and the completion of that in 1984 owed an enormous amount to their cajoling and, ultimately, very full involvement in the editorial process.

As is often the way, the publication of the *Flora* had the paradoxical effect of lowering activity instead of sustaining or even increasing it. For lack of a concrete objective of comparable scope in its place the previous torrent of records fell off to a trickle, and competing interests filled the resulting vacuum. In Larch's case there had long been no shortage of those and to collecting and recording non-marine molluscs and woodlice for the respective national atlases of those groups she has soon added investigating the uses of local plants as folk cures, establishing the identity of subfossil bones yielded by past excavations, co-authoring a book on the Island's industrial archaeology, and another on British holiday souvenirs. Conservation concern having meanwhile spread to the Island very belatedly, the establishment of nature trails and promoting the work of a local wildlife trust made additional calls on her energies.

These multifarious involvements and the wide perspective they imparted made Larch the obvious person to contribute the relevant volume in the 'Regional Naturalist' series instituted by that transient shooting star of the British publishing scene, David & Charles. Once *The Naturalist in the Isle of Man* was off her hands, in 1972, they were busy again with an intended similar book on the Canary Islands, after a captivating holiday soaking herself in the natural history of those in turn. Unfortunately, though, that one had to be abandoned when the publisher ran into financial difficulties and had to cancel the contract. At the same time it was a symptom of widening horizons: concentrating so exclusively on one comparatively small island had begun to feel too restricting. Attendance at B.S.B.I. field meetings elsewhere, including on the Continent, had given her an appetite for other and richer floras. The limited prospects for professional advancement in so small and static a community, moreover, were meanwhile leading her to give thought to strengthening her qualifications and thus her geographical options. To that end, halfway through her career, she registered on an Open University course in botany. An early by-product of that was an impressive biometric analysis of a relic oak population on the Island's cliffs.

In later years the onset of heart trouble made solitary fieldwork medically inadvisable. Friends who relished the wonderful volleys of sometimes hilariously ill-assorted items of information for which she was well-known – and which found equal expression in her letters – were more than happy to have such an outstandingly well-informed guide on drives around the Island, but Larch was greatly restricted thenceforward in what she could accomplish. In her capacity as B.S.B.I. Recorder she had diligently put together the

relevant local data for the Society's Rare Species Survey, but she regretfully had to recognise that it had become physically beyond her to fulfil the recording requirements of the *New Atlas*. What she was able to supply on the other hand, was an exceptionally full set of records for the alien species, as she had for some years been concentrating on those with a view to publishing a supplement to the 1984 *Flora*. The unusually numerous exotics that flourish in the Island's mild climate, traditionally disdained by recorders of the wild flora, had particularly engaged the attention of Marjorie Devereau and herself on their each acquiring gardens of their own and turning into enthusiastic plantswomen. From marrying archaeology came in 1985 *A History of Manx Gardens and Gardening...*, a publication on that then surprisingly almost virgin subject that was so well-received than an enlarged edition was called for in 2003. The discovery in the meantime near Peel of a remarkable assemblage of unusual adventives fired her to study those intensively as well, the preliminary results appearing in the Island's principal natural history journal two years later. At the time of her death she was preparing for publication a full-scale Alien Flora of the Island, and hopefully that will have reached a sufficiently advanced state for that intention to be realised.

Larch's irrepressible vivacity, the product of a quick and very sharp mind, will be widely missed. Thankfully, a great part of the very extensive and remarkable diverse body of knowledge that she built up over rather more than forty ceaselessly active and copiously productive years, has been committed to print. The invaluable co-ordinating role that she performed in the field of Manx Studies will nevertheless be very difficult to replace.

DAVID ALLEN



NAMES OF VICE-COUNTIES IN WATSONIA

S (113) Channel Islands

ENGLAND

- | | | |
|---------------------|--------------------------|--------------------------|
| 1. West Cornwall | 21. Middlesex | 54. North Lincolnshire |
| 1b. Scilly | 22. Berkshire | 55. Leicestershire |
| 2. East Cornwall | 23. Oxfordshire | 55b. Rutland |
| 3. South Devon | 24. Buckinghamshire | 56. Nottinghamshire |
| 4. North Devon | 25. East Suffolk | 57. Derbyshire |
| 5. South Somerset | 26. West Suffolk | 58. Cheshire |
| 6. North Somerset | 27. East Norfolk | 59. South Lancashire |
| 7. North Wiltshire | 28. West Norfolk | 60. West Lancashire |
| 8. South Wiltshire | 29. Cambridgeshire | 61. South-east Yorkshire |
| 9. Dorset | 30. Bedfordshire | 62. North-east Yorkshire |
| 10. Isle of Wight | 31. Huntingdonshire | 63. South-west Yorkshire |
| 11. South Hampshire | 32. Northamptonshire | 64. Mid-west Yorkshire |
| 12. North Hampshire | 33. East Gloucestershire | 65. North-west Yorkshire |
| 13. West Sussex | 34. West Gloucestershire | 66. County Durham |
| 14. East Sussex | 36. Herefordshire | 67. South Northumberland |
| 15. East Kent | 37. Worcestershire | 68. North Northumberland |
| 16. West Kent | 38. Warwickshire | 69. Westmorland |
| 17. Surrey | 39. Staffordshire | 69b. Furness |
| 18. South Essex | 40. Shropshire | 70. Cumberland |
| 19. North Essex | 53. South Lincolnshire | 71. Isle of Man |
| 20. Hertfordshire | | |

WALES

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|---------------------|---------------------|------------------|
| 35. Monmouthshire | 45. Pembrokeshire | 50. Denbighshire |
| 41. Glamorgan | 46. Cardiganshire | 51. Flintshire |
| 42. Brecknockshire | 47. Montgomeryshire | 52. Anglesey |
| 43. Radnorshire | 48. Merioneth | |
| 44. Carmarthenshire | 49. Caernarfonshire | |

SCOTLAND

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|-----------------------|-------------------------|----------------------|
| 72. Dumfriesshire | 86. Stirlingshire | 99. Dunbarton |
| 73. Kircudbrightshire | 87. West Perthshire | 100. Clyde Isles |
| 74. Wigtownshire | 88. Mid Perthshire | 101. Kintyre |
| 75. Ayrshire | 89. East Perthshire | 102. South Ebuades |
| 76. Renfrewshire | 90. Angus | 103. Mid Ebuades |
| 77. Lanarkshire | 91. Kincardineshire | 104. North Ebuades |
| 78. Peeblesshire | 92. South Aberdeenshire | 105. Wester Ross |
| 79. Selkirkshire | 93. North Aberdeenshire | 106. Easter Ross |
| 80. Roxburghshire | 94. Banffshire | 107. East Sutherland |
| 81. Berwickshire | 95. Moray | 108. West Sutherland |
| 82. East Lothian | 96. Easternness | 109. Caithness |
| 83. Midlothian | 96b. Nairnshire | 110. Outer Hebrides |
| 84. West Lothian | 97. Westernness | 111. Orkney |
| 85. Fife & Kinross | 98. Main Argyll | 112. Shetland |

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| H1. South Kerry | H15. South-east Galway | H29. Co. Leitrim |
| H2. North Kerry | H16. West Galway | H30. Co. Cavan |
| H3. West Cork | H17. North-east Galway | H31. Co. Louth |
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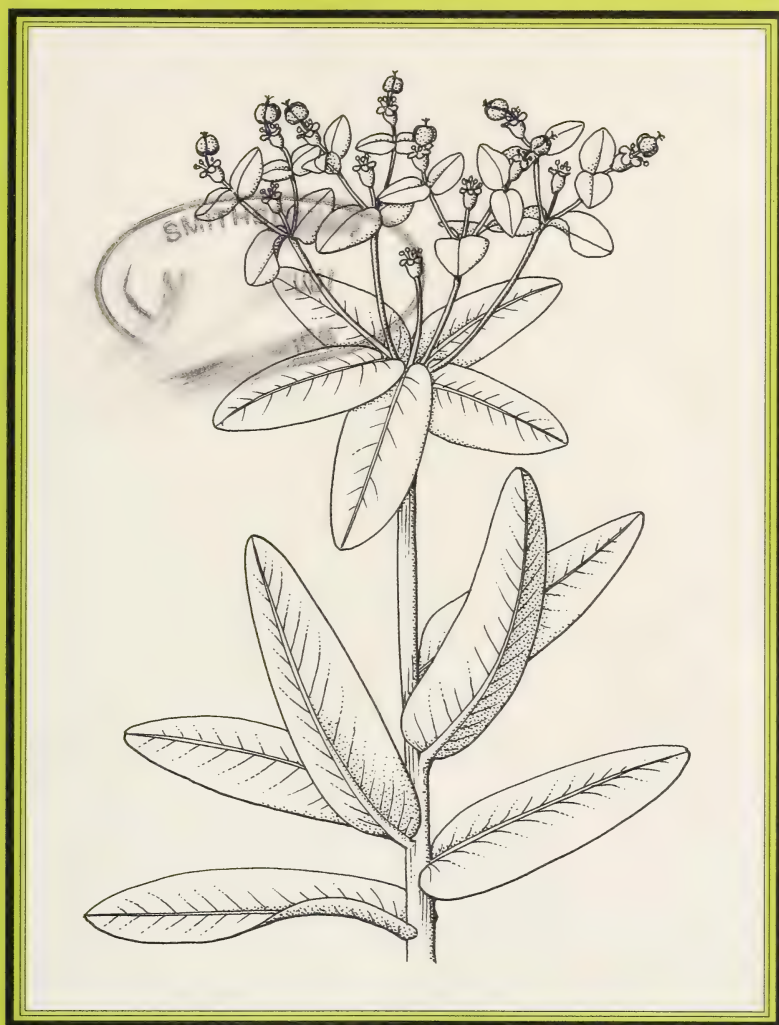
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The cover illustration of *Euphorbia hyberna* L. (Irish Spurge) was drawn by Rosemary Wise.

One-way introgressive hybridisation between *Sorbus aria* and *S. torminalis* (Rosaceae) in southern Britain

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ABSTRACT

Material of *Sorbus aria*-like plants from the Wye Valley with acutely-lobed leaves has been investigated using comparative morphology and reproductive fertility, which show that at least some such plants are *S. aria* introgressed with *S. torminalis*. The introgression was found to occur only from *S. aria* into *S. torminalis*. The primary and introgressed hybrids have lower pollen and fruit fertility than the parents. The parents show widespread overlap in distribution in southern Britain but introgression has been confirmed only for the Wye Valley. *Sorbus* × *vagensis* should be treated as a hybrid, not as a species.

KEYWORDS: Fertility, morphology, pollen, *Sorbus latifolia*, *Sorbus* × *tomentella*, *Sorbus* × *vagensis*.

INTRODUCTION

The *Sorbus latifolia* (Lam.) Pers., Broad-leaved Whitebeam aggregate comprises taxa which have arisen by hybridisation between *S. torminalis* (L.) Crantz, Wild Service-tree, and members of the *S. aria* (L.) Crantz, Common Whitebeam aggregate (Warburg 1962; Sell 1989; Nelson-Jones *et al.* 2002). They are characterised by having leaves with triangular, acute or acuminate lobes and greenish-grey tomentum below, and large fruits which are brown, orange or yellow when ripe. In Britain, the *S. latifolia* aggregate was first separated by Syme (1875, as *Pyrus latifolia* Syme), and now contains seven taxa (Sell 1989), six of which are apomictic polyploids (*S. bristolensis* Wilm., *S. croceocarpa* P. D. Sell, *S. decipiens* (Bechst.) Irmisch, *S. devoniensis* E. F. Warb., *S. latifolia* sensu stricto and *S. subcuneata* Wilm.), and the other is the primary diploid hybrid *S.* × *vagensis* Wilm.

When he first described it, Wilmott (1934) considered that *S.* × *vagensis* might be *S. torminalis* × *anglica* Hedl. or × *porrigentifomis* E. F. Warb., and suggested it grew true from seed after noting the morphological uniformity of a cluster of trees a little south of Symonds Yat top. He chose the epithet to reflect the occurrence of the hybrid in the Wye Valley (of the river Wye or *flumen Vaga*). Warburg subsequently found that the uniformity noted by Wilmott was due to suckering rather than reproduction from seed (Riddelsdell *et al.* 1948), and he treated it as a variable, diploid hybrid between *S. aria* and *S. torminalis* (Warburg 1952), which is now its accepted parentage. It is now known to have arisen a number of times independently, with *S. torminalis* as the female parent (Proctor & Groenhof 1992; Lemche 1999; Fay *et al.* 2002; Chester *et al.* 2007). Sell (1989) treated *S.* × *vagensis* as a species rather than a hybrid since British material did not match in morphology continental material of the same parentage; we follow his nomenclature here but not his concept of the taxon as a species.

During a series of *Sorbus* surveys of cliffs in the Wye Valley in 2000–2003 commissioned by English Nature (now Natural England), L. Houston, C. Charles and A. C. Tillotson repeatedly collected forms of *S. aria* with acutely-lobed leaves (Houston *et al.* 2001, 2002, 2003, 2004; Figure 1a, b). In exasperation at the absence of any name to call them, they were nicknamed *Sorbus* “Yet another form” by C. Charles. These plants were shown to T. Rich, who, after much discussion, began to suspect these might be *S. aria* introgressed with *S. torminalis*, not previously reported from Britain but known from the continent (Chabert 1906; Aas *et al.* 1994; Oddou-Muratorio *et al.* 2001).

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TABLE 1. CHARACTERS DISTINGUISHING *SORBUS ARIA*, *S. TORMINALIS* AND THEIR PRIMARY DIPLOID HYBRID *S. × VAGENSIS*, COMPILED FROM THE LITERATURE (E. G. WARBURG 1962, CHALLICE & KOVANDA 1978) AND PERSONAL OBSERVATION

	<i>Sorbus aria</i>	<i>Sorbus × vagensis</i>	<i>Sorbus torminalis</i>
Habit	No suckering	Weakly suckering	Strongly suckering
Petiole length	7–24(–29) mm	(15–)20–35(–43) mm	(15–)20–50(–58) mm
Leaf shape	±Orbicular, ovate, elliptical or oblong (rarely obovate), (1.0–)1.1–2.0(–2.4) times as long as wide	Ovate, elliptical, oblong or rhombic-elliptical, (0.8–)1.0–1.5(–1.9) times as long as wide	Ovate, 0.8–1.3(–1.5) times as long as wide
Leaf veins	(6–)9–14(–15) pairs	6–10(–12) pairs	(3–)4–6(–7) pairs
Leaf pubescence at maturity	White tomentose below	Greenish-grey tomentose below, sometimes subglabrous	± Glabrous below
Leaf apex	Obtuse to acute	Acute or subacute	Acuminate
Leaf base	Truncate to rounded (rarely cuneate or cordate)	Rounded or cuneate	Rounded, truncate or cordate, rarely broadly cuneate
Leaf lobing	Unlobed or with shallow broadly rounded lobes to 1/6 way to midrib	Shallow lobed with acute or acuminate lobes to ¼ way to the midrib	Deeply lobed with triangular, acute or acuminate lobes to ½ (rarely all) way to the midrib
Leaf margin	Doubly crenate-serrate, teeth with one side a little longer than the other	Finely serrate with small somewhat appressed teeth	Finely serrate with small strongly asymmetric appressed teeth
Inflorescence	Densely crowded	Crowded	Lax
Sepals	Eglandular	Sparsely glandular	Glandular
Styles	2–3, free, lanuginous at base	2–3, variably joined up to half way, lanuginous at base	3, joined up to ½–⅔ way, glabrous at base
Fruit colour	Red	Yellow, orange or brownish-orange	Brown
Lenticels on fruits	Few to medium, small to medium lenticels, sometimes large ones	Medium to numerous, small and medium lenticels	Numerous small lenticels and some large ones
Fruit length	(9–)10–15(–16) mm	(9–)10–17 mm	(9–)10–17(–18) mm

In this paper we present the results of morphological and reproductive biology investigations into these Wye Valley *S. aria* plants with acutely-lobed leaves. *Sorbus aria*, *S. torminalis* and *S. × vagensis* can be readily separated morphologically using many characters (Table 1), and putative backcrosses might be expected to show some characters intermediate between *S. × vagensis* and *S. aria*, such as relatively long petioles, few pairs of veins and greener undersides to the leaves.

Hybrids are often sterile or show reduced fertility compared to their parents. In order for back-crossing to occur, some of the primary hybrids and backcrosses must produce at least some fertile pollen and/or seeds. The primary hybrids were reported as either sterile or fertile in France (de Poucques 1951), but this has not been studied in Britain so the relative fertility of the taxa has been investigated from pollen and fruit.

We have also compiled information on the distribution of *S. × vagensis* and the locations where its parents occur together to see how widespread back-crossing might potentially be in Britain.

METHODS

COMPARATIVE MORPHOLOGY

Herbarium material of *S. aria* (21 samples), *S. torminalis* (18 samples), *S. × vagensis* (19 samples) and putative backcrosses of *S. × vagensis* with *S. aria* (13 samples) were selected from NMW (Appendix 1). Material was selected from the Wye Valley and from elsewhere in Britain where hybrids are unknown. Some material previously investigated for DNA analysis (Fay *et al.* 2002) was also selected (marked in Appendix 1). The following set of eight characters were selected

from the most important characters found by Aas *et al.* (1994), with the addition of lobe shape:

1. petiole length.
2. lamina length.
3. lamina width.
4. lamina width at 0.9 of the leaf length.
5. shape of lamina base (scored as: 0 cordate, 1 weakly cordate, 2 truncate-cordate, 3 truncate, 4 broadly cuneate, 5 rounded, 6 rounded-cuneate, 7 cuneate).
6. number of pairs of veins (note: strictly speaking these are not true pairs).
7. depth of incision of deepest lobe (measured in direction of veins usually on the lowest or second lowest lobe from the base).
8. shape of largest lobe apex (scored as: 1 acuminate, 2 narrowly acute, 3 broadly acute, 4 narrowly obtuse, 5 broadly obtuse, 6 rounded, 7 not lobed).

Two leaves from the short lateral vegetative shoots, excluding the oldest and youngest leaf (Aas *et al.* 1994), were scored for each character. The data were analysed using Principal Components Analysis in 'PAST' version 1.27 (Hammer *et al.* 2001), with data normalised by division by the standard deviations.

POTENTIAL FERTILITY

Potential pollen viability was investigated using Alexander's Stain (Alexander 1969) which allows differentiation between unviable and potentially viable pollen. True pollen viability can be assessed by germinating fresh pollen, but this cannot be done with herbarium specimens. Unfortunately it was only rarely possible to use the same material for pollen analysis as for morphological analyses as material collected at flowering time often lacks mature leaves from the short shoots.

Anthers were removed from herbarium specimens with tweezers under a low-power binocular microscope, and placed onto a slide with a drop of Alexander's Stain, warmed briefly on the hotplate, then broken up with the tweezers to release the pollen. The preparation was then covered with a cover slip and replaced on the hotplate to improve the uptake of the stain. The slides were then examined under a high-power compound microscope for areas of dense pollen grains. A minimum of 50 grains were counted where possible. Potentially viable grains were counted as those which were

large and rounded-triangular with cell walls which stained green and had cytoplasm inside which stained uniformly bright red. Small deformed grains or those staining green only with very little or no red staining inside (i.e. no cytoplasm) were considered infertile. Repeat samples were taken from five specimens to assess the reliability of the method. The mean difference between samples was 14%, ranging from 2–23%; overall means are therefore more likely to be reliable than individual samples.

In 2004, an excellent fruiting year, 30 fruits were collected from trees of *S. aria*, *S. torminalis*, *S. × vagensis* and putative backcrosses in the Wye Valley, Buckinghamshire and the Avon Gorge and assessed for seed content. The fruits usually contain both large, plump, fertile seeds rather like apple pips, and smaller flat seeds which seem to consist only of a seed coat which had some development but then aborted. Some fruits were subsequently found to contain only aborted seeds and were not included. It was found that extraction of the seeds from *S. torminalis* fruits and to some extent from *S. × vagensis* fruits was considerably easier from fruit bletted in the fridge for a few months than from fresh fruit.

DISTRIBUTION OF TAXA

Records of *S. × vagensis* were compiled from herbaria (BEL, BIRA, BIRM, BM, BRISTM, CGE, E, GL, GLAM, K, LDS, LTR, MANCH, NMW, OXF, RNG and UPS), published and unpublished literature and reports, and from correspondence with botanists.

For comparison of the distribution of *S. × vagensis* with its parents, data were collated from existing databases and floras to investigate where *S. aria* and *S. torminalis* occur together. Hectad data were extracted from the *New Atlas* (Preston *et al.* 2002). Tetrad (2 × 2 km square) data were taken from local county floras for vice-counties where *S. aria* is considered native in Stace *et al.* (2003). Tetrads where both species were recorded were extracted and no distinction was made between alien and native sites within the vice-counties, although some records are clearly of planted trees. Unpublished data for Buckinghamshire were supplied by R. Maycock, Berkshire data by M. Crawley, Gloucestershire data by M. A. R. and C. Kitchen (the data were noted as incomplete) and Monmouthshire data by T. G. Evans.

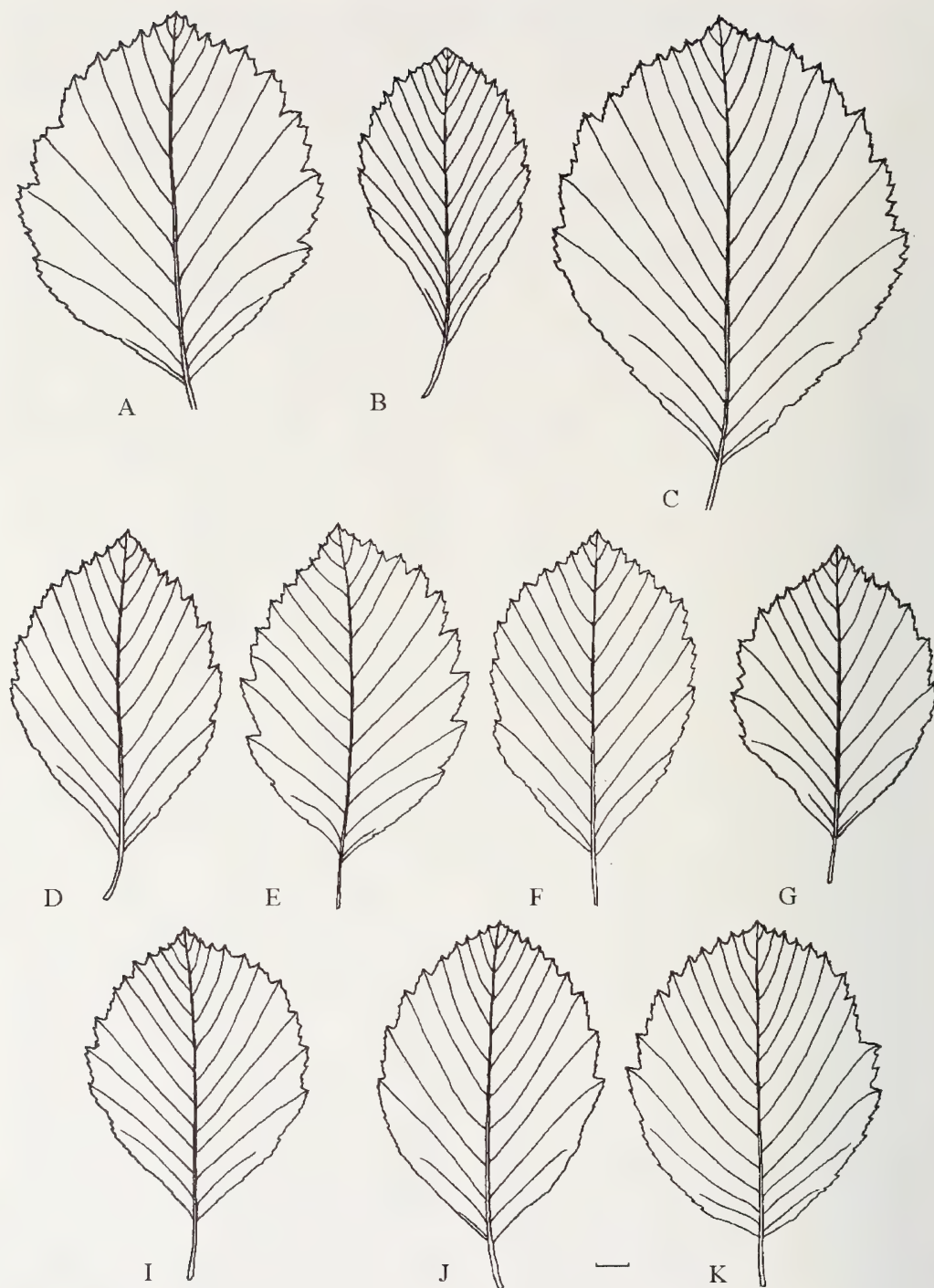


FIGURE 1. Putative *S. aria* $\times$ *S. x vagensis* backcrosses. A, Ban-y-gor rocks (V.2001.13.37). B, Ban-y-gor rocks (V.2002.17.108). C, Rosemary Topping (Sample 1). D, Gorrashill (Sample 11). E, Pinnacle of Pinnacles, Great Downard (Sample 39). F, Seven Sisters (Sample 40). G, Seven Sisters (Sample 59). H, Symonds Yat (Sample 62). I, Wintour's Leap (Sample 75). J, Wintour's Leap (Sample 77). Scale bar = 1 cm. Del. T. C. G. Rich.

RESULTS

COMPARATIVE MORPHOLOGY

Figure 1 shows variation in lobing of leaves of putative *S. aria* $\times$ *S. $\times$ vagensis* backcrosses; for comparative illustrations of *S. aria*, *S. torminalis* and *S. $\times$ vagensis*, see Fay *et al.* (2002). The variation is presumably due to differences in parentage.

The Principal Components Analysis plot for Components 1 and 2 is shown in Figure 2. Component 1 had an Eigenvalue of 4.33 and accounted for 54.5% of the variance. Component 2 had an Eigenvalue of 1.79 and accounted for 22.5% of the variance. The Jolliffe cut-off value, an informal indication of the value below which components may no longer be considered significant, was Eigenvalue 0.7, suggesting that the third Component was of minor importance. All eight characters had significant loadings in Component 1 (unsurprising in that they had all been selected as important),

with the depth of incision, number of veins and petiole length being the most important (in that order). The main loadings in Component 2 were leaf length, leaf width and width at 0.9 of the length.

Figure 2 shows *S. torminalis* is clearly separated from the other taxa by Component 1. *Sorbus $\times$ vagensis* is intermediate between *S. torminalis* and *S. aria*, as might be expected (though Sell 1989 regarded the leaf morphology as nearer to *S. torminalis* than to *S. aria*). A few *S. $\times$ vagensis* samples showed minor overlap with *S. aria*; one was of shaded leaves from the tree at Cheddar Wood, and the other a somewhat atypical form from Lady Park Wood with narrow obovate leaves rather like *S. subcuneata* (see Sell 1989, page 389). Plants with acutely-lobed leaves ascribed to the possible backcross of *S. $\times$ vagensis* with *S. aria* were located between *S. aria* and *S. $\times$ vagensis*, overlapping more with *S. aria* but showing less scatter. The greater overlap with

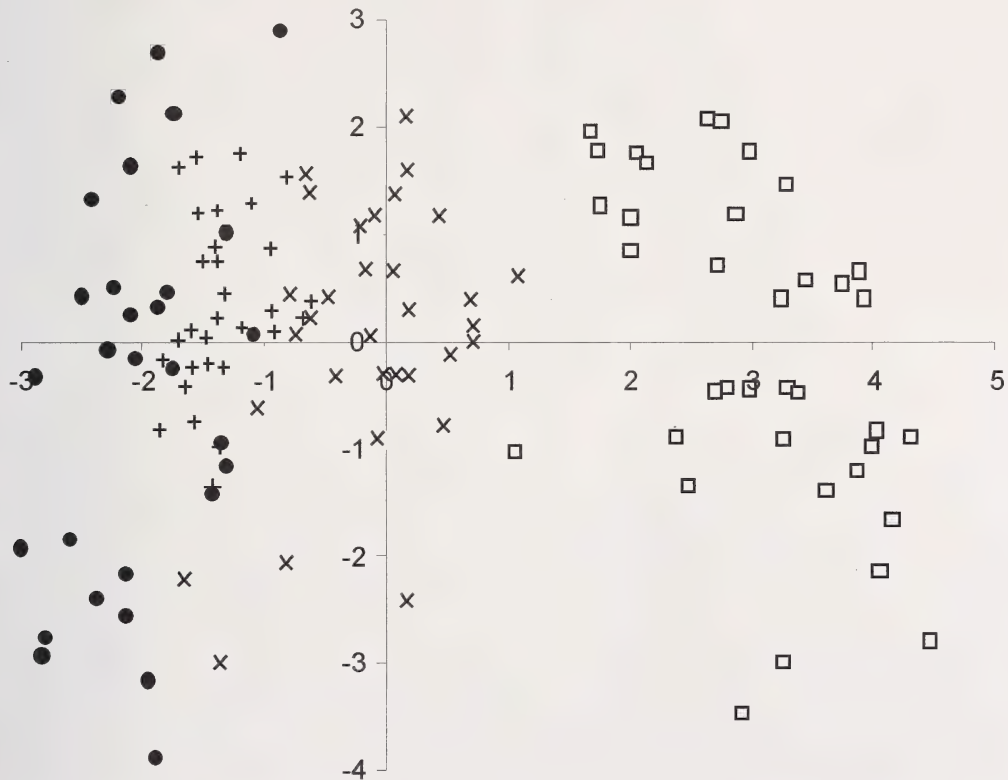


FIGURE 2. Principal components analysis of *Sorbus* taxa. ● *S. aria*; □ *S. torminalis*; × *S. $\times$ vagensis*; + possible backcrosses between *S. aria* and *S. $\times$ vagensis*.

TABLE 2. POTENTIAL POLLEN VIABILITY ON *SORBUS* ASSESSED USING ALEXANDER'S STAIN. (DATA IN PART COURTESY A. KARRAN AND J. ROGERS)

Species	Locality	NMW accession number	Percentage fertile
<i>S. aria</i>	Bix (v.c. 24)	23.94.1258	92
	Box Hill (v.c. 17)	83.6.480	56
	Buckingham (v.c. 24)	78.35.4800	73
	Cheddar Gorge (v.c. 6)	29.190.2	99
	Clevedon (v.c. 6)	49.29.1759	74
	Conkwell (v.c. 7)	28.131.2922	33
	Godstone (v.c. 17)	V.94.24.7521	67
	Horsley (v.c. 17)	V.2000.34.64	86
	Leigh Woods (v.c. 6)	25.12.1	100
	Nightingale Valley (v.c. 6)	25.149.10666	78
	Nuffield (v.c. 23)	V94.62.599	99
	Princes Risborough (v.c. 24)	V.94.24.1466	98
	Reigate (v.c. 17)	23.94.1256	23
	Sea Walls, Durdham (v.c. 34)	(fresh material)	97
	Tutshill (v.c. 34)	28.131.2924	100
		Mean	78
<i>S. torminalis</i>	Abergele (v.c. 50)	30-609-12	82
	Afon Arth, Cards. (v.c. 46)	76-68B-11	83
	Bewdley (v.c. 34)	42-138-311	89
	Castle Coch (v.c. 41)	2001-025-003	65
	Chepstow (v.c. 35)	28-131-2949	100
	Exeter (v.c. 3)	22-289a-123	92
	Hampstead (v.c. 21)	26-540-128	90
	Lawrenny (v.c. 45)	76-42B-4	65
	Monmouth (v.c. 35)	35-435-48	92
	Much Marcle (v.c. 34)	23-94-1250	46
	Newlyn (v.c. 1)	25-149-10649	98
	Overton-Chirk (v.c. 40)	94-24-1462	90
	Pen Moyle (v.c. 34)	No number	50
	Sandy Haven (v.c. 45)	72-137B-8	66
	Stafford (v.c. 39)	No number	96
	Symonds Yat (v.c. 34)	49-29-1765	78
		Mean	75
<i>S. × vagensis</i>	Bicknor Walks (v.c. 34)	25.149.10659	25
	Gorrashill (v.c. 35)	V.2004.3.100	29
	Symonds Yat (v.c. 34)	28.131.2903*	0
	Symonds Yat (v.c. 34)	28.131.2939	0
	Symonds Yat (v.c. 34)	28.131.2941	5
	Symonds Yat (v.c. 34)	25.149.10652*	0
		Mean	10
putative backcross	Symonds Yat (v.c. 34)	V.2004.3.111	35

* possible duplicate collections from the same plant

S. aria might be expected as plants might be F2, F3 or further backcrosses with *S. aria*. These PCA results are very similar to those of Aas *et al.* (1994) for Swiss material.

POTENTIAL FERTILITY

Table 2 lists the potential pollen viability of the taxa studied using Alexander's Stain. Both parents had quite high mean potential pollen viability (*Sorbus aria* mean 78% and range 23–100%, *S. torminalis* mean 75% and range 46–100%), but viability was much lower in *S. × vagensis* (mean 10%, range 0–29%). The one putative backcross studied had 35% pollen viability, higher than *S. × vagensis*, but still low compared to *S. aria* and *S. torminalis*.

Fruits were present on all the *S. × vagensis* and putative backcrosses investigated in the Wye Valley in 2004. The number of fruits produced varied between trees, for instance some *S. × vagensis* trees produced copious quantities of fruit but others only small numbers, though whether this is due to inherent differences in fertility or variation in pollination remains to be established. Table 3 lists the mean number of seed per fruit for the samples analysed. The parents *S. aria* and *S. torminalis* were the most fertile (overall mean 2.4 ± 0.104 s.e. and 1.9 ± 0.076 s.e. seeds per fruit respectively), *S. × vagensis* had lower fertility (overall mean 1.5 ± 0.064 s.e.) and the putative backcrosses lower fertility still (overall

mean 1.2 ± 0.057 s.e.). A one-way analysis of variance shows that there are significant differences in fruit set among the four taxa ($F = 29.5$, 3 d.f., $P < 0.001$), and each pair is significantly different from each other with the exception of *S. × vagensis* and the putative backcrosses (Tukey test).

DISTRIBUTION OF TAXA

The records traced for *Sorbus × vagensis* are listed in Appendix 2 and are mapped at a tetrad level in Figure 3. This shows *S. × vagensis* is restricted in distribution from the Mendips to the Wye Valley, and has been recorded in about 16 sites in 13 tetrads in V.cc. 6, 34, 35 and 36, principally concentrated on the Wye Valley. It occurs on open rocks, cliffs, scrubby woodland and in tall woodland, almost always on Carboniferous Limestone and associated soils, associated with *Fraxinus excelsior*, *Tilia cordata*, *Taxus baccata* and other *Sorbus* species including both its parents.

A comparison of the maps of *S. aria* and *S. torminalis* in the *New Atlas* (Preston *et al.* 2002) shows that they overlap extensively in distribution in southern England and Wales, being jointly present in over 160 hectads, which suggests the possibility of widespread hybridisation. However, as the hectad mapping scale is relatively crude, in many of these hectads *S. aria* and *S. torminalis* may not actually be growing together, especially as they

TABLE 3. NUMBER OF FERTILE SEEDS PER FRUIT FOR FERTILE FRUITS OF FOUR *SORBUS* TAXA COLLECTED IN AUTUMN 2004

Taxon	Locality	n	Mean no. seeds per fertile fruit ($\pm$ s.e.)
<i>S. aria</i>	Leigh Woods	30	1.93 ± 0.11
	Great Doward	17	2.4 ± 0.25
	Yousden, Buckinghamshire	30	2.9 ± 0.16
<i>S. torminalis</i>	Leigh Woods	30	2.63 ± 0.17
	Near Ship Rock, Coldwell Rocks	27	1.67 ± 0.16
	Symonds Yat 261	27	1.37 ± 0.13
	Symonds Yat car park corner	30	1.63 ± 0.17
	Symonds Yat near toilets	30	2.5 ± 0.21
	Symonds Yat, Bowlers Hole	30	1.73 ± 0.13
<i>S. × vagensis</i>	Biblings, Great Doward	30	1.53 ± 0.13
	Symonds Yat, car park corner	27	1.11 ± 0.08
	Symonds Yat, 260	23	1.65 ± 0.16
	Symonds Yat, row of 10	16	1.13 ± 0.09
	Symonds Yat, west of toilets	14	1.14 ± 0.1
	Needle Rock, Coldwell Rocks	30	2.1 ± 0.16
putative backcross	West of Ship Rock, Coldwell Rocks	27	1.15 ± 0.09
	Bowlers Hole	7	1.14 ± 0.14
	Symonds Yat, car park by rowan	24	1.25 ± 0.09

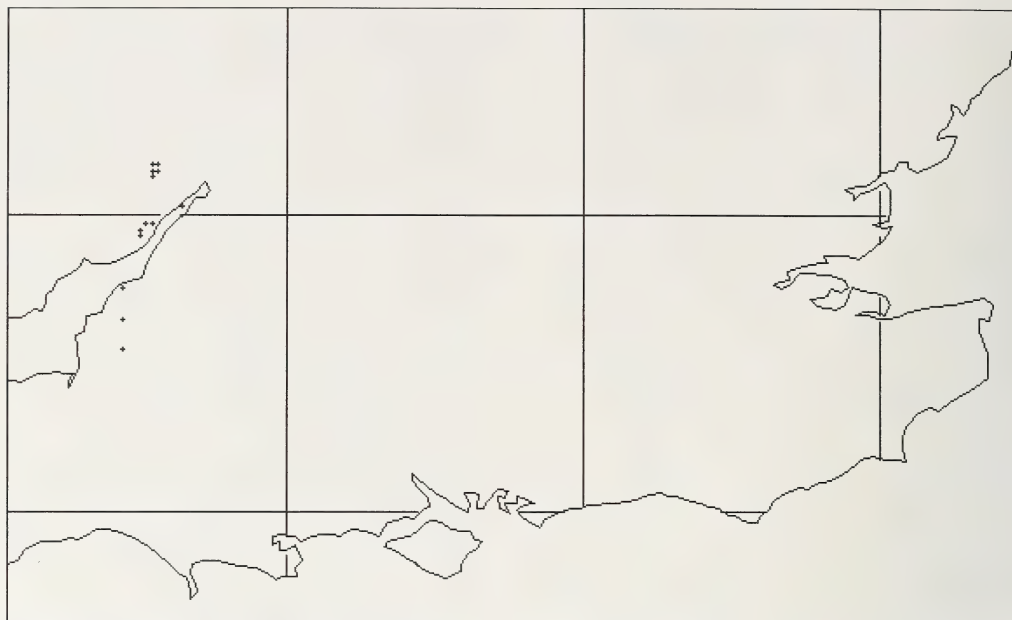


FIGURE 3. Tetrad distribution map of *Sorbus* $\times$ *vagensis*.

occupy different niches. *Sorbus aria* is most characteristic of open woods, scrub and hedges on calcareous soils over chalk and limestone, and is found more rarely on acidic soils. *Sorbus torminalis* is usually associated with ancient woodlands and hedgerows, and shows a marked preference for soils derived from clays and those developed over hard limestone (Roper 1993). Finer scale data were therefore compiled at the tetrad level for which there are $\pm$ comparable data across southern Britain, and Figure 4 shows tetrads in which *S. aria* and *S. torminalis* have both been recorded. This still does not necessarily indicate the two species are actually growing together, but gives a closer indication of where they are more likely to do so. This shows 149 tetrads scattered across southern Britain with clusters in the Wye Valley, the Mendips, Berkshire and the North Downs in Kent. Given this widespread occurrence of both species in reasonable proximity, it is perhaps surprising that the primary hybrid *S.* $\times$ *vagensis* is not more widely recorded, but we know relatively few sites where *S. aria* and *S. torminalis* grow intimately associated with each other. In a systematic survey of the central plateau of Switzerland, Rudow & Aas (1997) found the primary hybrid in 38 of the 160 sites investigated; it occurred in 35% of the sites where both parents were present, and 87% of its sites had both parents.

Putative backcrosses – identified from their morphology – were widespread in the Wye Valley (Appendix 1), and some similar plants were found in Cheddar in 2006 (L. Houston, pers. comm.). No clear backcross material has been seen from elsewhere in Britain.

DISCUSSION

The Principal Components Analysis (Figure 2) indicates that the Wye Valley plants with acutely-lobed leaves could be *S. aria* introgressed with *S. torminalis*. Morphologically, the backcrosses are easily separated from the primary *S.* $\times$ *vagensis* in having shorter petioles, much shallower lobes, whiter undersides of the leaves and red fruits. The clearer examples of backcrosses can be differentiated from *S. aria* by the combination of the acute lobes and greener undersides of the leaves. It is harder to be certain about the dividing line between pure *S. aria* and introgressed hybrids due to morphological variation in lobing of *S. aria* leaves. Variation in the extent of rounded lobes can be seen in many apparently pure *S. aria* populations (e.g. Bignor Hill, Sussex or Park Wood, Buckinghamshire; NMW), but plants with acutely-lobed leaves are less frequent and tend to occur only where *S. torminalis* grows frequently in the vicinity of *S. aria*. Preliminary phytochemical data support the occurrence of back-crossing

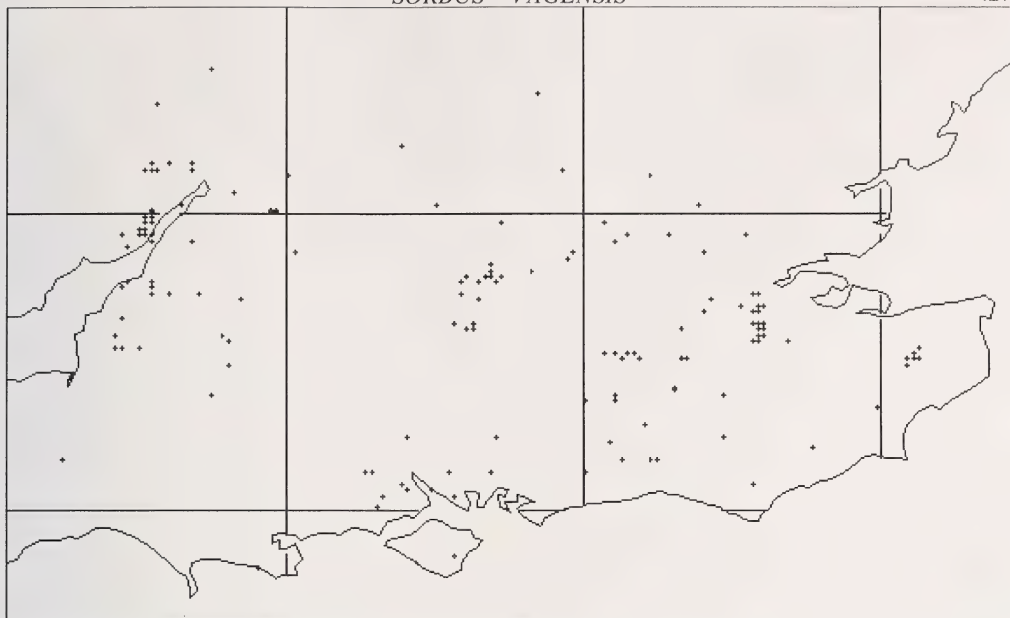


FIGURE 4. Tetrads in southern Britain in which both *Sorbus aria* and *S. torminalis* have been recorded.

(unpublished data), but further analysis requires a detailed molecular investigation.

The pollen tests suggest that at least some *S. $\times$ vagensis* trees and putative backcrosses have potentially fertile pollen, but that the fertility is an order of magnitude lower than that of the parents. Some trees had sterile pollen. All trees examined in 2004 had at least some fruit with well-formed seeds, with the hybrids having lower numbers of seeds per fruit than the parents, as might be expected. It is possible that all trees can act as mothers, or as both mothers and fathers, allowing continual introgression to occur. De Poucques (1951) suggested that when the hybrids have *S. aria* as the female parent they produce fertile fruits but when *S. torminalis* is the female parent they are sterile; this is inconsistent with our findings in the Wye Valley where *S. torminalis* is consistently the female parent (Chester *et al.* 2007) and *S. $\times$ vagensis* is fertile.

Given the large overlap in distribution of the parents in southern England, hybridisation is surprisingly rare, and so far introgressed hybrids have only been confirmed for the Wye Valley. There are other areas such as Surrey where *S. aria* plants with acutely-lobed leaves occur, and which could be relict from introgression at some stage in the past. *Sorbus $\times$ vagensis* has not been recorded in Surrey, but

other *S. latifolia* aggregate taxa such as *S. croceocarpa* and *S. latifolia sensu stricto* are occasionally naturalised in that area and could be parents, although we have no evidence that this is so.

We conclude that introgression between *S. aria* and *S. torminalis* does occur in Britain. Backcrossing between *S. aria* and *S. torminalis* was first suggested for Britain by Riddelsdell *et al.* (1948) but they presented no evidence. Backcrossing has also been reported for Germany and Switzerland by Aas *et al.* (1994), and for France by Chabert (1906) and Oddou-Muratorio *et al.* (2001). Interestingly, like Aas *et al.* (1994), the introgression we have traced seems only to occur from *S. torminalis* into *S. aria* and not in the other direction and we have seen no material suggestive of back-crossing between *S. $\times$ vagensis* and *S. torminalis*. However, Oddou-Muratorio *et al.* (2001), from widespread sampling of French material, presented chloroplast DNA evidence showing that gene flow does occur from *S. aria* into *S. torminalis* albeit at a much lower rate than from *S. torminalis* into *S. aria*. Chabert (1906) gave a description of one plant from Fontainebleau he attributed to *S. latifolia $\times$ torminalis*. Use of such molecular methods and widespread sampling may show that gene flow occurs from *S. aria* into *S. torminalis* in Britain too.

There is now strong evidence that *S. × vagensis* behaves like many other hybrids, being diploid, of multiple origin, reduced fertility and back-crossing with one or both parents. We prefer to treat it as a hybrid as did Warburg (1952) and Stace (1997), and consider that Wilmott's (1934) and Sell's (1989) treatment of it as a species cannot be upheld.

Nomenclature of the hybrids may need to be updated. If *S. × vagensis* does not match continental material of *S. aria × torminalis* morphologically, as suggested by Sell (1989), then it might be worth retaining the name to label it separately. If *S. × vagensis* does match continental material of *S. aria × torminalis*, then *S. × vagensis* Wilm. becomes a synonym of *S. × tomentella* Gand. The name *S. latifolia* (Lam.) Pers. is often used for *S. aria × torminalis*, but Sell (1989) applied it to the widely cultivated, polyploid plant with broadly ovate leaves which can be consistently separated from *S. × vagensis* (at least in Britain). Further revision of the taxonomy of the hybrids should await a comparison of British *S. × vagensis* with continental *S. × tomentella* and *S. latifolia* sensu stricto and their ploidy level and reproductive mechanisms as French plants have been reported as either diploid or tetraploid, and as either fixed hybrids or not (de Pouques 1951, 1953; Dillemann & de Pouques 1954).

It may be useful to have a name for the introgressed plants, but there is no clear name available. Chabert (1906) described *S. aria × latifolia* from Fontainebleau as *S. latifolia* (Lam.) Pers. var. *ambigens* Chabert, and his brief description matches our plants from the Wye Valley with acutely-lobed leaves, though

the parentage may be different. Plants with comparably lobed leaves have previously been reported from Britain under the names *S. incisa* (Rchb.) Hedl. or *S. aria* var. *incisa* Rchb. (Hedlund 1901, Marshall 1916, White 1912, Salmon 1930). Hedlund (1901) described *S. incisa* as similar to *S. aria* but having broadly elliptic leaves which were more lobed above, and he preferred to treat it as a species rather than accept a suggestion by Bechstein that it was only a form of *S. aria* which developed in fertile ground in the lowlands (*S. aria* sensu stricto being more a plant of the mountains). Examination of specimens determined as *S. incisa* in Hedlund's herbarium in Uppsala (UPS) reveals a range of British and continental *S. aria* material with ovate leaves and predominantly rounded lobes (as shown in Hedlund's 1901 Figure 33), or more rarely with acute lobes, and three incorrectly determined specimens of *S. anglica* Hedl. It is clear that Hedlund's concept is somewhat heterogeneous, and the name *S. incisa* is not clearly applicable to our Wye Valley plants with acutely-lobed leaves.

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REFERENCES

- AAS, G., MAIER, J., BALTISBERGER, M. & METZGER, S. (1994). Morphology, isozyme variation, cytology and reproduction of hybrids between *Sorbus aria* (L.) Crantz and *S. torminalis* (L.) Crantz. *Botanica Helvetica* **104**: 195–214.
- ALEXANDER, M. P. (1969). Differential staining of aborted and non-aborted pollen. *Stain Technology* **44**: 117–122.
- CHABERT, M. A. (1906). Note sur quelques Pomacées. *Bulletin de la Société Botanique de France* **53**: 308–315.
- CHESTER, M., COWAN, R. S., FAY, M. F. & RICH, T. C. G. (2007). Parentage of endemic *Sorbus* L. (Rosaceae) species in the British Isles – evidence from plastid DNA. *Botanical Journal of the Linnean Society* (in press).
- DE POUQUES, M.-L. (1951). Étude chromosomique des *Sorbus latifolia* Pers. et *Sorbus confusa* Greml. *Bulletin de la Société Botanique de France* **98**: 89–92.
- DE POUQUES, M.-L. (1953). La différenciation de certains *Sorbus* par le pollen. *Bulletin de la Société Scientifique de Nancy* **12**: 133–136.
- DILLEMANN, G. & DE POUQUES, M.-L. (1954). Le pollen du *Sorbus latifolia* Pers. et son origine hybride. *Bulletin de la Société Botanique de France* **101**: 239–240.

- FAY, M. F., GERNANDT, D. S., COWAN, R. S., KITCHEN, M. A. R., KITCHEN, C. & RICH, T. C. G. (2002). Parentage of an unknown member of the *Sorbus latifolia* (Lam.) Pers. group. *Watsonia* **24**: 91–100.
- HAMMER, Ø., HARPER, D. A. T. & RYAN, P. D. (2001). PAST: Paleontological Statistics Software Package for Education and Data Analysis. *Palaeontologia Electronica* **4**(1): 9pp.
http://palaeo-electronica.org/2001_1/past/issue1_01.htm
- HEDLUND, T. (1901). Monographie der Gattung *Sorbus*. *Kungliga Svenska Vetenskaps-Akademiens Handlingar* **35**: 1–147. Stockholm.
- HOUSTON, L., TILLOTSON, A. & CHARLES, C. (2001). *Wye Valley Sorbus project. 1. Ban-y-gor rocks Autumn 2000*. Unpublished contract report to English Nature, Ledbury, March 2001.
- HOUSTON, L., TILLOTSON, A. & CHARLES, C. (2002). *Wye Valley Sorbus project. 2. Shorn Cliff Autumn 2001*. Unpublished contract report to English Nature, Ledbury, March 2002.
- HOUSTON, L., TILLOTSON, A. & CHARLES, C. (2003). *Wye Valley Sorbus project. 3. Upper Wye Gorge Autumn 2002*. Unpublished contract report to English Nature, Ledbury, March 2003.
- HOUSTON, L., TILLOTSON, A. & CHARLES, C. (2004). *Wye Valley Sorbus project. 4. Wintour's Leap and Lady Park Wood Autumn 2003*. Unpublished contract report to English Nature, Ledbury, March 2004.
- LEMICHE, E. B. (1999). *The origins and interactions of British Sorbus species*. PhD thesis, Darwin College, Cambridge.
- MARSHALL, E. S. (1916). Notes on *Sorbus*. *Journal of Botany* **54**: 10–14.
- NELSON-JONES, E. B., BRIGGS, D. & SMITH, A. G. (2002). The origin of intermediate species of the genus *Sorbus*. *Theoretical and Applied Genetics* **105**: 953–963.
- ODDOU-MURATORIO, S., PETIT, R. J., LE GUERROUE, B., GUESNET, D. & DEMESURE, B. (2001). Pollen-versus seed-mediated gene flow in a scattered forest tree species. *Evolution* **55**: 112–1135.
- PRESTON, C. D., PEARMAN, D. A. & DINES, T. D. (2002). *New Atlas of the British and Irish flora*. Oxford University Press, Oxford.
- PROCTOR, M. C. F. & GROENHOF, A. C. (1992). Peroxidase isoenzyme and morphological variation in *Sorbus* L. in South Wales and adjacent areas, with particular reference to *S. porrigentifolmis* E. F. Warb. *Watsonia* **19**: 21–37.
- RIDDELSDELL, H. J., HEDLEY, G. W. & PRICE, W. R. (1948). *Flora of Gloucestershire*. T. Buncle & Co., Arbroath.
- ROPER, P. (1993). The distribution of the Wild Service Tree, *Sorbus torminalis* (L.) Crantz, in the British Isles. *Watsonia* **19**: 209–229.
- RUDOW, A. & AAS, G. (1997). *Sorbus latifolia* s.l. in der zentralen Nordschweiz: verbreitung, standort und populationsbiologie. *Botanica Helvetica* **107**: 51–73.
- SALMON, C. E. (1930). Notes on *Sorbus*. *Journal of Botany* **68**: 172–177.
- SELL, P. D. (1989). The *Sorbus latifolia* (Lam.) Pers. aggregate in the British Isles. *Watsonia* **17**: 385–399.
- STACE, C. A. (1997). *New flora of the British Isles*, 2nd ed. Cambridge University Press, Cambridge.
- STACE, C. A., ELLIS, R. G., KENT, D. H. & MCCOSH, D. A. (2003). *Vice-county census catalogue of the vascular plants of Great Britain*. B.S.B.I., London.
- SYME, J. T. B. (1875). On the forms (subspecies or hybrids) of *Pyrus aria*, Hook. *Report of the Botanical Exchange Club for 1872–4*: 17–25.
- WARBURG, E. F. (1952). *Sorbus* L., pp. 539–556 in CLAPHAM, A. R., TUTIN, T. G. & WARBURG, E. F. (1952). *Flora of the British Isles*. Cambridge University Press, Cambridge.
- WARBURG, E. F. (1962). *Sorbus* L., pp. 423–437 in CLAPHAM, A. R., TUTIN, T. G. & WARBURG, E. F. (1962). *Flora of the British Isles*. 2nd ed. Cambridge University Press, Cambridge.
- WHITE, J. W. (1912). *The flora of Bristol*. John Wright and Sons, Bristol.
- WILLIS, A. J. (1978). Bristol botany in 1978. *Proceedings of the Bristol Naturalists' Society* **38**: 33–48.
- WILLIS, A. J. (1984). Bristol botany in 1984. *Proceedings of the Bristol Naturalists' Society* **44**: 61–70.
- WILLIS, A. J. (1991). Bristol botany in 1991. *Proceedings of the Bristol Naturalists' Society* **51**: 29–40.
- WILMOTT, A. J. (1934). Some interesting British *Sorbi*. *Proceedings of the Linnean Society of London* **146**: 73–79.

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APPENDIX 1. *SORBUS* MATERIAL USED FOR MORPHOLOGICAL ANALYSIS

NMW accession numbers are given, and * indicates material included in DNA study by Fay *et al.* (2002).

SORBUS ARIA

Bignor Hill (v.c. 13), V.2003.1.147; Bignor Hill (v.c. 13), V.2003.1.50; Blackdown (v.c. 13), V.2003.1.27; Bois de Garenne Sancere, Cher, France, V.2001.25.1129; Burnham Beeches (v.c. 24), V.2001.48.11; Coldwell (v.c. 34), V.2000.009.104*; Durford Heath (v.c. 13), V.2003.1.135; Durford Heath (v.c. 13), V.2003.1.136; Durford Heath (v.c. 13), V.2003.1.133; Gorrashill Wood (v.c. 35), V.2003.1.86; Great Doward (v.c. 36), V.2000.009.116; Laval en Lonnais, France, V.2001.25.1196; Lords Wood Quarry Great Doward (v.c. 36), V.2000.009.105*; Matlock (v.c. 57), V.1998.31.33; Mons en Lonnais, France, 85.40.6150; Naas (v.c. 34), V.2000.009.103*; Noar Hill (v.c. 12), V.2001.025.087; Pepperbox Hill (v.c. 8), V.2001.025.093; Pilgrim's Way, Clandon (v.c. 17), 49.29.1757; Snoozin' Susie, Symonds Yat (v.c. 34), V.1999.033.528; Stane Street (v.c. 17), V.2003.1.144.

SORBUS TORMINALIS

Babel (v.c. 44), V.1999.012.25; Bangor (v.c. 49), 72.91B.10; Bois de Font Moreau, France, V.2001.25.1046; Bois de Roi Fontainebleau, France, V.2001.25.1184; Bontddu (v.c. 48), 73.60B.8; Cathays Cemetery (v.c. 41), V.2002.17.149; Coldwell Rocks (v.c. 34), V.2000.009.110*; Crawley Cliff, Oxwich (v.c. 41), V.2001.025.102; Cwmbach, Llanelli (v.c. 44), V.1999.008.41; Krivoklat, Bohemia, Czech Republic, V.2003.1.258; Lady Park Wood (v.c. 35), V.2001.025.040; Leigh Woods (v.c. 6), V.2001.025.294; Leigh Woods towpath (v.c. 6), V.2001.25.277; Llantrithyd (v.c. 41), V.2001.032.5; Naas (v.c. 34), V.2000.009.109*; Newbridge, Meifod (v.c. 47), V.89.48.1; Saundersfoot (v.c. 45), V.2001.025.022; Wyndcliff (v.c. 35), V.2001.025.216.

SORBUS × *VAGENSI*S

Car park, Symonds Yat (v.c. 34), V.1999.033.541; Cheddar Wood (v.c. 6), V.1999.033.533; Coldwell (v.c. 34), V.2000.009.111*; Gorrashill Wood (v.c. 35), V.2003.1.84; Hedgeline Terrace, Symonds Yat (v.c. 34), V.2003.006.68; Lady Park Wood (v.c. 35), V.2004.011.37; Lady Park Wood (v.c. 35), 44.14.26; Lords Wood (v.c. 36), V.2000.009.112*; Lover's Leap (v.c. 35), V.2000.25.63; Naas (v.c. 34), V.2000.009.113*; Needle Rock, Coldwell Rocks (v.c. 34), V.1999.033.514; Nutwood, Ban y Gor (v.c. 34), V.2001.013.131; Symonds Yat (v.c. 34), 49.29.1775; White Wall waterpipe, Symonds Yat (v.c. 34), V.2003.6.53; White Wall, Symonds Yat (v.c. 34), V.2003.006.54; Wintour's Leap (v.c. 34), V.2004.011.30; Wintour's Leap (v.c. 34), V.2004.011.38; Wyndcliff (v.c. 35), 28.131.2898.

PUTATIVE BACKCROSS *S.* × *VAGENSI*S × *S. ARIA*

Bowlers Hole (v.c. 34), V.2003.006.81; Gorrashill Wood (v.c. 35), V.2003.1.85; Mounton Valley (v.c. 35), 28.131.2884; Pinnacle of Pinnacles, Great Doward (v.c. 36), V.2002.17.155; Rosemary Topping (v.c. 34), V.2003.1.88; Rosemary Topping (v.c. 34), V.2003.1.87; Seven Sisters (v.c. 36), V.2001.025.049; Seven Sisters (v.c. 36), V.2003.6.80; Seven Sisters, Great Doward (v.c. 36), V.2003.006.79; Symonds Yat Rock viewpoint (v.c. 34), V.2003.6.84; Symonds Yat West climbing area (v.c. 34), V.2003.6.82; Wintour's Leap (v.c. 34), V.2004.011.112; Wintour's Leap (v.c. 34), V.2004.011.113; Wintour's Leap (v.c. 34), V.2004.011.114.

APPENDIX 2. RECORDS OF *SORBUS* × *VAGENSIS*

V.C. 6, NORTH SOMERSET

Cheddar Wood (ST445550), one tree, McDonnell, E. J. & Rich, T. C. G., 28 October 1999, **NMW**.

King's Wood, Yatton (c. ST4564), at least two, well separated, coppiced trees in old woodland, Nethercott, P. J. M., 1984 (Willis 1984).

Weston Big Wood (c. ST4575), Archibald, J. F., 1968 (cf. Sell 1989); Nethercott, P. J. M., 1978, three trees (Willis 1978); Proctor, M. C. F., 10 June 1989, **NMW**; two large trees lost during storm of 25 January 2000, another damaged but regrowing, Nethercott, P. J. M., 1990 (Willis 1991). Not refound 2004.

V.C. 15, EAST KENT

[Blean Woods, Archibald, J. F., about 1959, *in litt.* to P. J. M. Nethercott (Willis 1978); unconfirmed.]

V.C. 34 WEST GLOUCESTER

Coldwell Rocks/Bicknor Woods/ Bicknor Walks/ English Bicknor (c. SO5615), Ley, A., 9 June 1874, **CGE**, **MANCH**; Bicknor Woods; Ley, A., 25 May 1875, **MANCH**; Watkins, B. M., June 1877, **MANCH**; Ley, A., 23 June 1877, **BEL**, **BIRA**, **E**; Watkins, B. M., October 1877, **BEL**, **BIRA**, **CGE**, **GLAM**, **MANCH**, **OXF**; Armitage, E., May and June 1888, **BRISTM**, **LTR**, **NMW**; Ley, A., 2 June 1888, 12 August 1891, 27 October 1892 and November 1892, **BEL**, **MANCH**, **UPS**; Armitage, E., October 1893 and May 1894, **BRISTM**; Ley, A., 12 May 1894 and 13 June 1899, **UPS**; Armitage, E., 24 August 1916 and July 1930, **BRISTM**, **NMW**; Roper, I. M., 17 August 1925, **LDS**; Warburg, E. F., September 1935, **BM**; Welch, B., 9 June 1939, **NMW**; Riddelsdell, H. J., 1941, **BRISTM** (Riddelsdell *et al.* 1948); Miles, B. A., 5 September 1956, **CGE**; Bishop, S. H. & M. S., 6 June 1992, **BRISTM**; Rich, T. C. G. & Houston, L., 4 October 1999; opposite Needle Rock; Rich, T. C. G., 30 June 2000, **NMW**; Charles, C., Houston, L. & Tillotson, A. C., September 2002, **NMW**; Rich, T. C. G. & Evans, T. G., 3 September 2003, **NMW**.

Highmeadow Woods (c. SO5413), Riddelsdell *et al.* (1948).

Staunton, woods near (c. SO5412), Ley, A., 28 June 1881, **CGE**, **MANCH** (Riddelsdell *et al.* 1948).

Symonds Yat (c. SO5615), Ley, A., June 1871, **CGE**; Ley, A., 12 August 1872, **E**; Purchas, W. H., August 1873, **MANCH**; Ley, A., 25 May 1875, **CGE**, **E**, **GLAM**, **K**; Bailey, C., 2 June 1882, **MANCH**; woods near, Ley, A., 12 Oct 1882, 26 May 1896 and 13 June 1899, **E**, **K**, **MANCH**, **NMW**, **OXF**; Shoolbred, W. A., 12 June 1901, **NMW**; Ley, A. & Armitage, E., May 1903, **BRISTM**; Bickham, S. H. & Ley, A., 8 June 1907, **CGE**; Ley, A., May 1909 and 6 June 1910, **K**, **UPS**; Anon., 4 September 1931, **BIRA**; Limestone rocks, Wedgwood, M. L., 10 June 1932, **BRISTM**; Wilmott, A. J., 18 September 1933, **UPS**; W. B., 4 November 1934, **UPS**; Vachell, E., August 1946, **NMW**; Burges, R. C. L., May 1948, **RNG**; Harris's Tea Garden, Mills, J. N., 2 August 1952, **MANCH**; limestone Woods, Tutin, T. G., 14 June 1953, **LTR**; Hyde, H. A., 11 August 1959, **NMW**; Sell, P. D. & Briggs, D., 29 September 1975, **CGE**; Below Symonds Yat Rock, Rich, T. C. G. & Kitchen, M. A. R., 18 September 1999, **NMW**; Below Symonds Yat Rock, Peregrine Pinnacle, east scrub south of Yat Rock, west side Yat Rock seven trees, White Wall and south-east corner of the view point, Charles, C., Houston, L. & Tillotson, A. C., September 2002, **NMW**.

Naas Cliff/Warren Grove (SO656027), Bishop, S. H., 8 July 1982, **BRISTM**; Rich, T. C. G., Kitchen, M. A. R. & C., 18 September 1999, **NMW**; Rich, T. C. G., 30 June 2000, **NMW**.

Ban-y-gor Rocks (ST544969 to ST546970), Charles, C., Houston, L. & Tillotson, A. C., September and October 2000, **NMW**.

Wintour's Leap (ST540965 to ST539965), Charles, C., Houston, L. & Tillotson, A. C., 1 September 2003, **NMW**.

V.C. 35 MONMOUTH

Cliff Wood, Mounton (c. ST5093), 1996, GL; 1 tree at north end of cliff, ST50764.94086, Rich, T. C. G., 6 October 2005, **NMW**.

Lady Park Wood (c. SO5414), Wade, A. E., 15 September 1943, **NMW**; Limestone cliff, Stace, C. A. / B.S.B.I. meeting, 18 September 1982, **LTR**; By the River Wye; SO546144, Houston, L., 12 September 2003, **NMW**; SO54694.14390, Rich, T. C. G., 6 October 2005, **NMW**.

Gorrashill Wood, Mounton (c. ST5093), Ley, A., 21 May 1891, **UPS**; Shoolbred, W. A., 21 May 1891, **NMW**; South-east side of a valley at Mounton; ST506936, Evans, T. G., 2 October 1995, **NMW**; Evans, T. G. & Rich, T. C. G., 3 September 2003, **NMW**.

Piercefield Cliffs (c. ST5296), Ley, A., 22 June 1878, **MANCH**; woods, Ley, A., 16 May 1894, **BRISTM**; Limestone rocks, Wilmott, A. J., 23 June 1932; near Temple Door, Wedgwood, M. L., 18 September 1933, **BRISTM**; Lover's Leap, Chepstow Park, ST522967, Evans, T. G., 1988, **NMW**.

Wynd Cliff (c. ST5297), Ley, A., 23 June 1873, **BIRM**; Shoolbred, W. A., 9 June 1878 and 25 June 1894, **BEL**, **NMW**; Bickham, S. H., 20 August 1903, **CGE**, **E**; Warburg, E. F., September 1935, **BM**.

V.C. 36, HEREFORD

Great Doward (c. SO5516), Watkins, B. M., 1880, **CGE**; Ley, A., July 1888, **BRISTM**; Warburg, E. F., September 1935, **BM**; one large tree, SO555151, Rich, T. C. G. & Houston, L., 9 October 2002, **NMW**.

Lord's Wood (c. SO5515), Ley, A., 11 June 1888, **CGE**, **NMW**; near The Biblins, three trees SO551145, Stace, C. A. / B.S.B.I. meeting 18 September 1982, **LTR**; Evans, T. G. & Proctor, M. C. F., 5 October 1989; Rich, T. C. G., 30 June 2000 and three trees 2004, **NMW**.

Variation in *Asperula cynanchica* L. (Rubiaceae) in the British Isles

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ABSTRACT

Variation in *Asperula cynanchica* L. (Rubiaceae) in the British Isles has been studied from herbarium material, field observations and limited cultivation experiments. Morphological analyses indicate that all British and Irish material is referable to subsp. *cynanchica* with two varieties present: subsp. *cynanchica* var. *cynanchica* is widespread, subsp. *cynanchica* var. *densiflora* usually occurs near the coast and includes material from the British Isles previously referred to subsp. *occidentalis*. Subsp. *occidentalis* occurs in south-west France and northern Spain but does not occur in the British Isles.

KEYWORDS: *Asperula occidentalis* Rouy, infra-specific variation, France, Spain.

INTRODUCTION

Contenjean (1865) drew attention to what he thought to be a curious hybrid between *Asperula cynanchica* L. and *Galium arenarium* Lois. from the French coast at Biarritz and on the Basque coast in Spain. A specimen he collected was later described by Rouy (1903) as a new taxon, *Asperula occidentalis*, characterised by having short prostrate stems, small, obovate leaves, dense inflorescences and corolla lobes about half as long as the tube. Rouy followed Contenjean's (1865) suggestion that it was a hybrid (it is unlikely Rouy knew the plant in the field), but it is now regarded as a species of *Asperula* in its own right and there is no evidence that it is of hybrid origin (Ehrendorfer & Krendl 1976). *Asperula occidentalis* is part of the complex *A. cynanchica* group, and has been reported as a rare species of south-west France, northern Spain, south-west Britain and Ireland.

Asperula occidentalis was first reported in the British Isles by Tutin & Chater (1974), who had found two specimens which appeared to be *A. occidentalis* whilst working through herbarium material using the draft *Asperula* account in *Flora Europaea* (subsequently published as Ehrendorfer & Krendl 1976). The specimens were sent to Ehrendorfer who confirmed the identification. Since then, *A. occidentalis* has been reported in the British Isles from coastal sites in Alderney, Dorset, Wales and Ireland (Preston *et al.* 2002).

Various accounts of *Asperula* in the British Isles have suggested that the relationship of *A. occidentalis* to *A. cynanchica* requires further study (Tutin & Chater 1974; Ehrendorfer & Krendl 1976; Clapham *et al.* 1987; Rich & Jermy 1998; Sell & Murrell 2006). Stace (1989) relegated *A. occidentalis* to *A. cynanchica* subsp. *occidentalis* (Rouy) Stace, commenting that subspecific status was wholly appropriate for the slight and quantitative differences between them. In the most recent taxonomic treatment, Sell & Murrell (2006) recognised three taxa within *A. cynanchica* in the British Isles: subsp. *cynanchica* var. *cynanchica*, subsp. *cynanchica* var. *densiflora* Gren. & Godr., and subsp. *occidentalis*. We have undertaken morphological studies and limited cultivation experiments to investigate the variation within these taxa.

METHODS

Asperula specimens from Britain and Ireland held in the Welsh National Herbarium (NMW), including much material seen by T. G. Tutin and A. O. Chater in the 1970s), National Botanic Gardens, Glasnevin (DBN), Cambridge Botanic

Garden (**CGE**, material of subsp. *occidentalis* and var. *densiflora* as revised by P. D. Sell) and European material in Madrid (**MA**, material revised for *Flora Iberica* by A. Ortega) and Paris (**P**) were selected, representing a wide range of geographic localities and morphology. British material in Reading University (**RNG**) and images of French material in Lyon (**LY**) have also been seen during the course of the work. *Asperula* material has also been observed in Britain, Ireland and France 1999–2005, but could not be found in Spain.

Characters regarded as important were scored for 149 specimens using the treatments by Ehrendorfer & Krendl (1976) and Sell & Murrell (2006), which were also used to check or allocate names for the specimens. The presence or absence of stolons was noted (together with their colour if present). The length, width and the distance along the leaf to the widest point were measured on the longest leaf of each whorl at the lower, middle and upper stem to 0.1 mm accuracy using a graduated lens. The length of the internode above the middle stem leaf whorl was measured. Pedicel length was measured on the terminal flower of the main central axis (this was not always easy to see). The corolla tube, and corolla lobe length and width at the widest point were measured for one accessible flower on each plant. The presence or absence of an appendage to the corolla lobe was assessed under the microscope.

Characters used for the Principal Components Analysis (PCA) are listed in Table 1. Ratios were calculated for leaf length:width, middle internode length:middle leaf length, corolla lobe:tube length and lobe length:width from the measurements. The length to the widest points of the lower, middle and upper leaves was converted into percentages. The data were analysed using Principal Components Analysis with normalised variance-covariance in PAST v1.62 (Hammer *et al.* 2001).

Plants referable to subsp. *occidentalis* were collected from Portland Bill and Ballard Down (v.c. 9), Port Eynon (v.c. 41), Penally Burrows, Shrinkle Haven and Stackpole (v.c. 45), and subsp. *cynanchica* var. *cynanchica* from Banstead Downs (v.c. 17) and Westonbirt (v.c. 33). They were grown in John Innes potting compost in a greenhouse in Cardiff. They flowered freely in cultivation but were mostly short-lived. Unfortunately, the only voucher of all the cultivated plants collected and pressed was one from Penally Burrows (**NMW**).

TABLE 1. *ASPERULA* CHARACTERS USED IN PRINCIPAL COMPONENTS ANALYSIS

A.	Stolons (present/absent)
B.	Lower leaf length
C.	Lower leaf length to widest point
D.	Lower leaf position of widest point
E.	Lower leaf width
F.	Lower leaf length to width ratio
G.	Middle leaf length
H.	Middle leaf length to widest point
I.	Middle leaf position of widest point
J.	Middle leaf width
K.	Middle leaf length:width ratio
L.	Length of middle internode
M.	Middle internode:leaf length ratio
N.	Upper leaf length
O.	Upper leaf length to widest point
P.	Upper leaf position of widest point
Q.	Upper leaf width
R.	Upper leaf length:width ratio
S.	Pedicel length
T.	Corolla lobe length
U.	Corolla tube length
V.	Corolla lobe:tube ratio
W.	Corolla lobe width
X.	Corolla lobe length:width ratio
Y.	Lobe appendages (present/absent)

RESULTS

It was possible to name most of the plants using existing *Asperula* accounts, but four British specimens were intermediate between subsp. *cynanchica* and subsp. *occidentalis* and could not be named with confidence. Material of subsp. *occidentalis* from Spain and France appeared to be larger and distinct from material called subsp. *occidentalis* in the British Isles.

With few exceptions, scoring of most of the characters was straightforward. It was often difficult to decide if the lateral 'stems' without leaves were stolons or rhizomes; where these organs were obviously underground in the original situation, they lacked adventitious roots and were probably best regarded as subterranean stolons rather than rhizomes. The stolons were most prevalent in mat-forming plants ascribed to subsp. *occidentalis*, but the colour was also quite variable and inconsistent, and whilst some roots of subsp. *occidentalis* were strongly and distinctively orange-coloured, some were not. Some underground stolons also

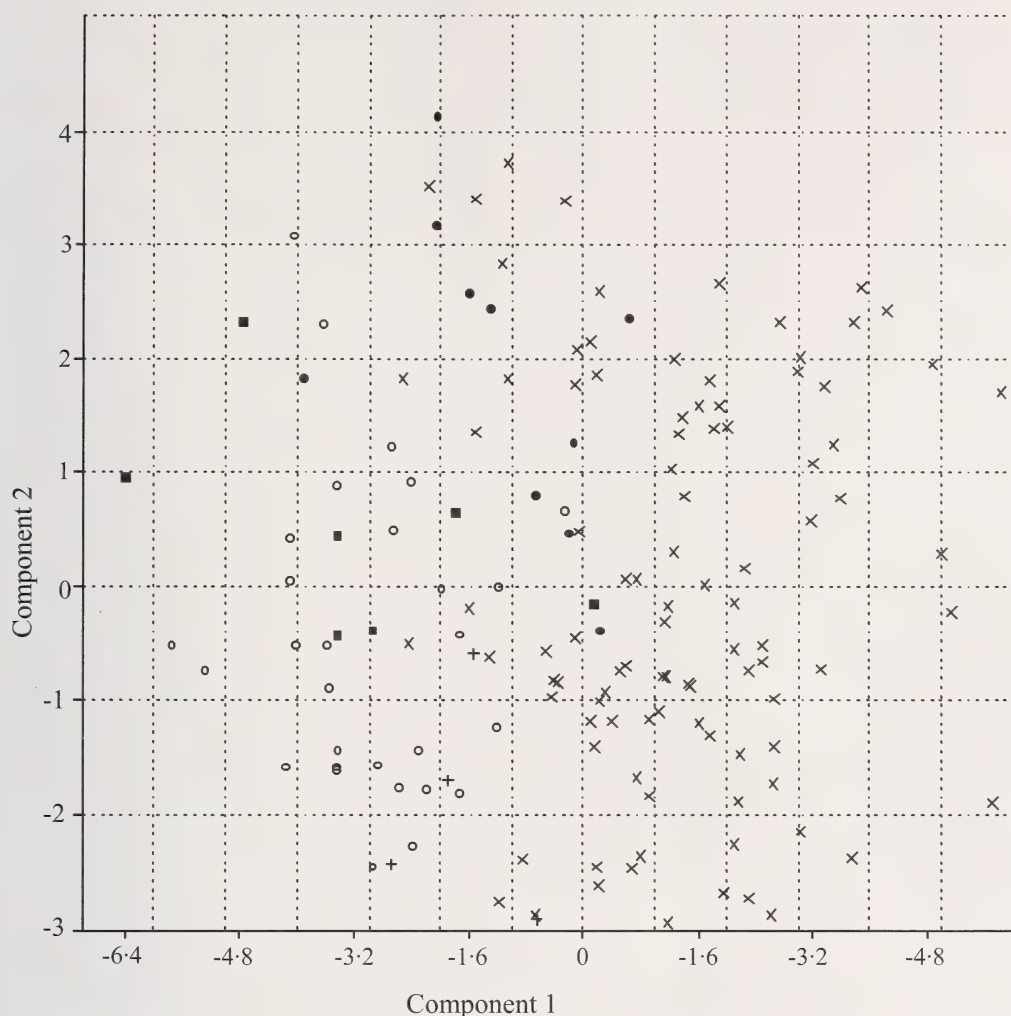


FIGURE 1. PCA of *Asperula cynanchica* taxa. $\times$, *A. cynanchica*, British Isles and Europe. $\bullet$, Subsp. *occidentalis*, Spain/France. $\circ$, 'Subsp. *occidentalis*', British Isles. $\blacksquare$, *A. cynanchica* var. *densiflora* sensu Sell & Murrell, British Isles. $+$, Intermediate between *A. cynanchica* and *A. occidentalis*, British Isles.

clearly bore leaves at some stage, and had presumably been buried by sand or soil, resulting in further upward growth. We do not regard the stolons as providing reliable taxonomic characters. The corolla appendage was not always well defined, even when corollas were soaked in hot water and laid out for careful examination.

The Principal Components Analysis of the all taxa is shown in Figure 1. Axis 1 accounts for 28% of the variation and is the most important for separating the taxa, the major variables being (in decreasing order of importance):

middle leaf length, upper leaf length:width ratio, middle leaf length:width ratio, upper leaf length and length of middle internode. Axis 2 accounts for 13% of the variation but provides little separation between the taxa, the main variables being the lower leaf length:width ratio, and the upper leaf length to widest point. Axis 3 accounts for 9% of the variation and contributed little to separating the taxa.

There is a strong pattern to the variation in Figure 1. Material of Spanish and French subsp. *occidentalis*, including material from the type locality at Biarritz, forms a reasonable cluster

in the top centre, largely distinct from British and Irish material named subsp. *occidentalis* on the left, but overlapping to a degree with subsp. *cynanchica* (British, Irish and continental Europe) on the right. The outlier to the left is a small, dense plant from Biarritz, but is otherwise similar to other subsp. *occidentalis* from the same locality. There is good separation of British and Irish material named subsp. *occidentalis* from subsp. *cynanchica*. There is complete overlap of British and Irish subsp. *cynanchica* var. *densiflora* with British and Irish material named subsp. *occidentalis*. The intermediate plants from England are largely in an area of overlap at the bottom of the figure between subsp. *cynanchica* and British and Irish subsp. *cynanchica* var. *densiflora* and subsp. *occidentalis*.

Separate Principal Components Analyses comparing subsp. *cynanchica* with British and Irish subsp. *occidentalis*, and comparing French/Spanish subsp. *occidentalis* with British and Irish subsp. *occidentalis* show better separation compared to Figure 1 (as might be expected for simpler data sets), whilst French/Spanish subsp. *occidentalis* still cluster within the variation in subsp. *cynanchica* when compared separately (data not presented).

All plants flowered and fruited freely in cultivation. The subsp. *occidentalis* plants retained their prostrate, dense habit and looked very similar to the wild plants, other than becoming slightly larger. Both subsp. *cynanchica* plants became larger and sprawling.

DISCUSSION

The morphological analyses indicate that there are three taxa which differ mainly in quantitative characters: subsp. *cynanchica*, subsp. *occidentalis* from France/Spain, and a third taxon which includes subsp. *cynanchica* var. *densiflora* and British and Irish material which has been called subsp. *occidentalis*. We do not accept that subsp. *occidentalis* occurs in the British Isles.

Asperula cynanchica is a variable taxon, and it remains to be seen whether true subsp. *occidentalis* from France and Spain is best retained within *A. cynanchica* or restored to a species in its own right. Its relegation to subspecific status was based on observations of

material from both the continent and the British Isles (pers. comm. C. A. Stace 2007), but the latter part of that material we now refer to subsp. *cynanchica* var. *densiflora*. Although our Principal Components Analysis shows that subsp. *occidentalis* is nested within the variable subsp. *cynanchica*, it is based on relatively few specimens of subsp. *occidentalis* and the inclusion of further samples might improve its definition. Rouy (1903) described two varieties of *A. occidentalis* at Biarritz, *α. galiiformis* and *β. cynanchiciformis*, the former small and dense, the latter more lax. This variation is also evident in the duplicates collected there later by E. J. Neyraut (LY, MA, P). These seem to be forms of the same taxon related to growth conditions, which could be verified by cultivation experiments. We suggest that no further taxonomic changes are made until a wider review of *A. cynanchica* and its close relatives throughout Europe is undertaken.

We also suggest that the name var. *densiflora* (as used by Sell & Murrell 2006) can be used for the third taxon (i.e. including British and Irish material which has been called subsp. *occidentalis*) until the full infraspecific variation in *A. cynanchica* has been reviewed. Var. *densiflora* was described by Grenier & Godron (1852) as having "Fleurs plus nombreuses; tiges plus courtes, plus ramassées et plus étalées" [Flowers more numerous; stems shorter, more branched and prostrate], and they recorded its habitat as dunes of the Atlantic and Mediterranean coasts. This description fits the British and Irish plants reasonably well, but we have not attempted to trace types. Rouy (1903) also listed nine other varieties in France.

Although var. *densiflora* maintains its growth form in cultivation, some populations look slightly different one to another, with Irish material in particular being somewhat variable. The South Wales material is relatively uniform. Our current feeling is that the dense, prostrate growth form may have originated a number of times from local *A. cynanchica* in response to the strong environmental selection pressure in coastal habitats, and is thus polyphyletic. This could be easily tested using molecular methods.

Diagnostic descriptions of the taxa from our data are given below. Measurements are presented as (minimum–) 10 percentile–90 percentile (–maximum).

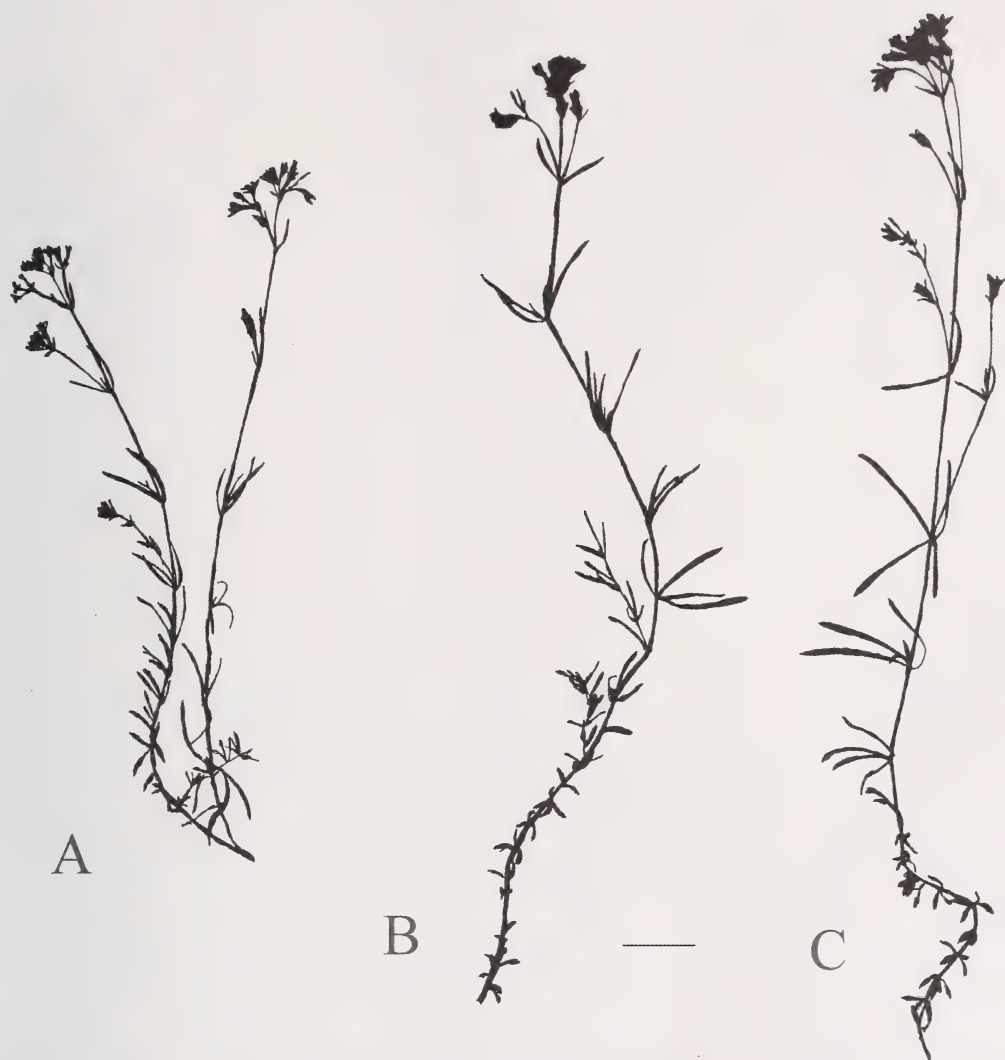


FIGURE 2. *Asperula cynanchica* var. *cynanchica* silhouettes. A, Petersfield (v.c. 12). B, Babraham (v.c. 29). C, White Horse Hill (v.c. 22). Scale bar 1 cm.

***Asperula cynanchica* L. subsp. *cynanchica* var. *cynanchica* (Fig. 2).**

Plant slender, lax, stems weakly ascending, stolons sometimes present, brownish. Lower stem leaves (2.5–)3–7(–13) mm × (0.3–)0.5–1.2(–2.1) mm, (1.7–)3–13(–20) times as long as wide. Middle stem leaves (5.6–)7–19(–26) mm × (0.3–)0.5–1.1(–2) mm, (4.6–)9–28(–45) times as long as wide. Middle internode (4–)8.6–27(–44) mm, (0.5–)0.9–2.4(–4.4) times as long as adjacent leaf. Upper stem leaves (5–)8–19(–35) mm × (0.4–)0.5–1(–1.5), (6.4–)10–32

(–50) times as long as wide. Inflorescence lax. Terminal pedicel (0–)0.4–1.1(–1.6) mm. Corolla tube (0.4–)0.6–1.1(–1.5) mm, (0.3–)0.4–0.7(–0.9) times as long as lobe. Corolla lobe (1–)1.3–2.2(–2.8) mm × (0.4–)0.5–1.1(–1.4), lobe (1.3–)1.6–3.2(–4.5) longer than wide. Lobe appendages usually present.

Distribution: Widespread in Europe on calcareous grasslands and occasionally on dunes. The map in Preston *et al.* (2002) shows its distribution in southern Britain and Ireland, though it is rarer in South Wales than var. *densiflora*.

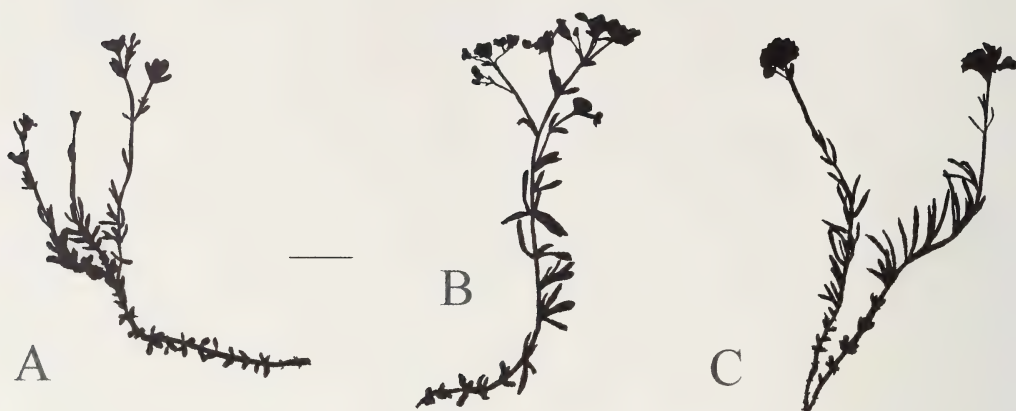


FIGURE 3. *Asperula cynanchica* var. *densiflora* silhouettes. A, B. Whorlebury Hill (v.c. 6). C. Bembridge (v.c. 10). Scale bar 1 cm.

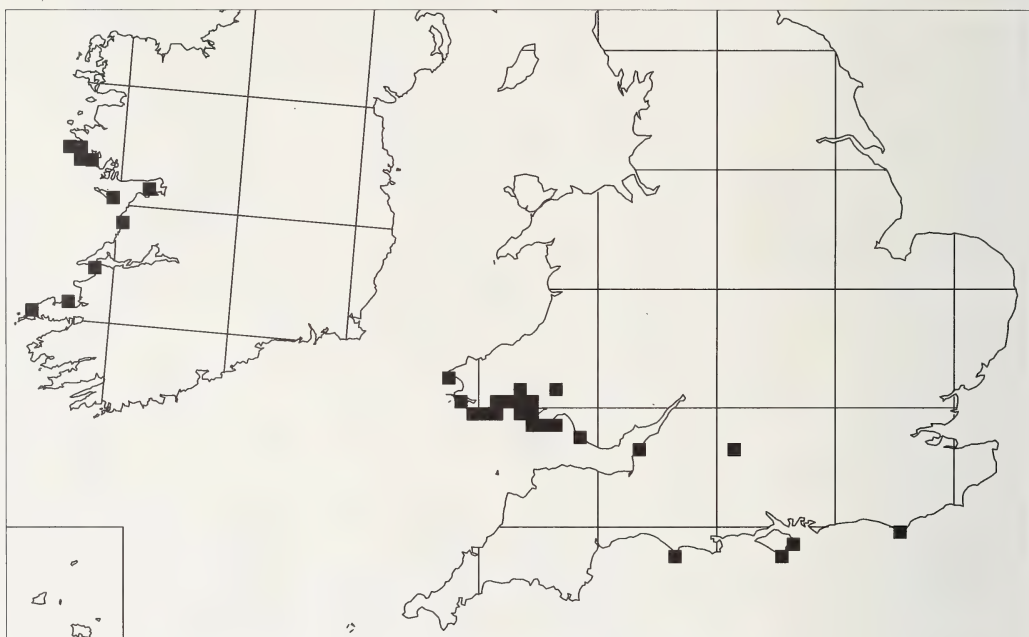


FIGURE 4. Distribution of *Asperula cynanchica* var. *densiflora* in the British Isles.

Asperula cynanchica L. subsp. *cynanchica* var. *densiflora* Gren. & Godr. (Fig. 3).

Plant small, compact, often mat-forming, prostrate, stolons brown or brownish-orange, or absent. Lower stem leaves (1-)2.3-4.2(-4.6) mm $\times$ (0.4-)0.6-1.4(-2.0) mm, (1.9-)2.1-5.7(-9.8) times as long as wide. Middle stem leaves (3.2-)4.2-9(-14) mm $\times$ (0.4-)0.6-1.4(-2) mm, (3-)4-11(-18) times as long as wide. Middle

internode 3-12(-16) mm, (0.5-)0.6-1.5(-2.3) times as long as adjacent leaf. Upper stem leaves 4-10(-15) mm $\times$ (0.4-)0.5-1.3(-1.7) mm, (4-)5.5-13(-19) times as long as wide. Inflorescence crowded. Terminal pedicel (0.2-)0.3-1.6(-1.7) mm. Corolla tube (0.8-)1-1.5(-1.6) mm, (0.4-)0.6-1 times as long as lobe. Corolla lobe (1-)1.3-1.9(-2.3) mm $\times$ (0.4-)0.6-1.3 mm, (1.2-)1.3-2.5(-2.8) times as long as wide. Lobe appendages distinct, weak or absent.



FIGURE 5. *Asperula cynanchica* subsp. *occidentalis* silhouettes. A, Liencres, Spain. B, C, Biarritz, France. D, El Tijo, Spain. Scale bar 1 cm.

Distribution: Southern Britain and Ireland (Figure 4), France, possibly elsewhere in Europe too. It is most frequent near the coast on sea cliffs and sand dunes, but may also occur inland. Some herbarium specimens contain a mixture of material suggesting that both varieties can grow together. Details of the specimens seen are given in Appendix 1.

Asperula cynanchica L. subsp. *occidentalis* (Rouy) Stace (Fig. 5).

Plant large, lax, stolons usually present, sometimes absent, bright orange or brown.

Lower stem leaves (2.3–)2.8–5.1(–7.8) mm × 0.9–1.9(–2.6), (1.5–)2–5.5(–6.5) times as long as wide. Middle stem leaves (5.8–)8–11(–13.5) mm × (0.7–)0.8–1.5(–1.8) mm, (3.9–)4.5–13(–17) times as long as wide. Middle internode 5–14(–17) mm, 0.6–1.4 times as long as adjacent leaf. Upper stem leaves (7.6–)9–15.3 mm × 0.7–1.1(–1.5), (7–)9–17(–21) times as long as wide. Inflorescence lax. Terminal pedicel 0–0.3(–0.4) mm, often very short. Corolla tube 0.9–1.2(–1.3) mm, 0.5–0.8 times as long as lobe. Corolla lobe (1.2–)1.4–2.1 mm × 0.4–1.1 mm, 1.5–3.6 times as long as wide. Lobe appendages always present.

Distribution: France (Basses-Pyrenees only; Ruderon (1995)) and northern Spain (Asturias, Cantabria, Guipúzcoa, Vizcaya) on calcareous grasslands and dunes. The specimens seen are cited in Appendix 2.

We have not seen voucher material of the records on the French flora website (www.tela-botanica.org) for Normandy but suspect they are likely to refer to var. *densiflora*, and the specimen from Le Poulignes, Loire-Inferior (P) is var. *densiflora*. We have no reason to doubt records cited in the Spanish flora website

(Poryecto Anthos: www.anthos.es) for northern Spain as they have been revised recently for *Flora Iberica*.

ACKNOWLEDGMENTS

We are grateful to the Keepers of CGE, DBN, MA, P and RNG for access to or loan of material, and to Gaëtan Guignard (LY) for images of the Rouy types, and Jerome Sawtschuk for help with translation. The map was plotted using DMAPW by Alan Morton.

KEY

1. Middle stem leaves (5–)7–19(–26) mm long, (5–)9–28(–45) times as long as wide and (0·5–)0·9–2·4(–4·4) times as long as adjacent leafsubsp. *cynanchica* var. *cynanchica*
1. Middle stem leaves (3–)4–11(–14) mm long, 4–13(–18) times as long as wide and (0·5–)0·6–2·3 times as long as adjacent leaf2
2. Terminal pedicel (0·2–)0·3–1·6(–1·7) mm; corolla lobe appendages distinct, weak or absentsubsp. *cynanchica* var. *densiflora*
2. Terminal pedicel 0–0·3(–0·4) mm, often very short; corolla lobe appendages distinctsubsp. *occidentalis*

REFERENCES

- CLAPHAM, A. R., TUTIN, T. G. & MOORE, D. M. (1987). *Flora of the British Isles*. 3rd edition. Cambridge University Press, Cambridge.
- CONTEJEAN, M. Ch. (1865). Note sur quelques plantes rare ou critique du midi de la France. *Bulletin de la Société Botanique de France* **12**: 217–221.
- EHRENDORFER, F. & KRENDL, F. (1976). *Asperula* L., in TUTIN, T. G., HEYWOOD, V. H., BURGESS, N. A., MOORE, D. M., VALENTINE, D. H., WALTERS, S. M. & WEBB, D. A. (1976). *Flora Europaea* **4**: 4–14. Cambridge University Press, Cambridge.
- GRENIER, J. C. M. & GODRON, D. A. (1852). *Flore de France*, **2**. E. Savy, Paris.
- HAMMER, Ø., HARPER, D. A. T. & RYAN, P. D. (2001). PAST: Paleontological Statistics Software Package for Education and Data Analysis. *Palaeontologia Electronica* **4**(1): 9pp. http://palaeo-electronica.org/2001_1/past/issue1_01.htm.
- PRESTON, C. D., PEARMAN, D. A. & DINES, T. D. (2002). *New Atlas of the British and Irish flora*. Oxford University Press, Oxford.
- RICH, T. C. G. & JERMY, A. C. (1998). *Plant Crib 1998*. Botanical Society of the British Isles, London.
- ROUY, G. (1903). *Flore de France*. Volume 8. Asnières, Paris & Rochefort.
- RUDERON, J.-P. (1995). *Inventaire des plants protégées en France*. Éditions Nathan, Paris.
- SELL, P. D. & MURRELL, G. (2006). *Flora of Great Britain and Ireland. Volume 4. Campanulaceae to Asteraceae*. Cambridge University Press, Cambridge.
- STACE, C. A. (1989). New combinations in the British and Irish flora. *Watsonia* **17**: 444.
- STACE, C. A. (1997). *New flora of the British Isles*, 2nd ed. Cambridge University Press, Cambridge.
- TUTIN, T. G. & CHATER, A. O. (1974). *Asperula occidentalis* Rouy in the British Isles. *Watsonia* **10**: 170–171.
- WEBB, D. A. & SCANNELL, M. J. P. (1983). *Flora of Connemara and the Burren*. Royal Dublin Society and Cambridge University Press, Cambridge.

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APPENDIX 1
BRITISH AND IRISH SPECIMENS OF *ASPERULA CYNANCHICA*
VAR. *DENSIFLORA* SEEN

ENGLAND

Worlebury Hill (V.c. 6), 14 Aug 1887, J. W. White (**CGE**, **NMW**). Worle Hill, Weston Super Mare (v.c. 6), June 1842, G. W. H. Thwaites (**CGE**). Marlborough (v.c. 7), 8 July 1885, E. S. Marshall, (**CGE**). Kingsdown [Kingston?] (v.c. 9), 15 June 1899, E. F. Linton (**NMW**). Portland (v.c. 9), 1837, A. Bloxham (**CGE**). Church Ope Cove, Portland (v.c. 9), 6 July 2000 and 11 August 2003, T Rich (**NMW**). Ventnor (v.c. 10), August 1834, F. Ballard (**NMW**). Golf links at sea level, Bembridge (v.c. 10), 12 July 1905, Miss C. Bickham (**CGE**). Bembridge (v.c. 10), July 1829, W. Annesley (**CGE**, left hand specimen). Short turf near cliff edge, Beachy Head (v.c. 14), July 1955, F. Rose (**NMW**).

WALES

Near Swansea (v.c. 41), 1835, T. A. Babington (**CGE**). Nottage (v.c. 41), 1891, A. H. J. (**NMW**). Near Rhossili (v.c. 41), 25 May 1953, B. A. Miles (**CGE**). Rhossili cliff (v.c. 41), 28 May, 1929 (**NMW**). On limestone on Gower (v.c. 41), June 1835, T. A. Babington (**CGE**). Langland Cliff, Gower (v.c. 41), 16 June 1928, V. M. Peel (**NMW**). Mumbles Hill (v.c. 41), 6 June 1993, G. Hutchinson (**NMW**). Mumbles Head (v.c. 41), 4 June 1997, T. Rich (**NMW**). Horton Dunes, Gower (v.c. 41), 28 June 1945, J. A. Webb (**NMW**), and undated, Anon (**NMW**). Limestone cliffs between Langland and Caswell Bay (v.c. 41), 30 May 1909, G. R. Willan (**NMW**). Whitford Burrows (v.c. 41), July 1993, P. Russell (**NMW**). Porthcawl (v.c. 41), 1905, A. H. J. (**NMW**), 7 June 1901, W. A. Shoolbred (**NMW**) and 17 June 1931, A. E. Wade (**NMW**). Kenfig, 3 July 1982, H. J. M. Bowen (**RNG**). Pennard Castle (v.c. 45), June 1920, E. N. Thomas (**NMW**), and 1971, R. A. Boniface (**NMW**). Pembrey Local Nature Reserve (v.c. 44), 5 July 2000, R. D. Pryce & K. A. Cottingham (**NMW**). Carreg Cennan (v.c. 44), 15 July 1945, J. A. Webb (**NMW**). Pembrey (v.c. 44), 8 July 1936, J. M. Lewis (**NMW**). Laugharne Burrows (v.c. 44), 1987, J. Rees (**NMW**). Dry dunes, Laugharne Burrows (v.c. 44), 4 July 1982, R. D. Pryce (**NMW**). Sand dunes, Burry Port (v.c. 44), 13 July 1967, J. R. Gates (**NMW**). Pendine Dunes (v.c. 44), 28 June 1952 (**NMW**). Whitesand Bay (v.c. 45), 5 April 1975, R. M. Burton (**NMW**). Cliff, Barafundle Bay (v.c. 45), 25 July 1960, A. C. Powell (**NMW**). Wall on the Burrows, Tenby (v.c. 45), 1881, J. Sidebotham (**CGE**). Tenby (v.c. 45), 19 August 1848, C. C. Babington (**CGE**). Tenby Burrows, 2 July 1931, E. C. Howells (**NMW**). Giltar Point, 12 July 1999, T. Rich (**NMW**). Lydstep, 12 July 1999, T. Rich (**NMW**). Saddle Point (v.c. 45), 23 July 1999, T. Rich (**NMW**). Angle (v.c. 45), 1871, illeg. (**CGE**). Sand dunes, Penally, 2 August 1975, J. E. Lousley (**RNG**).

IRELAND

Smerwick Cove (v.c. H2), 13 July 1841, C. C. Babington (**CGE**). Abundant on the sandhills, Castlegregory (v.c. H2), 24 June 1902, E. S. Marshall (**CGE**, **NMW**). Sandhills, Lehinch (v.c. H9), 8 August 1893, H. C. Levinge (**DBN**) and July 1880, R. M. Barrington (**DBN**). Muckinish, Ballyvaughan (V.c. H9), 23 August 1895, N. Colgan (**DBN**, sand hill form). Near Kilmnovie, Aran Isles (v.c. H9), 5 September 1976, M. Scannell (**DBN**). Ballybunion (v.c. H16), August 1866, M. Barrington (**DBN**). Bunowen peninsular (H16), 16 June 1974, M. Scannell (**DBN**). Sandy ground, Mannim (v.c. H16), September 1979, M. Scannell (**DBN**), and 23 August 1974, D. McClintock (**RNG**). Dogs Bay (v.c. H16), 1966, F. Rose (**NMW**). Roundstone (v.c. H16), undated, R. M. Barrington (**DBN**). Near the beaches near Roundstone (v.c. H16), 12 September 1873, C. C. Babington (**CGE**).

APPENDIX 2

SPECIMENS OF *ASPERULA CYNANCHICA* SUBSP. *OCCIDENTALIS* SEEN

FRANCE

Biarritz, côte des basques, entre parents, 18 September 1869, M. Ch. Contejean (**LY**, holotype of var. *galiiformis*); sables maritime, May 1878, Bordère, (**LY**, holotype of var. *cynanchiciformis*); coastal sand dunes, 9 August 1903, E. J. Neyraut (**LY**, **MA** nos. 117219 and 117218, **P**).

SPAIN

Cantabria, Meron, San Vicente de la Barquera, sand dunes, 30 August 1983, C. Aedo (**MA** no. 622313). El Tejo, Santander, 18 August 1968, M. R. de la Fuente (**MA** no. 682797) and dunes, 30 June 1969, M. R. de la Fuente (**MA** no. 682794). Liencres, Santander, dunes, 18 May 1969, M. R. de la Fuente (**MA** no. 682798) and 24 May 1969, M. R. de la Fuente (**MA** no. 682799). Cuchia, Santander, 2 July 1971, M. R. de la Fuente (**MA** no. 682796). Loreda, Ribamontan al Mar, dunes, 12 June 1993, M. R. de la Fuente (**MA** no. 682795), and 19 May 1990, C. Aedo (**MA** no. 622378). Loreda, Santander, Port-duna-arenosa, 7 October 1979, M. R. de la Fuente (**MA** no. 682825).

Pollen studies in British *Hieracium* sect. *Alpina* (Asteraceae)

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ABSTRACT

A survey of pollen production in British *Hieracium* sect. *Alpina* (Asteraceae) taxa has been undertaken using Alexander's Stain as a test for potential pollen viability. Diploid *H. alpinum* s.s. from Europe produces abundant, well-formed, stainable pollen. No pollen was observed in British *H. alpinum* s.s. Potentially viable pollen was observed in 14 of the 39 sect. *Alpina* taxa investigated, including *H. holosericeum* (triploid), *H. leptodon* (tetraploid) and *H. pentaploideum* (pentaploid), sometimes in abundance. Cultivated plants were more likely to have pollen than wild plants, suggesting pollen production may be under both environmental and genetic control. The involvement of pollen should be considered in theories of evolution of *Hieracium* sect. *Alpina*.

KEYWORDS: *Hieracium alpinum*, pollen viability, Alexander's Stain, Britain.

INTRODUCTION

As far as it is known, all the British taxa of *Hieracium* sect. *Alpina* (Griseb.) Gremli are polyploid, obligate apomicts (Stace *et al.* 1997). In Britain, the taxa are triploid ($3n = 27$), tetraploid ($4n = 36$), or rarely pentaploid ($5n = 45$) (Stace *et al.* 1995). The apomictic reproductive system is by diplospory (as has been shown for *H. alpinum* sensu stricto by Skawińska (1962)), in which the embryo is derived directly from an unreduced archesporial cell, with no male gamete input either to the embryo, or for formation of the endosperm (i.e. they are not pseudogamous). Thus reproduction in these British apomictic polyploids is essentially clonal, with progeny genetically identical to the mother and to each other. In Europe, both diploids and polyploids occur in sect. *Alpina*. Chrtek (1997) and Štrochová *et al.* (2002) showed that *H. alpinum* in the eastern Carpathians is a diploid, sexual, self-incompatible taxon, with apomictic triploid clones elsewhere (including Britain) which did not produce pollen.

The main theory to explain the evolution of polyploid apomictic groups such as *Hieracium* sect. *Alpina* is that they have evolved through hybridisation. Hybridisation may have occurred between two sexual taxa, with the progeny subsequently becoming apomictic and polyploid independently. Alternatively, hybrids might have arisen from pollination of a sexual species by an apomictic polyploid whose apomictic genes are then expressed in subsequent generations. A combination of both mechanisms may have occurred. Other possible speciation mechanisms include point mutations, 'pseudo-sexual' recombination among different copies of the same chromosomes within the mother, and chromosome structural mutations which simultaneously affect numerous genes and traits (Tyler 2006).

Of the British sect. *Alpina* 34 of the 35 species are endemic, but it is not known where they originated or what their parentages are (Stace *et al.* 1997). As diploid *H. alpinum* is currently only known from the Carpathians, and is also the only known diploid in sect. *Alpina*, it is possible that some of our endemics originated in the Carpathians and then migrated to Britain. For the taxa to then become endemic to Britain, they would need to evolve independently in Britain and/or Europe, and diverge so much that they are recognised as distinct taxa. Alternatively, it is possible that diploid *H. alpinum* migrated to Britain after the last glacial period, gave rise to some of our endemics and then died out. The British endemics could also have arisen from some closely related sexual taxa, not necessarily diploids, which had migrated to Britain.

Stace *et al.* (1997) investigated the cytological and molecular variation in British sect. *Alpina*, and found that despite being apomictic, there is genetic variation both between and within taxa. The origin of the variation could be explained in parts by mutations, polyphyletic origin and relics of sexual hybridisations. As the amount of genetic variation

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observed was low, they suggested that the same or similar sexual parents, both diploid and probably tetraploid, gave rise repeatedly to a series of different diploid, triploid, tetraploid and pentaploid hybrids in more than one locality. They suggested that if diploid *H. alpinum* had been present in Britain, it may have died out due to low seed set due to its requirement for cross-pollination which would have been unpredictable in our suboptimal climate. The low levels of genetic diversity within the sect. *Alpina* species also suggested recent origins (presumably post-glacial), with some subsequent mutations.

As part of work trying to understand evolution of the British sect. *Alpina* endemics, a survey of pollen production was undertaken using Alexander's Stain (Alexander 1969). Alexander's Stain stains the outside of the pollen grain greenish-blue and cytoplasm inside red, so well-formed pollen grains with cytoplasm (which are potentially viable) can be picked out quickly. It is a quick method to screen many plants, including historical herbarium specimens, for potential fertility, but does not prove that the grains are viable. It is generally reported that the polyploid *Hieracium* apomicts produce no pollen or only small amounts of inviable pollen (e.g. Stace *et al.* 1997), but we have recently observed reasonable quantities of apparently viable pollen in both herbarium specimens and living material. The involvement of pollen in sexual reproduction might help to explain evolution in the genus and the concentrations of endemic species. *Hieracium alpinum* was investigated in detail due to the potential role of sexual diploids in the origin of the endemics, with a selection of material of the remaining British species of sect. *Alpina* for comparison.

METHODS

Pollen samples of British *H. alpinum* were taken from herbarium specimens in BM, E and NMW, aiming to cover as much of the geographic range as possible. Diploid material from Europe was provided by P. Mráz. Specimens of the remaining British sect. *Alpina* species were sampled in NMW. The accession numbers of all herbarium sheets examined are listed in Appendix 1.

Capitula were examined under a microscope and the ring of anthers removed from florets about to open, or where not available from recently opened florets with emerging styles,

using tweezers and a low-power binocular microscope. At least two florets from each specimen were examined, sometimes more. The anthers were placed onto a slide with a drop of Alexander's Stain, warmed briefly on the hotplate, then broken up with the tweezers to release the pollen, and the tissue 'stroked' to free the pollen grains stuck inside the anthers. The preparation was then covered with a cover slip and either placed onto a hotplate to improve the uptake of the stain for at least five minutes or left overnight.

The slides were then examined under a high-power compound binocular microscope. The areas on the slide with high numbers of pollen grains were sampled to estimate the percentage of fertile grains. Grains present on the stigmas were ignored as they may have come from another source. Numbers of potentially fertile and infertile grains were recorded, and the percentage fertility calculated.

RESULTS

Two main types of pollen grains were found. First, spherical grains with the cytoplasm inside which stained bright red and thick papillate cell walls which stained green. The grains could vary in size, sometimes more so in one species than another. These pollen grains were taken as potentially viable. Second, spherical grains staining green only, with no red staining inside (i.e. no cytoplasm). These were sometimes smaller in size than those with cytoplasm, but very few were deformed. These grains were considered infertile.

Potential pollen viability in European material of diploid *H. alpinum* is shown in Table 1. The specimens examined generally produced abundant, well-formed pollen of uniform size which had a high stainability.

In contrast, no pollen was found in the 85 British *H. alpinum* herbarium specimens, apart from in two specimens of doubtful origin or identification. The locations of *H. alpinum* specimens from which we have examined for pollen are shown in Figure 1.

Surprisingly, 14 of the 39 British *Hieracium* sect. *Alpina* taxa produced large amounts of pollen (Table 2). Where pollen was present within a taxon, it was not necessarily present in all individuals examined, and it varied in quantity between individuals. Furthermore, potential viable pollen was observed across the three higher ploidy levels (Table 3) including *H. holosericeum* (triploid), *H. leptodon* (tetraploid) and *H. pentaploideum* (pentaploid).

TABLE 1. POTENTIAL POLLEN VIABILITY IN DIPLOID *H. ALPINUM*. (TOTAL NUMBER OF POLLEN GRAINS COUNTED ARE GIVEN IN BRACKETS)

Origin	No. florets examined	Potential pollen viability
Chornohora Mountains, Ukraine, plant 1	2	99% (n = 50)
Chornohora Mountains, Ukraine, plant 2	2	99% (n = 50)
Chornohora Mountains, Ukraine, plant 3	2	41% (n = 86)
Rodna Mountains, Romania	2	99% (n = 50)
Bucegi Mountains, Romania	2	96% (n = 50)

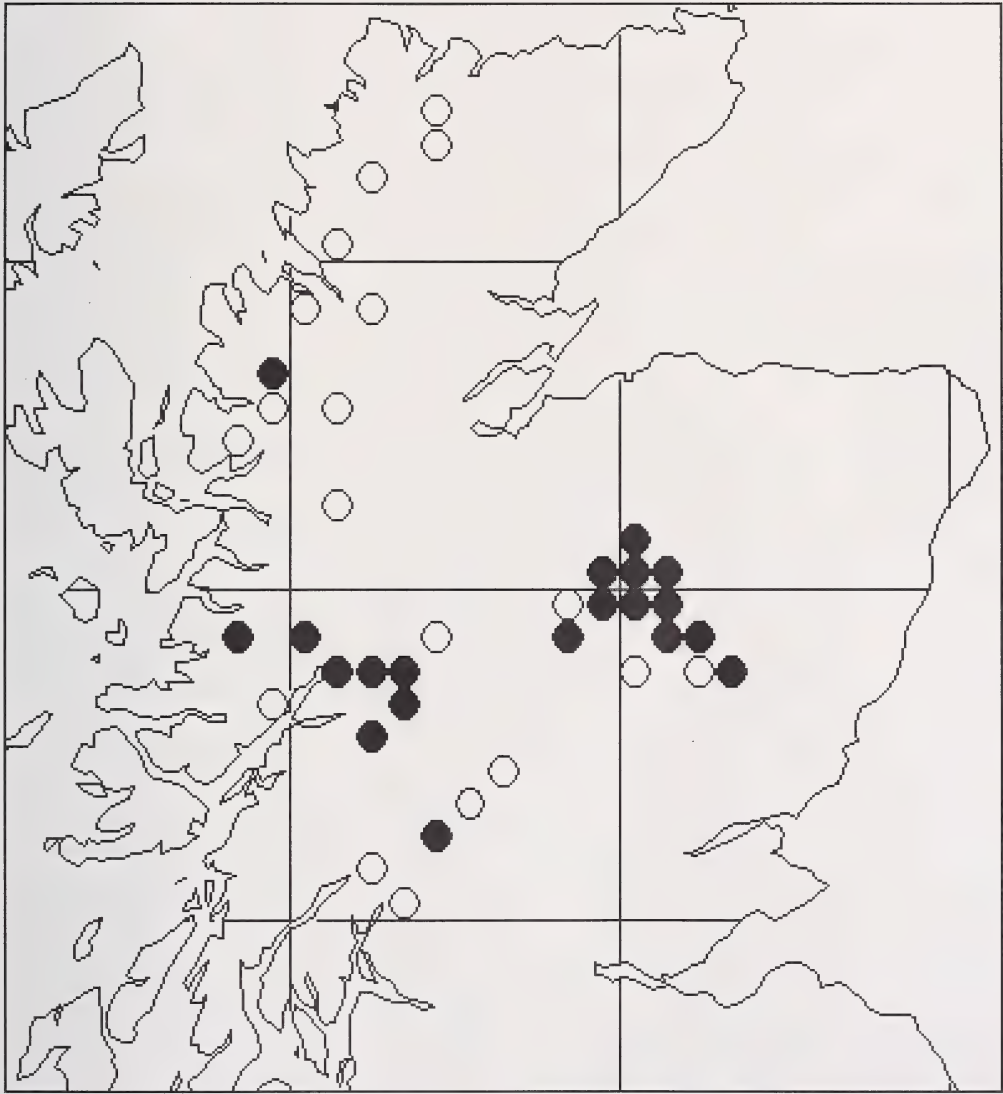


FIGURE 1. Localities from which no pollen was found in the 85 *Hieracium alpinum* herbarium specimens examined (●). Other *H. alpinum* localities from which no material has been examined (○). All records are shown irrespective of date.

TABLE 2. POLLEN PRODUCTION IN BRITISH SECT. *ALPINA* SPECIES. PLOIDY LEVELS ARE TAKEN FROM STACE *ET AL.* (1995, 1997). TOTAL NUMBER OF POLLEN GRAINS COUNTED ARE GIVEN IN BRACKETS

Taxon	Ploidy	No. plants examined	Potential pollen viability (%)
<i>H. backhousei</i> F. J. Hanb.	×4	2	No pollen
<i>H. calenduliflorum</i> Backh.	×4	2	No pollen
<i>H. calvum</i> P. D. Sell & D. J. Tennant	×4	2	No pollen
<i>H. completum</i> P. D. Sell & C. West	×4	3	45% (n = 115), 2 plants no pollen
<i>H. deargicola</i> P. D. Sell & D. J. Tennant	×4	1	No pollen
<i>H. einichense</i> P. D. Sell & D. J. Tennant	×4	1	No pollen
<i>H. eximium</i> Backh.	×4	3	No pollen
<i>H. eximium</i> Backh. f. <i>eximium</i>	×4	2	No pollen
<i>H. eximium</i> Backh. f. <i>tenellum</i> (Backh.) P. D. Sell & C. West	×4	3	No pollen
<i>H. globosiflorum</i> Pugsl.	×3	3	No pollen
<i>H. graniticola</i> W. R. Linton	×3	2	No pollen
<i>H. grovesii</i> Pugsl.	×4	3	11% (n = 63), 13% (n = 111), 6% (n = 63)
<i>H. hanburyi</i> Pugsl. f. <i>hanburyi</i>	×4	12	No pollen
<i>H. hanburyi</i> Pugsl. f. <i>atraceps</i> (Pugsl.) P. D. Sell & D. J. Tennant	×4	2	4% (n = 22), 1 plant no pollen
<i>H. hanburyi</i> Pugsl. f. <i>pusillum</i> P. D. Sell & D. J. Tennant	×4	1	No pollen
<i>H. holosericeum</i> Backh.	×3	10	24% (n = 50), 8% (n = 50), 8 plants no pollen
<i>H. insigne</i> Backh. f. <i>insigne</i>	×4	1	Underdeveloped pollen
<i>H. insigne</i> Backh. f. <i>celsum</i> P. D. Sell & C. West	×3 or ×4	5	35% (n = 47), 12% (n = 68), 100% (n = 31), 34% (n = 89), 1 plant no pollen
<i>H. kennethii</i> P. D. Sell & D. J. Tennant	×4	1	8% (n = 23)
<i>H. larigense</i> (Pugsl.) P. D. Sell & C. West	unknown	1	No pollen
<i>H. leptodon</i> P. D. Sell & D. J. Tennant	×4	6	64% (n = 62), 46% (n = 90), 33% (n = 24), 3 plants no pollen
<i>H. macrocarpum</i> Pugsl.	×4, ×4 +1	3	86% (n = 50), 2 plants no pollen
<i>H. marginatum</i> P. D. Sell & C. West	×4	2	94% (n = 72), 61% (n = 103)
<i>H. memorabile</i> P. D. Sell & C. West	×4	4	No pollen
<i>H. milesii</i> P. D. Sell & C. West	×4	3	No pollen
<i>H. mundum</i> P. D. Sell & C. West	×4	2	29% (n = 106), 1 plant no pollen
<i>H. notabile</i> P. D. Sell & C. West	×4	2	No pollen
<i>H. optimum</i> P. D. Sell & C. West	unknown	2	No pollen
<i>H. pensum</i> P. D. Sell & C. West	×4	1	25% (n = 5)
<i>H. pentaploideum</i> P. D. Sell & D. J. Tennant	×5	2	68% (n = 69), 100% (n = 50)
<i>H. perscitum</i> P. D. Sell & C. West	×4	2	24% (n = 148), 1 plant no pollen
<i>H. probum</i> P. D. Sell & C. West	×4	5	No pollen
<i>H. pseudocurvatum</i> (Zahn) Pugsl.	×3	1	No pollen
<i>H. pseudopetiolatum</i> (Zahn) Roffey	×3	3	12% (n = 26), two plants no pollen
<i>H. subglobosum</i> P. D. Sell & C. West	×3	4	1% (n = 50), 3 plants no pollen
<i>H. subgracilentipes</i> (Zahn) Roffey	×4	1	No pollen
<i>H. subtenuifrons</i> P. D. Sell & D. J. Tennant	×3 or ×4	3	No pollen
<i>H. tenuifrons</i> P. D. Sell & C. West	×4	4	36% (n = 112), 68% (n = 105), 2 plants no pollen

TABLE 3. NUMBER OF TAXA IN EACH PLOIDY LEVEL AND POLLEN PRODUCTION IN BRITISH SECT. *ALPINA* SPECIES

Ploidy	Total no. taxa	Pollen absent	Significant pollen production
×3	6	4	2
×3 or ×4	2	1	1
×4*	27	16	11
×5	1	0	1
Total	36	21	15

*includes *H. macrocarpum* aneuploid

It is unclear why pollen should be present in some individuals of a taxon, but absent in others. We noticed that cultivated plants were more likely to have pollen than plants collected from the wild. For instance, in *H. subglobosum*, the cultivated specimen had masses of pollen (although with only 1% viability) but the wild-collected plants had none. Excluding *H. alpinum*, 13 of the 28 cultivated specimens of sect. *Alpina* species had pollen (46%), compared to only 14 of the 87 wild-collected specimens (24%); this is significantly different (χ^2 , $p < 0.001$).

DISCUSSION

The key result is the observation that although no pollen was observed in British *H. alpinum*, significant amounts of potentially viable pollen were observed in over a third of the other sect. *Alpina* taxa. The stain does not prove that pollen is viable, which must be tested by germinating fresh pollen from cultivated plants, but the presence of pollen nonetheless suggests the possibility that it might have a role in evolution of the endemics.

Our survey of pollen on herbarium specimens shows there is no evidence that diploid *H. alpinum* occurs in Britain. Although there are only counts of three plants from two localities published (Stace *et al.* 1995), it is presumably uniformly triploid. Štrochová *et al.* (2002) showed allozyme and RAPD variation occurred within and between populations of the triploid cytotype of *H. alpinum*, and the geographic and genetic distances were found to be correlated, indicating isolation by distance. They interpreted the gradient of genetic variation observed from the variable diploids in the Eastern Carpathians to the uniform triploids elsewhere as resulting from the post-glacial recolonization of Europe from glacial refugia

in the Carpathians. Diploids may therefore never have been present in Britain.

If diploid *H. alpinum* has never been present in Britain, did the endemic taxa evolve here by hybridisation or migrate? The endemics are unlikely to have evolved from hybridisation with diploids in Britain as the only sexual, diploid species of *Hieracium* present is *H. umbellatum* L., which is so morphologically different that it cannot have been involved. The occurrence of pollen in polyploids suggests that the endemics could have evolved by hybridisation between some endemic taxa if the polyploids are partly sexual: this would require both fertile pollen and a diplospory apomictic reproductive system that is not absolute (i.e. occasional fusion of gametes may occur). Detection of such hybrids within sect. *Alpina* would be difficult as the species are generally very similar, differing in few characters and showing a reticulate pattern of morphological variation. *Hieracium* hybrids have only very rarely been observed in the wild (Mráz *et al.* 2003) or cultivation (Pugsley 1948). Migration of at least some parental taxa which subsequently became endemic in addition to *H. alpinum* is still required under this model.

Hybridisation between polyploids could explain how the endemic *H. pentaploideum* arose on An Teallach, Wester Ross (v.c. 105) from the other species recorded on the mountain. It could have resulted from a cross of an unreduced triploid gamete from *H. alpinum* or *H. holosericeum* with a reduced diploid gamete from a tetraploid such as *H. kennethii*, *H. marginatum* or *H. perscitum*. Similarly, Sell & Murrell (2006) note how species within the artificial group sect. *Subalpina* may have arisen as hybrids between sect. *Alpina* species and species within other sections such as sect. *Cerinthoidea*, sect. *Oreadea* and sect. *Vulgata*. Given that 42 of the 45 sect. *Subalpina* species are endemic, this

hybridisation is again likely to have happened between polyploids in Britain.

If the British sect. *Alpina* endemics did migrate from their place of origin in Europe, it is surprising that only *H. alpinum* still occurs there; it is difficult to explain how the 34 other species followed the same or very similar migration pattern.

The involvement of pollen should be considered in theories of evolution of *Hieracium* sect. *Alpina*, and experimental work to test this hypothesis is required. The variation in pollen production between specimens within a species

and the higher pollen production in cultivated specimens suggests that pollen production may be under environmental as well as genetic control.

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REFERENCES

- ALEXANDER, M. P. (1969). Differential staining of aborted and non-aborted pollen. *Stain Technology* **44**: 117–122.
- CHRTEK, J. JNR (1997). Taxonomy of the *Hieracium alpinum* group in the Sudeten Mountains, the West and the Ukrainian East Carpathians. *Folia Geobot. Phytotax.*, Praha **32**: 69–97.
- MRÁZ, P., CHRTEK, J. & PLAČKOVÁ, I. (2003). First record on recent natural hybridisation in the genus *Hieracium* s. str. In: *Hieracium workshop, Křivoklát, Czech Republic, 28 May – 1 June, 2003*. Institute of Botany, AS CR & Protected Landscape area “Křivoklátsko” [sine pag.]
- PUGSLEY, H. W. (1948). A prodomus of the British *Hieracia*. *Journal of the Linnean Society (Botany)* **54**: 1–356.
- SHI, Y., GORNALL, R. J., DRAPER, J. & STACE, C. A. (1996). Intraspecific molecular variation in *Hieracium* sect. *Alpina* (Asteraceae), an apomictic group. *Folia Geobotanica & Phytotaxonomica* **31**: 305–313.
- SKAWIŃSKA, R. (1962). Apomixis in *Hieracium alpinum* L. *Acta Biologica Cracoviensis, Series: Botanica* **5**: 89–96.
- STACE, C. A., GORNALL, R. J., SQUIRRELL, J. & SHI, Y. (1995). Chromosome numbers in *Hieracium* L. section *Alpina* (Fries) F. N. Williams. *Watsonia* **20**: 367–377.
- STACE, C. A., GORNALL, R. J. & SHI, Y. (1997). Cytological and molecular variation in apomictic *Hieracium* sect. *Alpina*. *Opera Botanica* **132**: 39–51.
- ŠTORCHOVÁ, H., CHRTEK, J. JNR, BARTISH, I. V., TETERA, M., KIRSCHNER, J. & ŠTEPÁNIK, J. (2002). Genetic variation in agamospermous taxa of *Hieracium* sect. *Alpina* (Compositae) in the Tatry Mts. (Slovakia). *Plant Systematics and Evolution* **235**: 1–17.
- TYLER, T. (2006). Patterns of morphometric variation and a new supraspecific classification of apomictic taxa of *Hieracium* (Asteraceae) from Denmark and southern Sweden. *Plant Systematics and Evolution* **261**: 39–88.

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APPENDIX 1. LIST OF ACCESSION NUMBERS OF HERBARIUM SHEETS OF BRITISH *HIERACIUM* SECT. *ALPINA* EXAMINED. SPECIMENS PREFIXED BM ARE FROM THE NATURAL HISTORY MUSEUM, LONDON, AND PREFIXED E FROM ROYAL BOTANIC GARDENS, EDINBURGH. ALL OTHER SHEETS ARE IN NMW

- H. alpinum*: 25.148.516, 25.149.5156, 27.72.1260, 28.131.4188, 28.131.4242, 49.29.5538, 85.40.2659, V.2005.1.233, BM000916035, BM000916037, BM000916049, BM000916050, BM000916052, BM000916053, BM000916054, BM000916055, BM000916056, BM000916057, BM000916058, BM000916062, BM000916063, BM000916064, BM000916065, BM000916066, BM000916067, BM000916068, BM000916069, BM000916070, BM000916071, BM000916072, BM000916073, BM000916074, BM000916075, BM000916076, BM000916077, BM000916078, BM000916082, BM000916083, BM000916084, BM000916085, BM000916106, BM000916086, BM000916087, BM000916088, BM000916089, BM000916090, BM000916091, BM000916092, BM000916093, BM000916094, BM000916095, BM000916096, BM000916097, BM000916098, BM000916099, BM000916100, BM000916101, BM000916102, BM000916103, BM000916104, BM000916105, BM000916107, BM000916108, E00031564, E00031565, E00031566, E00031567, E00031568, E00031569, E00031571, E00031572, E00031573, E00031574, E00031575, E00031576, E00031577, E00031578, E00031580, E00031581, E00031650, E00031663, E00048447, E00048602, E00171460, E00209980, E00209981.
- H. backhousei*: V.2000.008.6, V87.58.3081.
- H. calenduliflorum*: 27.72.1265, 28.131.4227.
- H. calvum*: V.2000.008.28, V.2000.008.30.
- H. completum*: 25.149.5178, 25.149.5195, V87.58.3080.
- H. deargicola*: V.2000.008.58.
- H. einichense*: V.2000.008.59.
- H. eximium*: 27.72.1268, 28.131.4206, 28.131.4219, 26.553.574, 28.131.4215a.
- H. eximium* f. *tenellum*: 27.72.1269, 28.131.4217.
- H. globosiflorum*: 20.347.29, 27.72.1267, 28.131.4244.
- H. graniticola*: 28.131.4239, V.2000.008.10.
- H. grovesii*: V.2000.008.12, V.2000.008.14, V.2000.008.15.
- H. hanburyi*: V.2005.1.234, 25.149.5176, 25.149.5188, 25.149.5192, 25.149.5193, 27.72.1273, 28.131.4303, 28.131.4304, 28.131.4306, 28.131.4307, 28.603.23, V87.58.3084.
- H. hanburyi* f. *atriceps*: 85.40.2660, V.2000.008.5.
- H. hanburyi* f. *pusillum*: V.2000.008.16.
- H. holosericeum*: 20.7., 26.553.573, 27.72.1262a, 28.131.4192, 28.131.4194, 28.131.4195, 28.131.4196, 28.603.69, 49.29.5536, V87.58.3093.
- H. insigne* f. *celsum*: V.2000.008.34, V.2000.008.35, V.2000.008.36, V.2000.008.37, V.2000.008.38.
- H. insigne* f. *insigne*: V.2000.008.39.
- H. kennethii*: V.2000.008.40.
- H. larigense*: V.2000.008.41.
- H. leptodon*: 28.131.4211, 28.131.4212, 28.131.4214, 28.131.4229, V.2000.008.42, V.2000.008.43.
- H. macrocarpum*: 28.131.4246, V.2000.008.17, V87.58.3095.
- H. marginatum*: V.2000.008.61, V.2000.008.19.
- H. memorabile*: 28.131.4257, 28.131.4258, 28.131.4260, V.2000.008.20.
- H. milesii*: 28.131.4237, 49.29.5534, V.2000.004.27.
- H. mundum*: 28.131.4259, V.2000.008.51.
- H. notabile*: 28.131.4225, V.2000.008.21.
- H. optimum*: 28.131.4213, V.2000.008.52.
- H. pensum*: V.2000.008.53.
- H. pentaploideum*: V.2000.008.60, V.2000.008.60.

H. perscitum: 28.131.4248, V.2000.008.54.

H. probum: 25.149.5179, 28.131.4238, 28.131.4253, 28.131.4319, V.2000.008.55.

H. pseudocurvatum: 28.131.4255.

H. pseudopetiolatum: V.2000.008.22, V87.58.3078.

H. subglobosum: 25.149.5173, 25.149.5177, 28.131.4247, V.2000.008.56.

H. subgracilentipes: V.2000.008.24.

H. subtenuifrons: V.2000.008.57, V.2000.008.63, V.2000.008.63.

H. tenuifrons: 28.131.4197a, 25.149.5169, 28.131.4209, 28.131.4231.

Hieracium portlandicum (Asteraceae), a new endemic hawkweed from the Isle of Portland, England related to *Hieracium leyanum*

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ABSTRACT

A new species of hawkweed is described. *Hieracium portlandicum* differs from *H. leyanum*, within which it was previously included, in being less hairy, and in having narrower, acute, light greyish-green, less hairy involucre bracts. It is a triploid apomict. *Hieracium leyanum* is a tetraploid apomict. *Hieracium portlandicum* is endemic to the Isle of Portland, Dorset, England, where it occurs on Portland Limestone rocks, and on soils derived from it. 103 plants are currently known from two sites, and a comparison against historical data indicates that it is declining. It is 'Endangered' under the IUCN Threat Criteria. Some distribution data are also given for *H. leyanum* which is 'Vulnerable' under the IUCN Threat Criteria. A lectotype for *H. pollinarium* var. *platyphyllum* on which *H. leyanum* is based is designated from Wales.

KEYWORDS: Compositae, chromosome number, lectotype, pollen viability, reproductive biology.

INTRODUCTION

The identity of a *Hieracium* species of the Isle of Portland, Dorset (v.c. 9) has been uncertain since it was first found by W. C. Medlycott in 1879. Ley *et al.* (1908) referred it to *H. leyanum* (Zahn) Roffey (under the synonym *H. platyphyllum*), and noted that the Portland record was a curious extension of range for what was otherwise an endemic species of

South Wales and the adjacent English counties. E. F. Linton (in Ley *et al.* 1908) also noted that the Portland plant differed from *H. leyanum* in characters which might have been due to climate and situation, and suggested it would be worthwhile cultivating the two forms side by side to test the identification. Linton's differences between the taxa noted on a herbarium sheet in **BM**, updated with modern terminology and with missing words added in square brackets, are as follows:

H. leyanum (as *H. platyphyllum*): Leaves with stellate hairs and scattered [simple eglandular] hairs beneath and on the margins; capitula rather large, thick truncate-based; involucre bracts big, broad, with long [simple eglandular] hairs and sparse stellate hairs.

Portland plant: Leaves hairy on both surfaces; capitula medium (not large); involucre bracts [small, narrow], with short, black-based [simple eglandular] hairs and stellate hairs; shortish glands very few on base of involucre bracts and peduncles.

Pugsley (1948) noted that the Portland plant differed materially from *H. leyanum* in having much narrower involucre bracts and deserved further investigation. Sell & West (1968) agreed it differed slightly but not enough to merit specific rank, and noted that the plant had not been seen in Portland 'in recent years'. Bowen

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(2000) listed it from four localities, including two recent ones, and noted that his use of the name *H. leyanum* was provisional, and his card index (currently held by D.A.P.) gives an additional site. Sell & Murrell (2006) retain it within *H. leyanum* and also suggest that the Portland plants are a good match for *H. rubicundiforme* (Zahn) Roffey.

In 2003, T. C. G. Rich began collating information on *H. leyanum* as part of a project on critical Welsh taxa and, intrigued by the isolated Portland locality, asked B. Edwards and D. A. Pearman to collect Portland seed to grow for comparison with Brecon material. Seed was duly collected, and following cultivation of plants beside each other, as suggested by Linton (Ley *et al.* 1908), the Portland plant is now considered to merit recognition as a species in its own right.

METHODS

MORPHOLOGY

Seeds were collected from the one fruiting plant seen at West Weare, Portland on 20 July 2003 by B. Edwards and D. A. Pearman, and from several plants in each of Craig Cerrig-leisiad, Cwm Tarrell and Darren Fach in Brecon in 2003 by T. C. G. Rich. Seeds were sown in damp John Innes no. 1 potting compost in a greenhouse and the resulting plants were grown on. Most seeds of the Brecon plants germinated in autumn 2003. Seedlings remained green during the winter, and they first flowered in June 2004. Three seeds of the Portland plant germinated in the spring of 2004 and flowered about three weeks after the Brecon plants. In 2005, one Portland plant flowered about five weeks after the Brecon plants (the other plant did not flower). The plants were compared side by side, and one specimen from each site was pressed (NMW).

Plants were also examined in the field, and herbarium material was examined in **BEL**, **BIRM**, **BM**, **CGE**, **DOR**, **E**, **LIV**, **MANCH**, **NMW** and **RNG**. Material of *C. West* in **MNE** has not been examined.

Terminology of hair lengths follows Sell & Murrell (2006).

CHROMOSOME COUNTS

Tips of actively growing roots were collected mid-morning and pre-treated in a 8-hydroxyl-quinoline for 20–24 hours in the fridge. They were then fixed in a 3:1 mixture of absolute ethanol: glacial acetic acid and stored until

needed in the fridge. Root tips were then hydrolysed in concentrated 5N HCl for 10 minutes at room temperature, then stored in 70% industrial methylated spirits. Meristems were dissected out in 45% acetic acid, and squashed between a microscope slide and coverslip in 0.1% aceto-orcein stain with brief flame treatment.

REPRODUCTIVE BIOLOGY

Two florets were taken from each herbarium sheet to assess potential pollen viability (Cleal & Rich 2004). Anther rings were removed from florets with tweezers under a low-power binocular microscope, and placed onto a slide with a drop of Alexander's Stain (Alexander 1969), warmed briefly on the hotplate, then broken up with the tweezers to release the pollen. The preparation was then covered with a cover slip and replaced on the hotplate to improve the uptake of the stain. The slides were examined under a high-power compound binocular microscope for areas of dense pollen grains. Potentially viable grains were counted as those which were spherical with thick papillate cell walls which stained green and had cytoplasm inside which stained uniformly bright red. Deformed grains (rare) or those staining green only with very little or no red staining inside (i.e. with little or no cytoplasm) were considered infertile.

To test for apomixis, young but well-developed capitula were cut with scissors at about their middle to excise the anthers and styles, before the florets opened, and seed set recorded. Control capitula on adjacent peduncles were left for comparison.

FIELD SURVEYS

Historical and recent records from Portland (Appendix 1) were used to plan the field survey in 2005. These indicated that *H. leyanum* sensu lato had been recorded in three areas on Portland: West Weare, Verne plateau, and more extensively down the east side from East Weare to Church Ope Cove. On 22 June 2005 these sites were visited by B. Edwards and T. Rich, and data were collected on habitat, population sizes, soils and associated plant species. Soil pH was measured with a pHep2 Hanna pocket-sized pH meter in a 50:50 mixture with distilled water on soil samples collected from around the roots.

Details of *H. leyanum* were collected during field surveys of other rare Welsh hawkweeds between 2000 and 2003 by T. Rich, with more detailed surveys being carried out specifically for it in 2004 and 2005.

RESULTS

MORPHOLOGY

Cultivated plants from Portland and from Brecon were vegetatively similar in leaf shape and size, with the exception that the Portland plants lacked the glaucous bloom of Brecon *H. leyanum* and had more simple eglandular hairs on the stems, petioles and leaves. Both taxa had hairs on both sides of the leaves, but the Portland plants were more densely hairy. The youngest leaves of both species tended to be glabrescent on the upper surface. In flower, all plants had capitula with at least some of the characteristic stylose florets (i.e. the ligules do not fully develop and remain tubular with exerted styles), though more of the florets were stylose in the Brecon plants (this can however be quite variable even within a population, e.g. as observed at Cwm Tarrell in 2004, or Dyffryn Cwannon in 2005). The Brecon plants had capitula with broader bases and slightly larger ligules – to 25 mm long – compared to more rounded bases and ligules to 21 mm in the Portland plant, but the variation in extent of development of stylose florets made systematic comparison difficult. The involucre bracts were clearly different; those of the Portland plants were narrower (as noted by Pugsley 1948), acute, lighter greyish-green with fairly numerous, short (to 0.4 mm), black-based glandular hairs, a few, scattered, long simple eglandular hairs and fairly numerous, appressed stellate hairs, and those of the Brecon plants were broader, obtuse, darker greyish-green, with dense, short to medium length (to 0.6 mm), black glandular hairs, some scattered, long simple eglandular hairs and dense, appressed stellate hairs.

The main differences between herbarium specimens from Portland and from Brecon-Hereford were largely as set out by Linton on the BM herbarium sheet (cf. above) and as observed in the cultivated material. The density of stellate hairs on the leaves of Brecon-Hereford *H. leyanum* was variable, ranging from virtually absent in some plants to sparse in others; most specimens of the Portland plants lacked stellate hairs on the leaves, but a few had very sparse stellate hairs near the edges. The leaves of the Portland plants were noticeably more hairy on the upper surface than those of Brecon-Hereford *H. leyanum*, some plants of the latter being $\pm$ glabrous on the upper surface, and the leaves of both taxa were

hairy below. Overall, the wild material was quite variable in hairiness at least at West Weare; sometimes plants were moderately hairy, sometimes they had dense, long, villose hairs. Portland plants were consistently more hairy than Brecon-Hereford plants. Long simple eglandular hairs were much more frequent on the involucre bracts of Brecon-Hereford material than in Portland material. The mean width of the long middle involucre bracts measured at about their middle was $1.54 \text{ mm} \pm 0.06 \text{ s.e.}$ ($n = 21$, range $1.1\text{--}1.8$ (-2.4) mm) for Brecon-Hereford *H. leyanum*, and $0.96 \text{ mm} \pm 0.12 \text{ s.e.}$ ($n = 25$, range $0.7\text{--}1.3$ mm) for the Portland plants; a t-test showed that these widths were significantly different ($p < 0.001$).

Comparison of the herbarium material with cultivated material of the same origin showed consistent differences between the Portland and Brecon plants, indicating that the cultivated plants are representative of the character differences in wild plants, though there was overall more variation in hairiness in the wild. The glandulosity of the involucre bracts were more difficult to determine, probably due to drying and storage of the plants, and the differences in leaf coloration between fresh plants were not apparent in herbarium material.

In the field, the most immediately apparent gross differences between Portland and Brecon plants were the differences in size, basal rosette leaves and development of the stylose capitula. Most of the Portland plants were small (up to 15 cm high) and slender (Barrett (1912) quotes measurements taken by Mr Fulleylove in 1911 from the east side as ranging from 7.5–45 cm, and averaging 27 cm), compared to the bigger Brecon plants – usually at least 35–70 cm tall, with two or three robust stems. The Brecon plants had noticeably glaucous, larger and relatively broader basal rosette leaves with few or no hairs on the upper surface, whilst the Portland plants had basal rosette leaves green, smaller and narrower, and hairy on both surfaces. Most capitula of the Portland plants seen in 2005 were normal and well-developed, whilst most of the Brecon plants had most capitula stylose, with a few normally developed capitula.

CHROMOSOME COUNTS

One count of $2n = 27$ (triploid) was obtained for each of two different plants grown from the seed collected from one plant at West Weare, Portland in 2003. Three counts of $2n = 36$ (tetraploid) and one of $2n = c. 37$ were obtained

TABLE 1. POTENTIAL POLLEN VIABILITY IN *H. LEYANUM* S.L. ASSESSED USING ALEXANDER'S STAIN

Locality	Accession no.	Date	% viable*
Black Mountains, Brecon	NMW.25.149.5446b	1898	22, 52
Black Mountains, Brecon	NMW.25.149.5446	1898	0, 6
Black Mountains, Brecon	NMW.25.149.5446c	1898	6, 22
Craig Cerrig-gleisiad, Brecon	NMW.V.2003.1.9	2003	8, 14
Craig Cerrig-gleisiad, Brecon, cultivated	NMW.V.2004.3.184	2004	4, 48
Darren Fach, Brecon	NMW.V.2000.9.710	2000	66, 68
Darren Fach, Brecon, cultivated	NMW.V.2004.3.183	2004	10, 40
Storey Arms, Brecon	NMW.V.2004.3.180	2004	40, 56
		Average	28.9 (± 5.92 s.e.)
Church Ope Cove, Portland	BM000792509	1931	6, 12
Portland	NMW.85.58.3164	1907	12, 16
Portland	BM000792507	1907	10, 32
Portland	BM000792504	1907	10, 24
West Weare, Portland, cultivated	NMW.V.2004.3.182	2004	6, 8
		Average	13.6 (± 2.65 s.e.)

* Two florets examined for each accession

for plants grown from seed from Craig Cerrig-gleisiad, Brecon and one count of $2n = 36$ (tetraploid) for plants grown from seed from Darren Fach, Brecon.

REPRODUCTIVE BIOLOGY

Neither taxon produced much pollen; potential pollen viability was generally more variable in Brecon-Hereford *H. leyanum* than in the Portland plants (Table 1). Although Brecon plants on average had about twice as much viable pollen as the Portland plants, a t-test showed no significant difference in potential pollen viability between the two taxa ($P > 0.06$).

One excised capitulum on each of two plants from Brecon and on one plant from Portland, and all control capitula, set seed, indicating that reproduction is apomictic in both Brecon and Portland plants, as it is for most other British *Hieracia* (vouchers in NMW). Pollen may therefore not be involved in seed production.

FIELD SURVEY 2005

At West Weare, Portland, 98 plants were found in block boulder scree in five scattered subpopulations of varying size (2, 3, 22, 35 and 36 plants). On the east side of the island, where there were probably once extensive populations, only five widely-separated plants were found between Church Ope Cove and Durdle Pier (population sizes 1, 1, 1 and 2 plants) on the side or tops of larger boulders on the more prominent ridges in the boulder field. Both of

these areas were very difficult to search, due to the nature of the terrain, and there is little doubt that more plants are present, but the decline from being 'plentiful' between Durdle Pier and Church Ope Cove (Barrett 1912) to 'rare' in 2005 is real. No plants were found at East Weare or Verne, most of the latter area either having been quarried or modified since it was recorded in 1925. Full details of the populations have been deposited at the Dorset Environmental Records Centre, English Nature and the B. S. B. I. Threatened Plants Database.

The Portland plants varied in size from small plants c. 10 cm tall with no or one stem leaf and two or three capitula, on the tops and sides of boulders, to larger plants 30–40 cm tall with one or rarely two stems leaves and many stems and capitula, on the deeper soils between boulders or in sheltered crevices. The plants were mostly in full flower at the time of survey, and one or two capitula had already set seed (flowering has been observed continuing until at least mid-July in previous years). Of the 103 plants found, 92 were flowering and 11 were vegetative, and the remains of some dead stems from 2004 showed that many plants, but not all, had flowered in successive years. Examination of the whorls of old leaf scars on the rootstock and stems below the current year's rosette of one plant indicated that it was at least 15 years old. Regeneration was noted in two of the sub-populations at West Weare, but

not in any of the other sub-populations. The block boulder screes and rocks are relatively unstable as the underlying Jurassic clays slip and move, and the populations probably are somewhat dynamic within this area.

The Portland plants were usually either growing directly on boulders of Portland Limestone, rooting into tiny cracks or crevices, or between boulders or in crevices in fine grit derived from the limestone. Two soil samples collected from West Weare had pH values of 6.7 and 6.8. Plants growing directly on rocks with virtually no soil are extremely drought-prone, and sea mist may be important in providing significant water during the summer. The current altitudinal range is c. 10–40 m, though historically the record from Verne plateau would have been at c. 100 m altitude.

The vegetation on the rocks or boulder scree was typically very open (from less than 1% to 10% cover) and varied in aspect and slope. It could not be equated to any recognisable plant community. The associated species were various combinations of *Asplenium ruta-muraria* L., *Buddleja davidii* Franch., *Centranthus ruber* (L.) DC., *Cymbalaria muralis* P. Gaertn., B. Mey. & Scherb., *Festuca rubra* L., *Geranium robertianum* L., *Hedera helix* L., *Imula conyzae* (Griess.) Meikle, *Ligustrum vulgare* L., *Lonicera periclymenum* L., *Lotus corniculatus* L., *Mycelis muralis* (L.) Dumort., *Pilosella officinarum* F. W. Schultz & Sch. Bip., *Plantago lanceolata* L., *Rubia peregrina* L., *Sonchus oleraceus* L., *Viburnum lantana* L. and rarely *Euphorbia portlandica* L.

Historical and recent records of *Hieracium leyanum* sensu stricto are listed in Appendix 2. It was refound in most localities and it could still occur at Red Daren and Fan y Big where there are large areas of inaccessible, crumbling rocks, but is unlikely to be still present at Craig y Cilau. It typically occurs in scrub or open rocks on Carboniferous Limestone or Old Red Sandstone, often in small, restricted populations.

DISCUSSION

To ascertain whether a new name is needed for the Portland plant, it is first necessary to lectotypify *H. leyanum* (Zahn) Roffey. The name *Hieracium ley[i]anum* (Zahn) Roffey was based on *H. sagittatum* Lindb. ex Stenstr. subsp. *leyianum* Zahn. This was a new name for the plant originally described as *H. pollinarium* F. J. Hanb. var. *platyphyllum* Ley (= *H. platyphyllum* (Ley) W. R. Linton) (Zahn

1921–1923), which was described from South Wales and Herefordshire by Ley (1898). A lectotype for *H. pollinarium* F. J. Hanb. var. *platyphyllum* is hereby designated as the sheet in herb. A. Ley (currently in CGE) collected by him and labelled ‘Taren ‘r Esgob, Breconshire, 12 July 1897’, with the corrected proofs of Ley’s (1898) *Journal of Botany* note attached. Thus *H. leyanum* is based on Welsh material.

The Portland plants differ consistently from Brecon-Hereford *H. leyanum* in morphology of the leaves and involucre, and in chromosome number. They merit recognition as a separate taxon, which for apomictic *Hieracium* is usually most appropriate at species rank:

***Hieracium portlandicum* T. C. G. Rich sp. nov.**

HOLOTYPUS: on boulder in block boulder scree, West Weare, Portland, Dorset (v.c. 9), England, SY684730, 22 June 2005, B. Edwards & T. C. G. Rich, NMW (accession number V.2005.1.1).

Ab Hieracio leyano foliis triste viridibus, in parte superiore pilis simplicibus eglandulosis satis numerosis vestitis, et involucri squamis angustis (circa 0.7–1.3 mm latis) acutis dilute cinereoviridibus, pilis stellatis appressis satis numerosis pilisque glanduliferis brevibus nigris satis numerosis vestitis, differt.

Differs from *H. leyanum* in having dull green leaves with fairly numerous simple eglandular hairs above, and narrow (c. 0.7–1.3 mm wide), acute, light greyish-green involucre bracts with fairly numerous appressed stellate hairs and fairly numerous short black glandular hairs.

Vernacular name: Portland Hawkweed.

Herbaceous, polycarpic, phyllopodous hemi-cryptophyte with branched rootstock and 1–6 stems, stems 9–45 cm high, with sparse to dense, medium length to long (to 3 mm), white simple eglandular hairs throughout and dense stellate hairs above. Basal rosette leaves to 8–12 cm long, dull green on the upper surface with minor reddish-purple tints, green or flushed reddish-purplish below, the petioles to 2 cm, winged, ± villous with medium length to long simple eglandular hairs and occasionally sparse stellate hairs, the lamina 3–6(–8) cm × 2–4(–5) cm, broadly elliptic or ovate, truncate to rounded at the base, obtuse-mucronate to acute or acuminate at the apex, the margins sparsely but sharply denticulate towards the

base with forward-pointing teeth and remotely glandular-denticulate to entire towards the apex and with dense, ciliate, medium length simple eglandular hairs, moderately hairy with curved, medium length simple eglandular hairs on the upper and lower surfaces, especially on the lower midrib, sometimes densely so, and often more hairy below, the youngest leaves more or less glabrous on the upper surface. Stem leaves usually 0–1(–2), similar to basal leaves but usually lanceolate and acuminate at the apex and more sharply toothed, often with much smaller, linear-lanceolate or filamentous bracts at the base of the synflorescence branches (when present). Synflorescence racemose-corymbose with (1–)2–9(–17) capitula, with long, ascending to spreading branches and peduncles, with dense stellate hairs and scattered short, black-based simple eglandular hairs and very short, dark glandular hairs above. Capitula medium-sized c. 35–45 mm in diameter, rounded to truncate at the base. Involucral bracts connivent in bud, in flower 10–12 mm long (11–13 mm to base of involucre), light greyish-green with paler margins, narrow (middle involucral bracts 0.7–1.3 mm wide at middle), linear-triangular, acute, with fairly numerous, appressed stellate hairs especially on the margins, and with fairly numerous short, black glandular hairs and very few to few, short to medium length, black-based simple eglandular hairs. Ligules to 21 mm (or to 26 mm to base of involucre) but central florets often discoid and shorter, mid-yellow, glabrous at the tips, the tips often variably cut into linear-oblong lobes. Styles discoloured with greyish-black papillae and stigmas. Margins of receptacle pits weakly dentate. Seeds 3.0–3.8 mm, purplish-black. Flowering time: June–July.

Hieracium portlandicum is endemic to the Isle of Portland, Dorset (v.c. 9), England, where it has been recorded in at least three localities (Figure 1). The population survey in 2005 revealed a total of 103 plants, and it has clearly declined on the east side of Portland during the last 100 years, suggesting that it is best treated as 'Endangered' under the IUCN Threat Criteria (IUCN 2001). The main threats are currently development of scrub, and especially the spread of alien *Cotoneaster* species and possibly *Hedera helix* over its rocky outcrops near Church Ope Cove. The other alien species associated with *H. portlandicum* do not currently pose a significant threat. No other species of *Hieracium* are recorded from the Isle of Portland.

Hieracium portlandicum is illustrated in Figure 2, which also shows involucral bracts of *H. leyanum* for comparison. There is an excellent photograph of *H. portlandicum* in Bowen (2000, Plate 37). Pugsley (1948) and Sell & Murrell (2006) give descriptions of *H. leyanum*. Sell & West (1968) noted that *H. leyanum*, *H. angustisquamum* (Pugsley) Pugsley and *H. holophyllum* W. R. Linton had many characters in common with *H. caledonicum* F. J. Hanbury, which could be the parent from which they were derived; this is also likely to be the case with *H. portlandicum*. *Hieracium caledonicum*, which occurs in northern Scotland, differs from *H. portlandicum* in having smaller capitula with broader, obtuse involucral bracts, *H. holophyllum* differs in having obtuse involucral bracts and yellow styles, and *H. angustisquamum* differs in having usually three stem leaves and obtuse involucral bracts. Sell & Murrell (2006) suggested that the Portland plants were a good match for *H. rubicundiforme* (formerly *H. rubicundum* F. Hanb.), but they differ in having green, not deep bluish-green, leaves which are hairy on both sides and in the acute, not obtuse involucral bracts. No chromosome counts are available for these other related taxa.

Pugsley (1948) placed *Hieracium leyanum* in Section *Vulgata* (Griseb.) Willk. & Lange, but Sell & West (1968) placed it in Section *Oreadea* (Fr.) Arv.-Touv.; *Hieracium portlandicum* is best included with *H. leyanum* in the latter.

Hieracium leyanum sensu stricto has been recorded from 12 sites in four vice-counties (Fig. 3). It has been seen between 2003 and 2005 in eight sites in four hectads, all in v.c. 42 Brecon, with a total population size of at least 800 plants (Appendix 2). It was not refound in Monmouthshire or Herefordshire. It qualifies for listing in the current British vascular plant red data book (Wigginton 1999), and it is best classified as 'Vulnerable' under the IUCN Threat Criteria until comprehensive surveys can be carried out (IUCN 2001).

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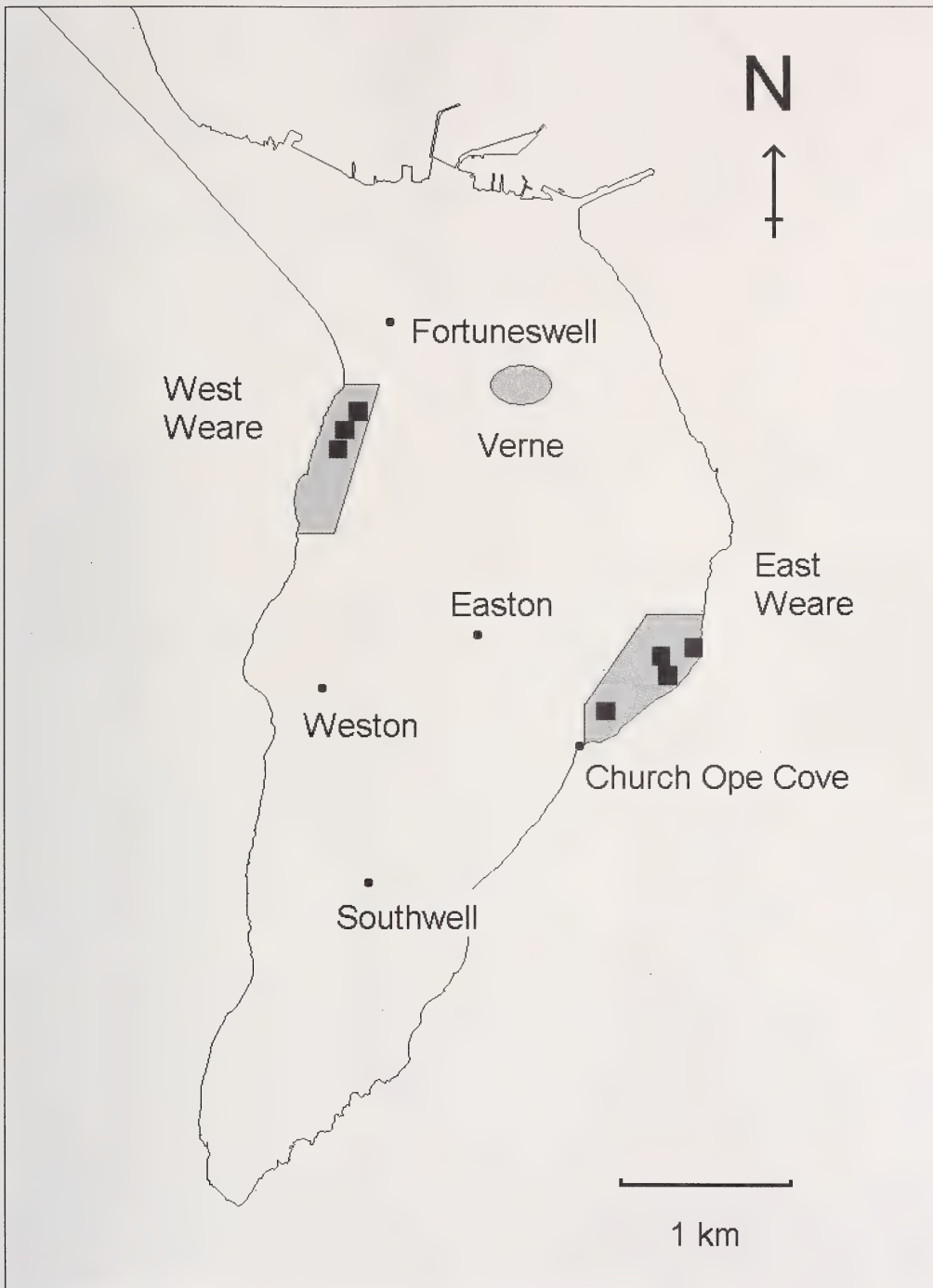


FIGURE 1. Distribution of *Hieracium portlandicum* on Portland, Dorset. ■, 2005. Grey shaded, approximate areas where it was recorded historically.

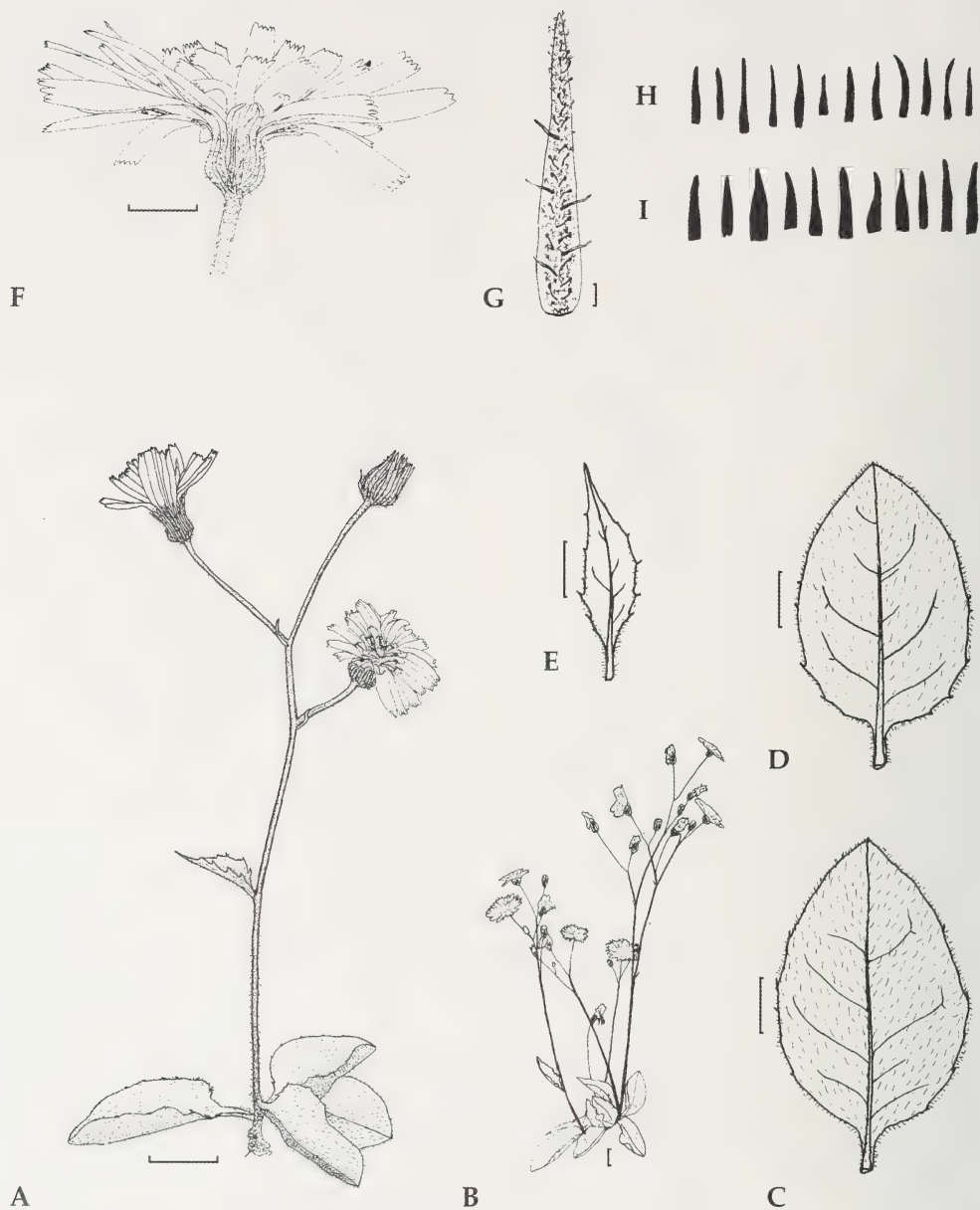


FIGURE 2. *Hieracium portlandicum*. A, Typical plant growing on a boulder. B, Habit of a larger plant growing in deeper soil. C, Lower side of rosette leaf. D, Upper side of rosette leaf. E, Upper side of stem leaf. F, Side view of capitulum. G, Involucral bract showing hairs types. H, Silhouettes of involucral bracts of *H. portlandicum*. I, Silhouettes of involucral bracts of *H. leyanum*. Scale bars: A, 2 cm; B-F, 1 cm; G, 1 mm. Del. T. C. G. Rich.



FIGURE 3. Distribution of *Hieracium leyanum sensu stricto* in South Wales and England. Records are for 1 km squares with symbols plotted at twice that size for clarity. ●, 2003–2005. ○, pre-1950. ×, error.

REFERENCES

- ALEXANDER, M. P. (1969). Differential staining of aborted and non-aborted pollen. *Stain Technology* **44**: 117–122.
- BARRETT, W. B. (1912). Contributions to a flora of Portland, with special reference to *Limonium recurvum*, C. E. Salmon. *Proceedings of the Dorset Natural History and Antiquarian Field Club* **33**: 96–143.
- BOWEN, H. J. M. (2000). *The flora of Dorset*. Pisces Publications, Newbury.
- CLEAL, H. & RICH, T. C. G. (2004). An investigation of pollen viability in *Hieracium*. Unpublished report, National Museums & Galleries of Wales, Cardiff.
- HAINES, F. H. (1926). Report of the Natural History Sectional Committee of the Dorset Natural History and Archaeological Field Club for the year 1925. *Dorset Natural History and Archaeological Field Club* **47**: 177–179.
- IUCN (2001). *IUCN Red list categories and criteria. Version 3.1*. IUCN, Gland.
- LEY, A. (1898). Two new forms of *Hieracium*. *Journal of Botany* **36**: 6–7.
- LEY, A. (1902). *H. caledonicum*, F. J. Hanb. *Report of the Botanical Exchange Club of the British Isles* **2**: 16.
- LEY, A., RIDDELSDELL, H. J. & LINTON, E. F. (1908). *H. platyphyllum*, Ley. *Report of the Botanical and Exchange Club of the British Isles for 1907*: 298.
- MILLS, J. N. & STACE, C. A. (1974). Chromosome numbers of British Plants, 2. *Watsonia* **10**: 167–168.
- PUGSLEY, H. W. (1948). A prodromus of the British *Hieracia*. *Journal of the Linnean Society (Botany)* **54**: 1–356.
- RIDDELSDELL, H. J., HEDLEY, G. W. & PRICE, W. R. (1948). *Flora of Gloucestershire*. T. Buncle & Co., Arbroath.
- SELL, P. D. & MURRELL, G. (2006). *Flora of Great Britain and Ireland*. Volume 4. Cambridge University Press, Cambridge.
- SELL, P. D. & WEST, C. (1968). *Hieracium* L., in PERRING, F. H. ed., *Critical Supplement to the Atlas of the British flora*. BSBI, London.
- WADE, A. E. (1970). *The flora of Monmouthshire*. National Museum of Wales, Cardiff.
- WIGGINTON, M. J., ed. (1999). *British Red Data Books. 1. Vascular Plants*. 3rd ed. Joint Nature Conservation Committee, Peterborough.
- ZAHN, K. H. (1921–1923). *Compositae – Hieracium*, in Engler, A. *Das Pflanzenreich* **77 (IV, 280)**: 1–1146.

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APPENDIX 1 - HISTORICAL AND RECENT RECORDS OF *H. PORTLANDICUM* SP. NOV. FROM PORTLAND

V.C. 9, DORSET

Portland, 11 June 1910, W. B. Barrett (**BM**, Barrett (1912) cited it as ‘Durdle Pier to Churchope, plentiful. Sparingly in West Weare’)

East Weare. Church Ope Cove, 2 September 1931, R. Meinertzhagen (**BM**); between Pennsylvania and the prison, June 1879, W. C. Medlycott (**DOR**); on the south side of the descent from the ... by Shepherds Dinner, 15 June 1886, J. C. Mansel-Pleydell (**DOR**); 20 June 1910, G. E. Fulleylove (**CGE**).

The Verne Plateau, 1925, M. J. Andrews (Haines 1926; Bowen 2000).

West Weare. 1885, W. B. Barrett *et al.* (Bowen 2000); Chesil Beach, amongst quarry debris at the foot of the cliffs, near the neck, 20 July 1907, H. J. Riddelsdell (**BM**, **CGE**, **NMW**); 21 August 1911, C. E. Salmon (**BM**); Hallelujah Cove, 1925, M. J. Andrews (Haines 1926); limestone rubble, 4 June 1988, R. FitzGerald, S. L. Jury, J. Bevan, R. Pankhurst *et al.* (B. S. B. I. field meeting; photograph in **RNG** as Fortuneswell, and incorrectly cited elsewhere as East Weare, pers. comm. R. FitzGerald 2005); 1989, H. J. M. Bowen (Bowen 2000); block boulder scree SY684730, 20 July 2003, B. Edwards & D. A. Pearman.

APPENDIX 2 – RECORDS OF *HIERACIUM LEYANUM* S.S.

V.C. 34, WEST GLOUCESTERSHIRE

Six plants in roadside quarry between Birdlip and Crickley Hill, undated, H. J. Riddelsdell, and not refound again (Riddelsdell *et al.* 1948). No voucher has been traced, but given that *H. leyanum* is so distinctive and that Riddelsdell had collected it elsewhere, the record is accepted.

V.C. 35, MONMOUTHSHIRE

Tarren yr Esgob in “Breconshire and Monmouthshire” (Ley 1902; Wade 1970); still present in the Brecon part of this site but not seen recently at the extreme eastern end in Monmouthshire, if it ever indeed occurred in v.c. 35.

The record plotted in ST59 in Sell & West (1968) is based on a specimen from rocks at the north point of Piercefield Park, 6 June 1900, A. Ley (**CGE**), determined by Sell & West, but which T. C. G. Rich believes to be *H. pachyphylloides* (Zahn) Roffey. Neither species was present on 5 July 2005, T. C. G. Rich.

V.C. 36, HEREFORDSHIRE

Red Daren, Hatteral Hills, 1892, 15 August 1893, 24 June 1896 and 9 June 1905, A. Ley (Ley 1898, **CGE**, **NMW**); there is also cultivated material from this site dated June 1896 and June 1897 (**BEL**, **CGE**, **MANCH**, **NMW**). A specimen from Longtown, 31 August 1886, A. Ley (**CGE**) is assumed to be from this site. Not refound, 27 June 2005, T. C. G. Rich, or on the adjacent Black Daren.

V.C. 42, BRECKNOCKSHIRE

Craig Cerrig-gleisiad (as Craig Gledsiau) central upper part, 1 August 1890 and 9 July 1895, A. Ley (**BM**, **CGE**); 7 July 1896, F. J. Hanbury (**BM**); August 1951, C. West (?**MNE**); Cliffs, 3 October 1962, B. Seddon (**NMW**); Cliff ledges SN961218-9, 4 July 1964, J. N. Mills (**MANCH**); Old Red Sandstone cliffs, SN961219, scarce, 24 June 2003, T. C. G. Rich & P. Hill (**NMW**).

Craig Cwm-du (as Craig du), Senni Valley, 13 June 1893, A. Ley (**BM**, **CGE**); cliffs, SN943211, 22 July 2004, M. Porter (**NMW**).

Craig y Cilau (as Craig Cille), undated, A. Ley (Ley 1898). This site has been extensively searched between 2000 and 2002 for *Hieracium* by T. C. G. Rich; presumed lost to the extensive quarrying. Cwm Tarrell, head of, 8 September 1888, and roadside rocks at head of, 9 and 10 July 1895, A. Ley (**BM**, **CGE**); 7 July 1896, F. J. Hanbury (**BM**); roadside, 13 June 1953, C. E. A. Andrews (**BIRM**); 22 June 1953, C. E. A. Andrews, J. R., & P. D. Sell (**BIRM**); July 1959, C. West (**MNE**?); damp cliff by road, SN9720, 18 June 1965, J. N. Mills & J. R. J. M. (**MANCH**); abundant on roadside and in quarry, SN973207, June 2004, T. C. G. Rich; this may be H. W. Pugsley’s site “roadside SW of Brecon”, 3 July 1935 (**NMW**).

Darren Fach (as Cefn Coed, Dan-y-Graig, Vaynor and possibly Cefn Cil-Sanws), limestone cliffs, 7 June 1894, 8 June 1894 and 28 May 1896, A. Ley (**BM**, **CGE**, **NMW**); 17 June 1932, H. A. Hyde & A. E. Wade (**NMW**); 20 June 1932, A. J. Wilmott (**BM**); 10 June 1957, C. E. A. Andrews (**BIRM**); scattered along top of cliff, SO019107, 9 June 2000, T. C. G. Rich (**NMW**). Ley (1898) cites also 'and other spots near Merthyr Tydfil'.

Darren Lwyd (as Taren Llwyd), 24 June 1896, 15 June 1897 and 8 July 1898, A. Ley (**BM**, **CGE**). Two populations of 10 plants at SO243330 and c. 40 plants at SO241339, 27 June 2005, T. C. G. Rich (**NMW**).

Dyffryn Crawnon, lime rocks at head of, 12 June 1893 and 11 July 1900, A. Ley (**BIRM**, **BM**, **CGE**); Sandstone cliffs, 27 May 1896, A. Ley & W. A. Shoolbred (**NMW**); 21 June 1953, C. E. A. Andrews (**BIRM**); July 1954, C. West (?**CGE**); 22 plants, old red sandstone crag, SO091154, 26 June 1975, P. D. Sell & L. Farrell (NCC rare species form). c. 45 plants, SO095149, 27 June 2005, T. C. G. Rich (**NMW**).

Fan y Big, 31 July 1900, A. Ley (**CGE**). Not refound, T. C. G. Rich 2004.

Sychbant, swallow hole near, 28 May 1896, A. Ley (**NMW**). About 300 plants on cliffs above and by cave, Cefn Sychbant, SN98570962, 6 July 2005, T. C. G. Rich (**NMW**).

Tarren yr Esgob (also as Black Mountains), 12 July 1893, June 1896, 12 July 1897, 1 July 1898, 7 July 1898, 8 July 1898, 4 July 1901, 12 August 1903, 17 September 1907, A. Ley (**BEL**, **BM**, **CGE**, **E**, **LIV**, **MANCH**, **NMW**, some of which may be cultivated but is not necessarily marked as such); 29 July 1902, W. R. Linton (Set of British *Hieracia* no. 90; **NMW**, etc.); 9 June 1905 and 4 July 1907, A. Ley (**BM**, **NMW**); 23 July 1923, H. J. Riddelsdell (**MANCH**, **NMW**); 20 June 1933, C. E. A. Andrews (**BIRM**); Old Red Sandstone, June 1953, C. West (**MNE?**); 20 June 1953, J. E. Raven (**E**); 20 June 1953, J. E. Lousley (**RNG**); Scattered on top cliff, c. 30 plants at SO250308, 27 June 2005, T. C. G. Rich (**NMW**), but there are likely to be more extensive populations to the west on this large site.

Conservation of Britain's biodiversity: *Hieracium cacuminum*, Summit Hawkweed (Asteraceae)

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ABSTRACT

Hieracium cacuminum, Summit Hawkweed, is a rare endemic Welsh hawkweed which has been confused with *H. siluriense*. A review of the records and field work showed that 240 plants are known in three sites; it was not refound in three other sites. It occurs on Old Red Sandstone cliffs and rocks in the Brecon Beacons. It is 'Endangered' under the IUCN Threat Criteria.

KEYWORDS: Brecon Beacons, Endemic, *Hieracium siluriense*, IUCN Threat Criteria, Lectotype, Wales

INTRODUCTION

Hieracium cacuminum (Ley) Ley, Summit Hawkweed or in Welsh Heboglys y Copa, and *H. siluriense* (F. J. Hanb.) P. D. Sell, Silurian Hawkweed or in Welsh Heboglys y Silwriaid, are two Welsh endemic hawkweeds which have been confused historically as a result of mixed material being cited with the original description of *H. cacuminum* by Ley (1895). Consequently, the distribution information in Ley (1895, 1909), Pugsley (1948) and Sell & West (1968) included both species. Sell & Murrell (2006) have recently clarified that the material on which *H. cacuminum* was based referred only to material collected in 1888 on the central Brecon Beacon cliff, and the other records cited belonged to *H. siluriense*. In order to clarify the distribution of *H. cacuminum*, a Red Data Book species (Wigginton 1999), and to provide an IUCN Threat Category as required under the Global Plant Conservation Strategy (Secretariat for the Conservation of

Biodiversity 2002), the records and ecology of *H. cacuminum* were reviewed, along with fresh field surveys, and are reported in summary herein; full details are held by T. Rich and are available on request.

Hieracium cacuminum was first described as *H. diaphanum* var. *cacuminum* by Ley (1895). A lectotype has been selected by P. D. Sell from material collected from a stream side, Brecon Beacons, 8 August 1888, A. Ley (herb. Ley, CGE) and is hereby designated by P.D.S. Hanbury (1904) used Ley's epithet when he transferred the variety to *H. vulgatum*. Later Ley (in Linton 1905) transferred it to *H. demissum*, and then raised it to species status after the Scandinavian *Hieracium* expert G. A. H. Dahlstedt had seen material in 1907 (Ley 1909).

Summary of synonymy:

Hieracium cacuminum (Ley) Ley, *J. Bot.* **47**: 51 (1909).

=*H. angustatum* (Lindeb.) Lindeb. subsp. *cacuminum* Zahn, in Engl., *Pflanzenr.* **76** (IV, 280): 471 (1921).

=*H. demissum* Strömf. var. *cacuminum* Ley in W. R. Linton *Brit. Hier.* 74 (1905).

=*H. diaphanum* Fries var. *cacuminum* Ley, *J. Bot.* **33**: 86 (1895).

=*H. vulgatum* Fries var. *cacuminum* Hanb. in *Bab. Man.* ed. 9, 258 (1904).

Pugsley (1948) regarded *H. cacuminum* as an anomalous member of section *Tridentata*. Sell & West (1968) and Sell & Murrell (2006) treat it as a member of section *Oreadea*. The English and Welsh names are derived from the Latin *cacumen* = peak, extreme top.

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TABLE 1. REVISED HISTORICAL RECORDS OF *HIERACIUM CACUMINUM*

V.C. 42 BRECON			
'Brecon Beacons' (SO02)			
Brecon Beacons, central cliff	14 July 1886	A. Ley	CGE
Brecon Beacons, stream side	8 August 1888	A. Ley	CGE (Lectotype), BM , NMW
Brecon Beacons	25 August 1890	A. Ley	BM , Pugsley (1948)
Brecon Beacon, on the face of the cliff near the summit	26 August 1890	A. Ley	BM
Brecknock Beacon (=Brecon Beacon), precipice of the	26 August 1890	A. Ley & W. H. Purchas	CGE
Brecon Beacons, sandstone mountain cliff	15 August 1894	A. Ley & W. A. Shoolbred	BM , CGE , LIV , NMW
Brecon Beacons	28 July 1899	A. Ley	BM , CGE , E , LIV , NMW ; Set of British <i>Hieracia</i> no. 116
Brecon Beacons, rocks near the path between the two beacons (original locality)	23 July 1902	W. R. Linton	BM , CGE , E , LIV , NMW ; Set of British <i>Hieracia</i> no. 116; Linton (1903)
Cwm Tarrell (SN92)			
Cwm Tarrell, by a stream	24 July 1883	A. Ley	BM
Cwm Tarrell	August 1888	A. Ley	BM
Cwm Tarrell	1890	A. Ley	BM , Hanbury (1894)
Head of Cwm Tarrell, rocky mountainside	9 July 1895	A. Ley	CGE , Ley (1909)
Glyn Tarrell, cultivated	June 1953	P. D. Sell	CGE
Glen Tarrell, rocky outcrop at head of	10 July 1959	C. West	CGE
Taf Fechan (SO01)			
Taf-fechan, sandstone cliffs	15 August 1894	W. A. Shoolbred	NMW
Taf Fechan, 1 mile above the Ystrad	23 July 1900	A. Ley	CGE
Fan Gyhirych (SN8818)			
Y-fan-Gihirich	4 August 1898	A. Ley	CGE , Ley (1909)
Glyn Collwng (SO0519)			
Rocks at the head of Glyn Collwng (limestone)/ Collwng Daren, east side above railway	18 July 1908	A. Ley	CGE , Ley (1909)
V.C. 44 CARMARTHEN			
Llyn y Fan Fach (SN8021)			
Llyn y Fan Fechan, crags of	3 August 1899	A. Ley	CGE , Ley (1909)
Cultivated ex Brecon Beacons			
	June 1898, 28 July 1899	A. Ley	BM , CGE , BEL , LIV

IDENTIFICATION

Hieracium cacuminum is illustrated in Figure 1. Key field key identification features separating it from most other *Hieracium* species in South Wales are the flexuous stem with 3–6 stem leaves decreasing in size up the stem and without a clear basal rosette at flowering, and

the few-headed inflorescence of capitula with dark involucre and very broad (1.7–2.3 mm wide), obtuse outer involucre bracts. Vegetative plants have similar rosette leaves to the lower leaves on the stems of flowering plants, but where similar species (such as *H. siluriense*) were present and there was doubt about the identification, these were not recorded.



FIGURE 1. *Hieracium cacuminum* and *H. siluriense*. A-K, *Hieracium cacuminum*. A, Whole shoot. B-G, Stem leaves from base showing decrease in size up stem (details of hairs not shown). H, First year rosette. I, Bud. J, Capitulum. K, Involutral bract. S, Involutral bract of *H. siluriense*. Scale bars 1 cm. Del. T. Rich.

Hieracium siluriense differs from *H. cacuminum* in usually having at least a loose basal rosette with 0–2(–3) stem leaves and narrower (to 1.7 mm wide), acute or subacute outer involucre bracts. The number of stellate hairs on the margins of the involucre bracts varies in both species, but in general there are more in *H. siluriense*. Full descriptions of both species are given by Sell & Murrell (2006).

DISTRIBUTION

Historical records were compiled from herbaria (BEL, BM, CGE, E, LIV, NMW), literature and the *Hieracium* database maintained by D. J. McCosh. The revised records of *H. cacuminum* are given in Table 1. *Hieracium cacuminum* has been recorded in six sites in two vice-counties in the Brecon Beacons in Wales, where it is endemic.

The historical records were used to direct field work, principally carried out in July 2004. Voucher specimens have been placed in the Welsh National Herbarium (NMW).

BRECON BEACONS (CENTRAL CLIFFS)

105 flowering *H. cacuminum* plants were found scattered along the cliff ledges on the NE facing side of Pen-y-fan on Old Red Sandstone between SO013215 and SO017212. They were often in clustered subpopulations, characteristically occurring on the sides of steep ‘alcoves’ formed by streams eroding the cliffs. The population estimate is a minimum as the crumbling sandstone cliffs are difficult to access safely. *Hieracium siluriense* is also present on the cliffs in greater numbers.

Other crags of the central Brecon Beacons were also searched. Cribyn (SO0221) had some suitable ledges, with some *H. siluriense* and an unknown species. Craig Cwm Cynwyn (SO0220) had locally frequent *H. siluriense* and one clump of *H. argenteum* Fr. The rocks on the NE side of Fan y Big (SO0320) and Craig Cwarell (SO0420) were rather acidic and no *Hieracium* was seen. Corn Du (SO0021) had no suitable ledges.

CWM TARRELL, CRAIG Y FRO

Cliffs, rocks and gullies at the head of Cwm Tarrell were searched and *H. cacuminum* was found in two places on Craig y Fro. Nineteen flowering and c. 100 vegetative plants occurred on Old Red Sandstone cliffs by a waterfall at

SN973203, and 4 flowering and 10 vegetative plants occurred on a small west-facing cliff at SN970206. At least five other *Hieracium* species were also present including *H. siluriense*.

FAN GYHIRYCH

The north-facing corrie has a low line of cliffs with a strongly calcifuge flora, and the only hawkweed seen was one patch of *H. sparsifolium* Lindeb.

GLYN COLLWNG

Two flowering plants of *H. cacuminum* were found on the rocks on the west side of the waterfall of Nant Bwrefwr, immediately outside the car park at SO055175, with *H. cf. diaphanum* agg. Two other *Hieracium* species were collected further upstream. No *H. cacuminum* was found elsewhere.

TAF FECHAN

The imprecise nature of the records made searching difficult, and no *H. cacuminum* was found in areas searched. *Hieracium siluriense* occurred at and below Neuadd Reservoir, and other species were found downstream in shaded woodlands. No *H. cacuminum* was seen on Graig Fan Ddu (SO0119) or Craig Gwaun Taf (SO0020).

LLYN Y FAN FACH

No *H. cacuminum* was found during extensive searches of the cliffs above the lake in 1999 and 2002, and it is probable that intensive sheep grazing has eliminated this and up to seven other hawkweeds which were recorded/collected by A. Ley 100 years ago.

The records are mapped in Figure 2. A total of c. 240 plants were seen in three sites in three hectads in one vice-county. It was not refound in three sites, but some of the localities are very imprecise and the original site may not have been found.

BIOLOGY AND ECOLOGY

Hieracium cacuminum is a polycarpic perennial which is dispersed by seed. Buds of two capitula were excised with scissors to remove the stigmas and anthers in a green-house, and covered; seeds were set in both excised and control buds, showing that reproduction is apomictic (voucher in NMW). The chromosome number is not known, but it is likely to be polyploid.



FIGURE 2. Distribution of *Hieracium cacuminum*. (● 2004–2005, ○ pre-2004, × = errors, mostly referable now to *H. siluriense*).

All populations of *H. cacuminum* occurred on low cliffs of Old Red Sandstone, either rooted in crevices or on immature soils derived from the sandstone. The ledges have vegetation 10–30 cm tall, with a moderate mixture of species. Typical species associated with *H. cacuminum* were *Festuca ovina* L. agg. (including *F. vivipara* (L.) Sm.), *Solidago virgaurea* L., *Luzula sylvatica* (Huds.) Gaudin, *Deschampsia flexuosa* (L.) Trin., *Rhytidadelphus loreus* (Hedw.) Warnst. and *Polytrichastrum alpinum* (Hedw.) G.L. Sm. In a few places *H. cacuminum* is also associated with more calcicolous species such as *Campanula rotundifolia* L. and *Thymus polytrichus* A. Kern. ex Borbás. The upland cliffs of Pen-y-fan in which *H. cacuminum* occurs are probably best ascribed to the U16 *Luzula sylvatica* – *Vaccinium myrtillus* cliff ledge vegetation of the national vegetation classification (Rodwell 1992).

All the sites are heavily grazed by sheep, and *H. cacuminum* is confined to ungrazed ledges and rocks. It is likely to be susceptible to grazing, like most other *Hieracium* species.

Soil pH, measured with a pHep2 Hanna pocket-sized pH meter in a 50:50 mixture with distilled water of soil samples collected from

around the roots, were pH 3.9 (ledge) and 7.1 (by waterfall) at Craig y Fro, and pH 3.7, 4.2 and 4.5 from ledges on Pen-y-fan. This range suggests that it is tolerant of both acid and calcareous soils. The soils were all damp but not waterlogged.

The altitudinal range was c. 480 m at Craig y Fro to c. 650 m on Pen-y-fan.

CONSERVATION

Under the IUCN (2001) Threat Criteria, *H. cacuminum* qualifies as 'Endangered' (total population less than 250 individuals, population declining). The remaining populations on Pen-y-fan and Craig y Fro are probably tolerably safe, as they are within the Brecon Beacons SSSI and SAC within the Brecon Beacons National Park. Although these designations offer no specific protection for *H. cacuminum*, the SAC is designated for the acidic and calcareous chasmophytic vegetation and the cliff ledge vegetation, in which *H. cacuminum* occurs. The two plants at Nant Bwrefwr are not in any designated sites, are close to a public car park and picnic area, and are highly threatened.

The biggest threats to *H. cacuminum* are from rock-falls, which could eliminate local populations, and over-grazing. It is possible that the decline in the three sites is attributable to over-grazing, though without knowledge of the precise original localities this is difficult to assess. Forestry or development of reservoirs could also be responsible for the loss from Taf Fechan. A reduction in grazing throughout the Brecon Beacons would benefit this and other *Hieracium* species.

Seed was collected from Craig y Fro and Pen-y-fan for the Millennium Seed Bank on 23 July 2004. No live collections are currently held in cultivation in botanic gardens.

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REFERENCES

- HANBURY, F. J. (1894). Notes on British *Hieracia*. *Journal of Botany* **32**: 225–229.
- HANBURY, F. J. (1904). *Hieracium*, in Babington, C. C. (1904). *Manual of British Botany*. 9th ed. Gurney & Jackson, London.
- IUCN (2001). *IUCN Red list categories and criteria. Version 3.1*. IUCN, Gland.
- LEY, A. (1895). Short notes. *Hieracium diaphanum* Fr. var. *cacuminum*, n. var. *Journal of Botany* **33**: 86–87.
- LEY, A. (1901). *H. nitidum*, Backh., var. *siluriense*, F. J. H. *Report of the Botanical Exchange Club of the British Isles for 1900*: 637.
- LEY, A. (1909). Brecon and West Yorkshire hawkweeds. *Journal of Botany* **47**: 8–16 and 47–55.
- LINTON, W. R. (1903). *Hieracium vulgatum*, var. *cacuminum*. *Report of the Botanical Exchange Club of the British Isles for 1902*: 54.
- LINTON, W. R. (1905). *An account of the British Hieracia*. West, Newman & Co., London.
- PUGSLEY, H. W. (1948). A prodromus of the British *Hieracia*. *Journal of the Linnean Society of London (Botany)* **54**: 1–356.
- RODWELL, J. S., ed. (1992). *British plant communities. Volume 3. Grasslands and montane communities*. Cambridge University Press, Cambridge.
- SECRETARIAT FOR THE CONSERVATION OF BIODIVERSITY (2002). *Global strategy for plant conservation*. Secretariat for the Conservation of Biodiversity, Montreal.
- SELL, P. D. & MURRELL, G. (2006). *Flora of Great Britain and Ireland. Volume 4*. Cambridge University Press, Cambridge.
- SELL, P. D. & WEST, C. (1968). *Hieracium* L., in, PERRING, F. H., ed., *Critical Supplement to the Atlas of the British flora*. BSBI, London.
- WIGGINTON, M. J., ed. (1999). *British Red Data Books. 1. Vascular Plants*. 3rd ed. Joint Nature Conservation Committee, Peterborough.

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Rumex patientia L. × *R. conglomeratus* Murray, a newly described dock hybrid

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ABSTRACT

A new hybrid, *Rumex* × *philpii* Kitchener **hybr. nov.** (Polygonaceae), between the neophyte *R. patientia* L. and native *R. conglomeratus* Murray, is described from a discovery in West Kent in 1978.

KEYWORDS: Hybridisation, Patience Dock, Clustered Dock.

INTRODUCTION

On 9 July 1978, in the course of recording for the purposes of the *Atlas of the Kent Flora* (Philp 1982), a population of *Rumex* was encountered by E. G. Philp in a dried-up reed bed near Snodland, West Kent (v.c. 16), which included *Rumex patientia* and some evident hybrid plants. One of these specimens was identified as *Rumex patientia* × *conglomeratus* (the hybrid between Patience and Clustered Docks), and confirmed as such in 1989 by J. R. Akeroyd and D. H. Kent from material gathered on 21 July 1978 and held in MNE. Other material is *Rumex patientia* × *obtusifolius*, and includes one specimen which appears more sterile than is usual for that taxon. It has been speculated that this may be the product of complex hybridization in which a third species may also be represented, but there is insufficient evidence to conclude that it is other than *R. patientia* × *obtusifolius*.

There appears to be no other record of *R. patientia* × *conglomeratus*, whether in the British Isles or otherwise. The site of its discovery lies in the valley of the River Medway at TQ7161, where a dried-up reed bed approaches the river wall, the river being tidal at this point. The environs of the site have been subject to disturbance, through maintenance of drainage channels, gravel extraction and various industrial (and more recently, leisure) uses. In the 1970s, *Rumex patientia* formed a fairly isolated introduction here, with another colony near Grain, and with most other West

Kent records being located along the Thames Valley from the London boundary eastwards to Gravesend. It is possible that the frequency of this species is overstated in the records that were contributed to Philp (1982) (E. G. Philp, pers. comm. 2006), at the expense of the closely related Greek Dock, *R. cristatus*, which has since spread considerably. This, however, does not cast any doubt on the identity of the Snodland colony of *R. patientia*.

The hybrid was distinctive by virtue of its high level of sterility. Even by late July, there was no evidence of seed formation and its tepals, while developing irregularly, did not include any which were fully formed, although the extent of development of some was such that it was possible to form an opinion in relation to the influence of putative parents. The tepals of *R. patientia* are entire, broadly ovate or sub-orbicular and may carry an inconspicuous tubercle. Those of *R. conglomeratus* are also entire, but are lingulate and bear three conspicuous tubercles. The tepals of the hybrid were entire and varied from broadly ovate to lingulate, but tubercles were either small or mal-formed. The hybrid's tepals were up to 3.5 mm long, intermediate between those of *R. conglomeratus* (2–3 mm) and *R. patientia* (5–8 mm). Local candidates for the parent other than *R. patientia* based on the possession of entire tepals would have been *R. crispus*, *R. hydrolapathum* or *R. conglomeratus*. Only the last-named of these is likely to have contributed the lingulate shape which is at one end of the spectrum of variation exhibited by the hybrid.

R. crispus appears also to be ruled out as a parent by the insufficient crisping of leaf margins. In any event, observations of *R. patientia* × *crispus* elsewhere in West Kent in 2006 point to a more comprehensive maturing of the flowering parts at least a month earlier as being normal. *R. hydrolapathum* offers a more plausible alternative as a parent, but would be expected to provide cuneate leaf bases, which

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TABLE 1. CHARACTERS OF *RUMEX PATIENTIA*, *R. CONGLOMERATUS* AND THEIR HYBRID

	<i>Rumex patientia</i>	<i>Rumex conglomeratus</i>	<i>Rumex patientia</i> × <i>conglomeratus</i>
Inflorescence	Congested, upright branches; occasional leafy bracts towards base of inflorescence	Open, branches wide angled; leafy bracts present along most of their length	Somewhat loosely congested, with upper branches upright (Fig. 1A), lower branches more spreading; many narrow leafy bracts present at least in lower half of branches, sometimes extending into upper half (Fig. 1B)
Tepals	Entire; 5–8 × 5–9 (10) mm; broadly ovate to sub-orbicular; generally bearing one small tubercle	Entire; 2–3 × 1–2 mm; lingulate; bearing 3 large tubercles	(Fig. 1D) Entire; generally imperfect but more developed tepals up to 3.5 × 2.5mm; broadly ovate to lingulate; occasionally with tubercles, somewhat elongate and mal-formed
Basal leaves	Ovate-lanceolate with subcuneate base	Oblong- to ovate-lanceolate with rounded base	(Fig. 1C) Oblong- to ovate-lanceolate with subcuneate or rounded base

were not present on this plant. The extent to which the hybrid demonstrated intermediacy between *R. patientia* and *R. conglomeratus* is set out in Table 1, but the key features are the tepal shape with its range of variation, the congested panicle inherited from *R. patientia* and the presence of leafy bracts subtending the flower whorls generally at least along the proximal half of the branches.

DESCRIPTION

Rumex × philpii Kitchener, **hybr. nov.** (*Rumex patientia* L. × *R. conglomeratus* Murray)

Hybrida inter *Rumicem patientiam* L. et *R. conglomeratum* Murray, characteribus inter parentium characteres variantibus. Herba robusta erecta, altior quam 1 m, bracteas angustas foliaceas florum verticillos subtendentes saltem in ramorum florentium dimidio inferiore, nonnunquam ad ramorum extremitates, ferens; valvae fructiferae integrae, lingulatae vel late ovatae; semina omnino vel plerumque sterilia.

Hybrid between *Rumex patientia* L. and *R. conglomeratus* Murray, with characters varying between those of the parents. Robust, erect herb, over 1 m high, bearing narrow leafy bracts subtending the flower whorls at least in the lower half of the flowering branches and sometimes to the ends of the branches; fruiting valves entire, lingulate to broadly ovate; seeds entirely or for the most part sterile.

HOLOTYPE: West Kent, v.c. 16, Snodland, in dried up part of reed bed, TQ7161, *E. G. Philp* (MNE). There are three sheets marked *Rumex patientia* × *conglomeratus* in MNE, and that designated as holotype is sheet 2 of the gathering of 21 July 1978.

The specific name is given in honour of Eric Philp, the finder of this hybrid, and who has done much to promote the understanding of the flora of Kent.

DISCUSSION

R. patientia is a native of south west Asia and south east Europe, and is widely but locally naturalised elsewhere in Europe (Jalas & Suominen 1979; Akeroyd, 1993) and in North America (Mosyakin 2005). Within the British Isles, it is scattered, but mainly present in the south east (Preston *et al.* 2002); although formerly grown as a vegetable, it may also be a constituent of grass seed (Grob 1978). *R. conglomeratus* has a wide native presence across Europe and in west and central Asia, and is naturalised elsewhere in temperate areas. There is accordingly considerable overlap in distribution.

R. patientia is mainly ruderal; *R. conglomeratus* grows in damp, open habitats. Whilst there is potential for hybridisation where *R. patientia* grows on the banks of watercourses and so approaches the wetter habitats preferred by *R. conglomeratus*, their



FIGURE 1. *Rumex* $\times$ *philpii*. A. Inflorescence. B. Branch. C. Lower leaves. D. Fruits. E. Diagrammatic section through fruit. *Rumex conglomeratus*. F. fruit. *Rumex patientia*. G. Fruit. Scale bar for A-C = 1 cm. Scale bar for D and E = 1 mm. Scale bar for F and G = 1 mm.

flowering periods in the British Isles constitute an isolating mechanism, as they do not normally overlap (*R. patientia*, May to June; *R. conglomeratus*, July to September). Hence, although species within subgenus *Rumex* generally appear to hybridise freely, this is not a cross to be expected in normal circumstances.

There is a parallel to be drawn in relation to the position regarding *R. cristatus*, which is sufficiently closely related to *R. patientia* for its separate specific status to have been queried by Stace (1997). Jauzein (1990) remarked on the failure of *R. cristatus* and *R. conglomeratus* to hybridise in a mixed group, where *R. cristatus* and *R. crispus* crossed readily. A similar disinclination to hybridise has been noted by the author in a large mixed colony of *R. cristatus* and *R. conglomeratus* at Rainham Marshes in South Essex, although this location has produced *R. × akeroydii* (Rumsey 1999) and hence demonstrated the feasibility of crosses between early and late flowering docks (in this case, *R. cristatus* and *R. palustris*). *R.*

patientia is also recorded as having hybridised with *R. palustris* (*R. × peisonis*) in Austria (Rechinger 1933), which is further evidence that the isolating mechanism of normal flowering periods can be overcome. The extreme rarity of *R. × akeroydii* and *R. × peisonis*, however, also suggests that overcoming such mismatches in flowering periods is a highly uncommon event.

It appears unlikely that *R. × philpii* will have arisen through earlier flowering of *R. conglomeratus*, but rather that delayed or secondary flowering of *R. patientia* may have taken place, perhaps as a consequence of damage to the plant or disruption of the habitat.

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REFERENCES

- AKEROYD, J. R. (1993). *Rumex* L., in TUTIN, T. G. *et al.*, eds. *Flora Europaea* 1: 99–107 (2nd ed.) Cambridge University Press, Cambridge.
- GROB, R. (1978). Identifikation um *Rumex*-Keimlingen. *Seed Science Technology* 6: 563–578.
- JALAS, J. & SUOMINEN, J. eds. (1979). *Atlas Florae Europaea 4 Polygonaceae*. Committee for the mapping of the flora of Europe and Societas Biologica Fennica Vanamo, Helsinki.
- JAUZEIN, P. (1990). *Rumex cristatus* DC. en France. *Le Monde des Plantes* 437: 1–3.
- MOSYAKIN, S. L. (2005). *Rumex*, in *Flora of North America, North of Mexico*, 5 *Magnoliophyta: Caryophyllidae, part 2*. Oxford University Press, New York & Oxford.
- PHILP, E. G. (1982). *Atlas of the Kent Flora*. The Kent Field Club, West Malling.
- PRESTON, C. D., PEARMAN, D. A. & DINES, T. D. (2002). *New Atlas of the British & Irish Flora*. Oxford University Press, Oxford.
- RECHINGER, K. H. (1933). Vorarbeiten zu einer Monographie der Gattung *Rumex* II. Die Arten der Subsektion *Patientiae*. *Repertorium specierum novarum regni vegetabilis* 31: 225–283.
- RUMSEY, F. J. (1999). *Rumex × akeroydii* – a new Dock hybrid. *Watsonia* 22: 413–416.
- STACE, C. A. (1997) *New Flora of the British Isles* (2nd ed.) Cambridge University Press, Cambridge.

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A reconsideration of *Orobanche maritima* Pugsley (Orobanchaceae) and related taxa in southern England and the Channel Islands

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ABSTRACT

Sub-specific status is considered more appropriate for the plant currently known as *O. minor* var. *maritima*. Its distribution in south-east England is reviewed and revised. The distinctive yellow coastal taxon described from Jersey, originally as a variant of *O. ritro* (= *O. elatior*), is recognised here as a variant of *O. minor* subsp. *maritima* and the necessary new combination made.

KEYWORDS: *Orobanche*, Taxonomy, Broomrape, British Isles.

INTRODUCTION

Orobanche minor Sm. is throughout much of its British range a rather ephemeral species clearly often introduced in seed mixes and undeniably neophytic. Intra-populational variation tends to be low and inter-populational differences great but without any geographical structure as one might expect of an inbreeding species which is routinely and randomly introduced. Populations in coastal situations in southern England have greater claims to native status and pose a more complex series of taxonomic and nomenclatural problems. Among the most distinctive of these plants, and that with the most coherent distribution and tightly defined host range, is the taxon described by Pugsley (1940) as *O. maritima* Pugsley. This is currently recognised as *O. minor* Sm. var. *maritima* (Pugsl.) Rumsey & Jury. Material ascribable to this taxon was first (incorrectly) recorded in the British Isles under the name *O. amethystea* Thuill. by the Rev. W. S. Hore (Hore 1845). The title of his paper indicates that he clearly had some doubts about its identity, not least because of apparent differences in the lower lip of the corolla and the smaller sepals of his plant, but ultimately he seems to have become convinced that this was the correct determination. This view was clearly not shared by Borrer (see Pugsley 1940) but the plant was treated under this name as a

possible sub-species of *O. minor* by Syme (1866). He described its diagnostic features as a “corolla bent back into a quadrant in the lower third, the upper two thirds of the back nearly straight; [the] lower lip with the middle segment conspicuously larger than the others.” Its host range and distribution were reported as “parasitical on *Daucus* in Whitesand Bay, Cornwall; near Plymouth, Devon; on the undercliff, S.E. of St. Margaret’s Bay, S. Kent; on *Eryngium maritimum*, near Cobo, Guernsey and St. Ouen’s Bay, Jersey.”

One probable outcome though of this account was that *Eryngium maritimum* became fixed in the botanical public’s consciousness as a host to *O. amethystea* auct. Angl. non Thuill., or *O. maritima* as it was to become (Pugsley 1940) and maritime examples of the *O. minor* aggregate occurring on this host were uncritically accepted as being of this taxon. This confusion has been further perpetuated by the similarity in host to the true continental *O. amethystea*, a large reddish-brown plant closely allied to *O. minor*, primarily parasitic on *Eryngium campestre*, which has erroneously but understandably been recorded as British subsequently, eg. Philp (1982).

Pugsley (1940) neatly summarised much of the earlier confusion when recognising *O. maritima* as a good species and he added several new distinguishing characters: the dark purplish colouration, an often bulbous stem-base, dense short pubescence, short broad-based bracts, shorter less acuminate sepals which were somewhat contiguous, i.e. fused beneath the corolla, and a less deeply lobed stigma. He considered the host range of his new species to include *Plantago coronopus* and *Ononis repens* as well as *Daucus*, and first made the linkage of this taxon with the coastal form of the wild carrot, “*D. gummiifer*” now regarded as *D. carota* subsp. *gummiifer* (Syme) Hook. f., while deliberately excluding material from the Isle of Wight and Channel Islands parasitic on *Eryngium maritimum*.

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THE TAXONOMIC STATUS OF *OROBANCHE MARITIMA*

Of the additional characters cited by Pugsley (1940) when recognising this taxon at specific rank many are discontinuously variable and highly plastic; intensity of colouration is at least partially influenced by the nutrient status of the plant, itself controlled by the nature, i.e. both the species and the vigour, of its host. Stem bulbosity is again dictated by the nature of the haustorial interface and this too is host-specific. Bract and sepal shape are highly and continuously variable and therefore not characters that can be used in isolation. Corolla shape (curvature of the back) is also difficult to quantify, highly variable, and fails to correlate with other supposedly diagnostic characters. The fusion of the stigma lobes is a condition which may be demonstrated by plants which show few or none of the other "*maritima*" characteristics and apparently may not always be shown by those that do (see Syme 1866, Plate MXVII). Likewise the degree of fusion of the sepals, a character that consistently defines such taxa as *O. elatior* and continental species such as *O. clausonis* Pomel, is variable within a single spike and the majority of the sepals examined on the holotype (Seacombe, Dorset, Pugsley 587 (BM)) are un-fused. The sole remaining defining character is that of the shape of the lower lip of the corolla, with its pronounced rounded, less erose-edged, central lobe with large basal bosses; a feature difficult to see in herbarium material. Quantification and therefore identification of intermediates with the typical *O. minor* state is accordingly difficult. That said, on balance most material can be assigned to a taxon on the overall balance of the characters. This becomes increasingly difficult, however, at the southern and western end of *O. maritima*'s range in Cornwall, the Scillies and Channel Islands, where it apparently exhibits a broader host and habitat range, and at the disjunct eastern end of its range on the chalk cliffs and dunes of Kent. It is perhaps revealing that its primary host *Daucus carota* subsp. *gummifer* shows a similar if less marked eastward disjunction (Preston *et al.* 2002) and likewise intergrades morphologically with its more common inland counterpart in this area. It is accordingly tempting to suggest a closely linked co-evolutionary history for these taxa (Rumsey 1994).

The areas in which we have the most difficulty discriminating taxa are those contact zones between var. *maritima* and other closely related plants. In the Purbeck limestone area of

the Dorset coast from which the taxon was described by Pugsley, the plant is essentially isolated by habitat, but on lower coastal cliffs in proximity to dune grasslands and vegetated shingles to the west (Devon, Cornwall, the Channel Islands) there exists ever greater opportunity for gene flow from *O. minor* s. s.

Confusion is also possible in south-east Kent with the extremely rare *O. picridis* F. W. Schultz, which occupies a similar ecological niche, if different host(s). It is clear from the error in Sitwell (1984) that this species is mistaken for *O. minor* var. *maritima*. Webb and Chater (1972) clearly regarded *O. maritima* as possessing some similarity to *O. picridis*: characters such as the straighter corolla back, more hirsute filaments, usually entire, not bidentate, calyx segments, etc. are common to both. On some well filled Victorian herbarium sheets from the St. Margaret's area some individuals which otherwise appear to be *O. picridis* have shorter, more highly pigmented corollas, and shorter, if still filiform sepals (eg. St. Margaret's, 1875, Bennett (BM)). A similar example, but more closely approaching *O. minor* s.l., was photographed by Philip Chantler near St. Margarets in June 2004. The narrow strip of coastal grassland abutting onto cultivated land east of St. Margaret's also currently supports *O. minor* s. s. in arable margins and associated trackways and intermediate plants between this and *O. picridis*, and others which more closely approach var. *maritima*, are currently being investigated by C. Thorogood as part of his doctoral research.

The pattern of distribution, degree of morphological separation and the potential gene-flow under sympatry, etc. demonstrated by this taxon, I now consider is best recognised by according it sub-specific level under *O. minor*.

***Orobanche minor* Sm. subsp. *maritima* (Pugsley) Rumsey, stat. nov.**

Basionym: *O. maritima* Pugsley 1940 *J. Bot., Lond.* 78: 110.

HOLOTYPE: Seacombe, Dorset. Pugsley 587, BM

PARATYPES: Dover to Folkestone, 1882, Bennett (BM); Donderry, East Cornwall, 1876, Briggs (BM).

[syn.: *O. minor* var. *maritima* (Pugsley) Rumsey & Jury].

O. minor subsp. *maritima* can best be distinguished from subsp. *minor* by the pronounced yellowish bosses on the lower corolla lip, which has the middle lobe larger than the laterals and rather reniform in shape.

The corolla is straight backed with a sharply inflected base, has short, often entire sepals and a broad-based rather triangular bract that does not exceed the flower. The plant is short, rarely exceeding 30 cm., the stem is puberulent, strongly pigmented and always bulbous at its base.

DISTRIBUTION OF *OROBANCHE MINOR* SUBSP.
MARITIMA IN KENT

The distribution of *O. minor* subsp. *maritima* in Kent has been made uncertain due to confusion with other maritime forms of *O. minor*. The only reported chromosome count for *O. maritima* (Hamblen 1958) actually relates to the controversial *O. minor* population on the sand dunes of Sandwich Bay. Here, plant stature (height, corolla length) and pigmentation are highly variable, variation that appears in large part to be correlated with host identity. Plants with abnormally developed flowers, pedicellate, or with very reduced corollas and fused stigmatic surfaces, have also been seen here by the author. The records for this hectad (TR36) given by Stewart *et al.* (1994) are therefore suspect. High chalk sea cliffs and the undercliff ledge/talus slope habitat do not extend northwards of TR34 and I have seen no unequivocal material that I would assign to subsp. *maritima* from TR35 or TR36.

Hanbury and Marshall (1899) listed Syme's record from St. Margaret's (TR34); from the Undercliff at Lydden Spout, west of Dover (TR23), where found by Hanbury and a further record from the Dover area by Walton, that they thought perhaps referred to a different station. Hanbury and Marshall also note that "Mr. Druce finds a specimen from Dover Cliffs in herb. Dillenius which he is disposed to place here". In more recent times Philp (1982) only knew of a single small colony in tetrad TR23Z, presumably Hanbury's Lydden locality.

Since the year 2000, plants clearly referable to *maritima* have been seen on cliff ledges and cliff-tops in three separate hectads in E. Kent, v.c. 15, at the following locations: Lydden Spout (TR2939), Samphire Hoe (TR3039), Lighthouse Down, west of St. Margaret's Bay (TR3644), and between Monument and St. Margaret's Bay (TR3744).

All populations are small and the total annual counts in recent years have not exceeded 60 plants and are often much lower. Cliff erosion in the St. Margaret's area threatens the plants' long-term survival immediately west of the

Bay and the dense shading by trees of ledges immediately behind the bay is posing an additional threat.

THE STATUS OF *OROBANCHE MINOR* VAR *FLAVA*

The first recognition of what has come to be called *O. minor* var. *flava* E. Regel in British floras was made by Syme (1866). He noted after discussing "*O. amethystea*" "there are several other forms of *O. minor* which possibly deserve to be considered as sub-species; one occurs near Grand Havre, Guernsey [but see Druce's (1911) comment], on *Leontodon autumnale*, which has the corolla curved like *O. amethystea*, but much shorter and denser spike, and the whole plant, including the flowers, is yellow". As Syme correctly pointed out, the yellow-flowered taxon once present on coastal dunes in Jersey and Alderney (Pugsley 1940) is morphologically closer to subsp. *maritima* than to subsp. *minor*.

Examples lacking anthocyanin are known in many *Orobanche* species and it has been suggested these may result from a single gene mutation (Rumsey & Jury 1991). These are best treated taxonomically as *formae*. The Channel Island plant, however, had subtle but distinct morphological differences, a different preferred host range (Asteraceae-tribe Lactuceae) and a discrete distribution. The rank of variety therefore seems appropriate but must be newly combined under subsp. *maritima*.

The question then follows as to whether the name by which we have known this plant since Pugsley (1940) is correct. I consider that this taxon is not synonymous with *O. minor* Sm. var. *flava* Regel, or the later var. *lutea* Tourlet, both of which from their published descriptions (and geography) are almost certainly forms of *O. minor* subsp. *minor* which lack purple pigmentation. The earliest available epithet for the distinctive Channel Island plant would seem to be Beck's "hypochaeridis", a name with a troubled history. Material sent by Druce to Beck was apparently named by the latter as a form of *O. ritro* Gren. & Godr.; this name Druce then published without formal description, or citation of type, as forma *hypochaeroides* Beck (Druce 1907). Druce revised his opinion as to the rank of this taxon, recognising it as a variety (Druce 1911) but it still remained as a *nomina nuda*. This was appreciated by Beck (1922) who upon transfer of *O. ritro* into his *O. major* (= *O. elatior* Sutton) arguably validated

the name as *O. major* f. *hypochoeridis*, the authority for which was inaccurately cited by him as "(Druce) Beck".

The Channel Islands plant would thus become:

Orobanche minor Sm. subsp. *maritima* (Pugsley) Rumsey var. *hypochoeridis* (Beck) Rumsey **comb. et stat. nov.**

Basionym: *O. major* L. forma *hypochoeridis* Beck in Fedde, Rep. **18**:36 (1922).

HOLOTYPE: Jersey, St. Ouen's Bay on *Hypochaeris radicata* L. and other composites, L.V. Lester-Garland in herb. G. C. Druce (OXF)

[syn.: *Orobanche minor* Sm. var. *flava* angl. auct. non E. Regel].

The plant was apparently last recorded in Jersey in 1951(as *O. ritro*, A. G & F. W. Holder s.n. (LIV!)). More recently it has only been recorded from Newport Docks (v.c. 35)

(Rumsey & Jury 1991) but the small population there, while possessing comparatively dense, round-topped inflorescences, differs in the other distinguishing features and furthermore is parasitic on legumes. Further work is needed to establish its identity and relationships. It is thus possible that *Orobanche minor* subsp. *maritima* var. *hypochoeridis* is now extinct.

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REFERENCES

- BECK VON MANNAGETTA, G. (1922). *Orobanchae novae. Fedde, Repertorium specierum novarum regni vegetabilis* **18**: 33–40.
- DRUCE, G. C. (1907). Notes on the flora of the Channel Islands. *Journal of Botany, British and Foreign* **45**: 419–428.
- DRUCE, G. C. (1911). Short notes. *Orobanche ritro* Gren. & Godr. var. *hypochaeroides*. *Journal of Botany, British and Foreign* **49**: 300–301.
- HAMBLER, D. J. (1958). Chromosome numbers in some members of the family Orobanchaceae. *Botanical Journal of the Linnean Society* **55**: 772–777.
- HANBURY, F. J. & MARSHALL, E. S. (1899). *Flora of Kent*. F. J. Hanbury, London.
- HORE, W. S. (1845). Description of a species of *Orobanche* new to Great Britain, probably *Orobanche amethystea*, Thuillier. *Phytologist* **2**: 239–240.
- PHILP, E. G. (1982). *Atlas of the Kent Flora*. Kent Field Club, Maidstone.
- PRESTON, C. D., PEARMAN, D. A. & DINES, T. D. (2002). *New Atlas of the British and Irish Flora*. Oxford University Press, Oxford.
- PUGSLEY, H. W. (1940). Notes on *Orobanche* L. *Journal of Botany (London)* **78**: 105–116.
- RUMSEY, F. J. & JURY, S. L. (1991). An account of *Orobanche* L. in Britain and Ireland. *Watsonia* **18**: 257–295.
- RUMSEY, F. J. (1994). *Orobanche minor* var. *maritima*, in STEWART, A., PEARMAN, D. A. & PRESTON, C. D. *Scarce Plants in Britain*. J. N. C. C. Peterborough.
- SITWELL, N. (1984). *Shell Guides to Britain's Threatened Wildlife*. London.
- STEWART, A., PEARMAN, D. A. & PRESTON, C. D. (1994). *Scarce Plants in Britain*. J. N. C. C., Peterborough.
- SYME, J. T. B. (1866) ed., *English Botany*, 3rd ed., vol. 6., Robert Hardwicke, London.
- WEBB, D. A. & CHATER, A. O. (1972). *Orobanche*, in TUTIN, T. G., BURGESS, N. A., HEYWOOD, V. H., MOORE, D. M., VALENTINE, D. H., WALTERS, S. M. & WEBB, D. A. *Flora Europaea*, vol. 3. Cambridge University Press, Cambridge.

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An overlooked boreal clubmoss *Lycopodium lagopus* (Laest. ex Hartm.) Zinserl. ex Kusen. (Lycopodiaceae) in Britain

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ABSTRACT

Lycopodium lagopus (Laest. ex Hartm.) Zinserl. ex Kusen. (syn. *L. clavatum* L. subsp. *monostachyon* (Grev. & Hooker) Selander), a widespread circum-arctic taxon, is reported from Britain for the first time. First collected in the 19th century, it had been dismissed as *L. clavatum* and its significance not recognised. The appropriate taxonomic rank for this plant has long proved controversial but where sympatric with *L. clavatum* it apparently maintains its distinctions, supporting the view that it deserves specific rank. Its current status and British range are unclear but it is considered likely to be extremely localised and as an arctic disjunct element in our flora facing at least as great a threat as its declining lowland counterpart, not least through global warming and upland management practices.

KEYWORDS: *Lycopodium clavatum* subsp. *monostachyon*, Cairngorms, Arctic Stag's-horn Clubmoss, v.c. 96, v.c. 97.

INTRODUCTION

During routine study of herbarium material at BM associated with the production of a revised checklist of the Pteridophyte flora of the British Isles and Ireland (Rumsey, *in prep.*), and the B.S.B.I. hybrids project, two specimens of what were recognised as the boreal form of Stag's-horn Clubmoss (*Lycopodium clavatum* L. *sensu lato*) were detected. This plant was initially described as a variety of *L. clavatum* from Canada, under the name var. *monostachyon*, by Greville and Hooker (Hooker 1831) and independently from Scandinavia as var. *lagopus* by Laestadius (Hartman 1858); it was still treated at this rank by Rothmaler in the first edition of *Flora Europaea* (Tutin *et al.* 1964). More recently the consensus view has seen its elevation to subspecies, e.g. Jermy in Tutin *et al.* (1993), Øllgaard & Tind (1993), Kukkonen in Jonsell (2000), but frequently with indications that specific rank might be more appropriate.

However, amongst the recent major floras, only Wagner & Beitel (1993) in their account for the Flora of North America have accorded it specific status, a rank first published by Kuseneva (1953).

In spite of the massive historical interest in Pteridophytes in the British Isles, this taxon would seem to have gone un-noticed here. The club-mosses were certainly less regarded than the ferns during the Victorian fern craze, perhaps as they were less amenable to cultivation and were not treated in the majority of the fern works of the period. We thus have fewer descriptive accounts of minor morphological variants than with the true ferns, many of which have proved to be worthy of higher taxonomic rank, or have been shown to be of hybrid origin. Subsequently the failure to detect this taxon may, in part, be down to its controversial and lowly varietal status, inaccessibility of extra-British literature, and that common failing, our failure to look critically at apparently distinctive plants that require little effort to identify. In these respects it closely mirrors our treatment of another critical Boreal clubmoss *Huperzia selago* (L.) Bernh. ex Schrank & Mart. subsp. *arctica* (Grossh. ex Tolm.) Á. & D. Löve (Corner *et al.* 1998).

DISTRIBUTION

Lycopodium lagopus (Laest. ex Hartm.) Zinserl. ex Kusen. (Arctic Stags-horn Clubmoss) has an Arctic circum-polar distribution and is also recorded in the Swiss and Austrian Alps and in the High Tatras in the Carpathians (Dostál 1984). In the sub-arctic it is a common plant of well-drained base-poor tundra slopes in nutrient-poor dwarf-shrub heath, sub-alpine birch forest and rather dry coniferous woodland. In the Scandes it entirely replaces *L. clavatum* in the north, becoming less frequent as one proceeds south but extending to southern Norway (Aust-Agder) and as far south

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as Dalarna province in central Sweden (Kukkonen 2000). It is frequent in Northern Finland south to Kainuu province and then extends at similar latitudes in a zone of fluctuating width of 2–5° on the meridian throughout the Soviet arctic (Griffiths & Packer 1995), along the Bering Coast of Alaska into North America and Canada. It is also present in S.W. Greenland. In North America it extends as far south as southern Michigan (Wagner & Beitel 1993), again replacing *L. clavatum* in the north and with only a limited zone of sympatry, as also noted for the Soviet Arctic. In these contact zones may be found transitional plants with peduncles longer than their solitary strobili.

IDENTIFICATION

The two taxa most noticeably differ when fruiting: *L. clavatum*, the widespread lowland plant has a long main fruiting axis, or peduncle which is >2.5 cm at maturity. It usually bears two, or more, strobili, each on short branches (pedicels) at the apex of the peduncle. In contrast, *Lycopodium lagopus* (Laest. ex Hartm.) Zinserl. ex Kusen. has strobili that are borne singly, and are sessile, or on a short peduncle (usually in British material <1cm long). In very rare instances when two cones are formed, these are borne directly on the peduncle apex, i.e. are non-pedicellate. Wagner & Beitel (1993) also comment that the sporophylls of *L. lagopus* are less abruptly contracted to a point than are those of *L. clavatum*. The growth forms of both taxa are broadly similar but the boreal taxon has a more congested habit, its branches upright and less obliquely spreading and with more marked annual growth zones. The foliage of the boreal plant is also more appressed or incurved and not loosely spreading.

The microphylls are shorter, narrower and with less prominent hair tips, which may be more caducous and thus similar to *L. annotinum*, with which it often grows. Wagner & Beitel (1993) suggest that the microphylls of *L. lagopus* are more toothed than the generally entire microphylls of *L. clavatum* but a random selection of Scottish examples of *clavatum* was indistinguishable from the British *lagopus* in this respect, all showing some minute denticulation. Many of these characters, however, are somewhat plastic and under a degree of environmental control, e.g. with greater exposure in montane environments *L. clavatum* shows dwarfing generally and greater microphyll appression and the yellower colour typical of the boreal plant. Similar plasticity of *lagopus* towards the *clavatum* expression might be expected in its warmest, most mesic environments. As the modifying influence of the environment remains unstudied, the taxonomic status of the boreal plant continues to prove controversial and must still remain to an extent unresolved awaiting genetic and other research. It is reported that the morphological distinctions appear less than clear-cut in some parts of its broad zone of sympatry in the Scandes, particularly the more oceanic areas (Kukkonen 2000). Intermediates (with longer peduncles but single coned) are most frequent in this zone of sympatry at the southern extremity of the Scandinavian range of *L. lagopus*; whether these plants represent hybrids, the fertility of which is unknown, or perhaps, in some cases, extreme environmentally-induced expressions of the boreal taxon, is unclear. All authors, however, agree that these “races” maintain their distinctions where growing together under uniform conditions and this is our most compelling evidence to suggest that they should be regarded as distinct species.

TABLE 1. CHARACTERS DISTINGUISHING *LYCOPODIUM LAGOPUS* AND *L. CLAVATUM* (BASED ON BRITISH MATERIAL)

Character	<i>L. lagopus</i>	<i>L. clavatum</i>
Strobilus number	1(–2)	(1)–2–3(–5)
Peduncle length	0–12 mm	25–)30–70(–130) mm
Microphyll length (minus hair point)	3–5 mm long	4–6 mm long
Microphyll posture	ascending to incurved appressed	spreading to ascending
Lateral branching	± upright	oblique, spreading

The presence of a single strobilus alone should not be taken as sufficient confirmatory evidence, as *L. clavatum* may also produce occasional single strobili (although generally other fertile branches will show the more normal number); only where this character is coupled with the very short, or absent peduncle can one be certain. Single coned plants should however be treated with interest, as well as caution, and their spores should be examined for signs of abortion, indicative of hybridisation.

LYCOPodium LAGOPUS IN BRITAIN

L. lagopus was apparently first collected in the British Isles by E. S. Marshall in 1896. (Garbh Bheinn, Fersit Forest – at 2,800 ft, v.c. 97 W. Inverness 24/7/1896 **BM**) Unfortunately this is one of several mountains of this name, however, the addition of the phrase Fersit Forest by Marshall would seem to indicate that the peak at NN3571 is intended. The specimen is without information as to habitat, or associates, but from the stated altitude must have been collected from close to the summit (858 m alt.). The material has more the appearance of *L. annotinum* with its sessile strobili (peduncles 0–12 mm, mean 4 mm) and in the texture of its foliage, the characteristic hair points of which have largely been lost from all but the newest growth. This caducous character is also demonstrated by *L. clavatum* s. *stricto* in Western North America, where it is regarded as characteristic of what has been called var. *integrifolium* Goldie.

The second site for *L. lagopus* was detected more recently (v.c. 96 Easternness, E. Side of Geal Carn, Glen Feshie (Cairngorms NNR) NGR. NH888008, 2,800 ft. AC J[ermy] 10801. [1st Aug.] 1974 **BM**). Geal Carn was visited by Clive Jermy in 1974 in an attempt to relocate *Diphasiastrum* × *issleri* (Rouy) J. Holub, collected here by Wheldon & Wilson in the 1890s (Jermy in Wigginton 1999). This was not located on the 1974 visit but was refound subsequently in 1991 at a slightly lower altitude (810 m) than that given for the *L. lagopus* specimen. Indeed if the grid reference

cited is accurate then the specimen may be from closer to 880 m than the c. 853 m indicated on the label and again on gentle slopes close to a summit plateau. It was recorded as growing in *Calluna* (*Arctostaphylos-Empetrum*) heath with *Lycopodium annotinum* and *Diphasi[astrum] alpinum*. Significantly both sites fall above the 840 m alt. altitudinal limit of *Lycopodium clavatum* given in Preston *et al.* (2002).

Aside from the disjunct high Alpine and Carpathian localities reported for this species, the Scottish sites represent the most southerly occurrences of this essentially sub-arctic taxon, but phytogeographically similar disjunctions provide some of the most interesting and enigmatic plants of our montane flora. Most of these taxa have been detected comparatively recently, e.g. *Diapensia*, *Artemisia norvegica*, etc. and this is even more apparent with our bryophytes, e.g. *Marsupella arctica* (Long *et al.* 1990). Indeed it is perhaps more remarkable that similarly distributed plants, such as *Phyllodoce caerulea*, were detected so early. These plants have scattered locations on rather acidic and thus less well botanised Scottish mountain summits, which in spite of their comparatively low altitude support a surprisingly rich arctic flora because of their climatic severity.

It is probable that further sites for this taxon will be found in the Scottish highlands now that its distinguishing features have been demonstrated, but it is unlikely that it will prove to be anything other than rare. With continuing high levels of upland grazing, and poorly managed muir-burn, both of which strongly impact clubmosses in particular, and a general regression of our arctic flora through climatic change, it is likely that this species is under threat, but with our present state of knowledge we can only assign it an IUCN DD (Data deficient) category pending further research.

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REFERENCES

- CORNER, R. W. M., JERMY, A. C. & RUMSEY, F. J. (1998). *Huperzia*, in RICH, T. C. G. & JERMY, A. C. *Plant Crib 1998*. B.S.B.I., London.
- DOSTÁL, J. (1984). *Lycopodiaceae* in Hegi, G. *Illustrierte Flora von Mittel Europa*. Bd.1: Pteridophyta. Verlag Paul Parey, Berlin.

- GRIFFITHS, G. C. D. & PACKER, J. G. (1995). *Flora of the Russian Arctic. Volume 1. Polypodiaceae – Gramineae*. University of Alberta Press, Edmonton.
- HARTMAN, C. J. (1858). *Hanbok I Skandnaviens Flora, Ed. 7*. Zacharias Haeggström, Stockholm.
- GREVILLE, R. K. & HOOKER, W. J. (1831). Enumerato Filicum, Part 1. Lycopodineae Sw. *Botanical Miscellany* 2: 360–403.
- JONSELL, B. (ed.) (2000). *Flora Nordica 1. Lycopodiaceae-Polygonaceae*. The Bergius Foundation, Stockholm.
- KUKKONEN, I. (2000). in JONSELL, B. (ed.) (2000) *Flora Nordica 1. Lycopodiaceae-Polygonaceae*. The Bergius Foundation, Stockholm.
- KUSENEVA, O. I. *Lycopodiaceae*, in GORODKOV, B. N. (ed.) (1953). *Flora Murmanskoi oblasti*, Vol. 1. Akaemiua Nauk SSSR, Moscow.
- LONG, D. G., PATON, J. A. & ROTHERO, G. P. (1990). *Marsupella arctica* (Berggr.) Bryhn & Kaal. in Scotland, new to the British Isles. *Journal of Bryology* 16: 163–171.
- ØLLGAARD, B. & TIND, K. (1993). *Scandinavian Ferns*. Rhodos, Copenhagen.
- PRESTON, C. D., PEARMAN, D. A. & DINES, T. D. (2002). *New Atlas of the British and Irish Flora*. Oxford University Press, Oxford.
- TUTIN, T. G., BURGESS, N. A., HEYWOOD, V. H., MOORE, D. M., VALENTINE, D. H., WALTERS, S. M. & WEBB, D. A. (1964). *Flora Europaea* Vol. 1. Cambridge: Cambridge University Press.
- TUTIN, T. G., BURGESS, N. A., CHATER, A. O., EDMONDSON, J. R., HEYWOOD, V. H., MOORE, D. M., VALENTINE, D. H., WALTERS, S. M. & WEBB, D. A. (1993). *Flora Europaea* Vol. 1, 2nd. ed. Cambridge: Cambridge University Press.
- WAGNER, W. H. (JNR.) & BEITEL, J. (1993). *Lycopodiaceae*, in FLORA OF NORTH AMERICA EDITORIAL COMMITTEE (eds.). *Flora of North America Vol. 2 Pteridophytes & Gymnosperms*. Oxford University Press, New York.

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A new species of *Taraxacum* Wigg. (Asteraceae) from south-west England and Ireland

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ABSTRACT

A new species of Dandelion, *Taraxacum ronaе*, is described from England and Ireland. It has been known since 1973, but has been confused with other species in the Section *Naevosa* that also have strongly marked leaves.

KEYWORDS: Dandelion, unnamed taxon, type specimens, habitat.

INTRODUCTION

Many of the early gatherings of dandelions from Northern Ireland and Cornwall – members of the section *Naevosa* – were difficult to place within the framework of the pioneer account of *Taraxacum* in the British Isles (Richards 1972). Some of these were originally determined as *T. maculigerum* H. Lindb., later on as the newly-described *T. maculosum* A. J. Richards (Richards 1981), and finally as *T. drucei* Dahlst. The cause of this confusion was the unsuspected presence of a hitherto unnamed taxon, differing significantly from all these species. As material of this dandelion has been seen from four English and six Irish vice-counties, in a total of thirty-one 10 km squares (Fig. 2), it is now proposed to describe it as a new species.

***Taraxacum ronaе* L. J. Margetts, sp. nov.**

Planta magnitudine mediocris. Folia patula vel ascendentia, mediocriter-viridia, dense quasi colore piceo fucata, lucida, glabra, anguste oblanceolata, ad 240 mm longa; lobi laterales 4–5, patentes vel modice recurvati, triangulares, integri ad apicem acutum gradatim contracti, margine distali concavo; lobus terminalis parvus vel paulo major, triangularis, plerumque apice parvo mucronato; interstitium inter lobos longum, integrum; petiolus ad tertiam partem folii longitudinis, angustus, exalatus, purpureus; costa saepe colore tincta. Scapus aequans vel longior (dum floret) quam folia, abrupte sub involucri angustatus, plerumque purpureus sed zona pallide viridi sub involucri conico. Involucri squamae exteriores erectae, ovato-lanceolatae, 7–8.5 ×

3–5 mm, supra pallide virides, subtus atrovirentes, apice calloso subpurpureo, anguste sed clare marginato, basi saepe pruinosa. Calathium luteum, 30–40 mm diametro; ligulae stria pallide purpurea ornatae; styli et stigmata primo sublutei, deinde obscuri; antherae polliniferae. Achenium, cona exclusa, pallide brunneum, 3.0–3.2 mm, subter glabrum, supra spinulosum; cona 0.75–0.9 mm; rostrum 7 mm; pappus albus.

Plant medium-sized. Leaves spreading to ascending, mid-green, heavily covered with dark markings, shiny, glabrous, narrowly oblanceolate, to 240 mm long; lateral lobes 4–5, patent to slightly recurved, entire, triangular, tapering to acute point, with concave distal margin; terminal lobe small to a little larger, triangular, usually with a small mucronate apex; interlobes long, entire; petiole to 1/3 of leaf length, narrow, unwinged, purple; midrib often coloured. Scape equalling or longer than leaves at flowering, abruptly narrowed below involucre, usually purple, with a pale green zone below the conical involucre. Exterior bracts erect, ovate-lanceolate, 7–8.5 × 3–5 mm, pale green on upper surface, dark green on lower surface, with apex callose and purplish, narrowly but distinctly bordered, often pruinose at base. Capitulum yellow, 30–40 mm in diameter; ligules striped pale purple; styles and stigmas yellowish at first, discoloured later; pollen present. Achene excluding cone, body pale brown, 3.0–3.2 mm, smooth below, spinulose above; cone 0.75–0.9 mm; rostrum 7 mm; pappus white.

HOLOTYPE: Honiton, South Devon, v.c. 3, ST157008, in garden, 19 April 2005, L. J. Margetts, no. Dev/06/1 (NMW).

ISOTYPE: (OXF); (herb. L. J. Margetts).

Representative exsiccatae:

v.c. 1

Connor Downs, on heathland, SW63, 22 April 1973, L. J. Margetts, no. 10; Tehidy, Camborne, in garden of South Drive, SW64, 26 March 1974, L. J. Margetts, no. 75; Penpol, in garden of Penpol House, SW83, 6 April 1973, L. J. Margetts, no. 11; all (herb. A. J. Richards).



FIGURE 1. *Taraxacum ronaе*. Scale bar 5 cm.



FIGURE 2. Distribution of *Taraxacum ronaе* in 10 km squares.

V.C. H21

Road from Redgap to Knockandinag, in flush north of road, O0224, 1988, *J. Parnell*, s.n. (**herb. A. J. Richards**).

V.C. H33

Fermanagh, near the border with Co. Monaghan, on vertical bank by roadside ditch, H5139, 30 March 1975, *P. Hackney*, no. H5052, as *T. maculigerum* (**BEL**).

V.C. H37

Castledillon, Co. Armagh, roadside verge, H9048, 29 May 1980, *P. Hackney*, no. H7833, as *T. spectabile* (**BEL**).

V.C. H38

Enniskeen House Hotel, Newcastle, damp acid grassland, J3631, 4 June 2005, *D. Doogue*, s.n., as *T. drucei* (**herb. D. Doogue**).

V.C. H39

Red Bay, bank below cliffs near harbour, D240257, 14 April 1981, *C. R. & P. Hackney*, no. H7979, as *T. maculigerum* (**BEL**).

V.C. H40

Castleroe, Co. Londonderry, roadside, C863298, 1978, *D. S. Lambert*, no. H6686, as *T. maculosum* (**BEL**); Castlerock, C763352, 1982, *D. S. Lambert*, s.n., as *T. patricianum* C. C. Haworth in sched. *nomen nudum* (**herb. A. J. Richards**).

This dandelion, like some other species in the Section *Naevosa*, has leaves that are strongly covered with dark markings. It was previously determined as *T. maculosum*, and as such it was listed in *A review of the Cornish flora 1980* (Margetts & David 1981), and also in *The difficult and critical plants of the Lizard district of Cornwall* (Margetts 1988); the illustration there (plate 11, as *T. maculosum*) shows a typical plant of *T. ronaе*. However, in *The Cornish Flora Supplement 1981–1990* (Margetts & Spurgin 1991), the records for *T. maculosum* are rejected with the comment ‘the Cornish plant is now known to be a different species, as yet unnamed’. Later, C. C. Haworth and A. J. Richards came to the conclusion that the material from Northern Ireland and the

south-west was conspecific with the northern species *T. drucei*, and accordingly it was mapped as this in *Dandelions of Great Britain and Ireland* (Dudman & Richards 2000).

However, the type specimens of *T. drucei* in the Fielding-Druce Herbarium (**OXF**), reveal clearly how different this species is from *T. ronaе*: the leaves are spatulate, with rounded terminal lobes (Fig. 1), the petioles are shorter, the involucre are rounded below, and the achenes are less spinulose, with shorter cones. In leaf-shape *T. ronaе* resembles *T. maculosum* but, unlike that species, it produces abundant pollen; in the herbarium the two look deceptively alike, but in the fresh state the matt, roughly hairy leaves of *T. maculosum* are quite distinct. *T. ronaе* is readily recognised in the field by its narrow, shiny and smooth leaves and long narrow petioles. *T. ronaе* replaces *T. maculosum* in the extreme south-west, being frequent in Cornwall, and especially so on the Lizard, but extending east into Devon, with outlying records from South Somerset and Dorset. In Ireland it occurs in six vice-counties. In Cornwall its usual habitat is on the sides or at the base of grassy Cornish ‘hedges’, though it also occurs on disturbed ground, and occasionally in plant nurseries and gardens. In Devon, on the eastern fringe of its distribution, its infrequent occurrences seem to be those of a casual. In Northern Ireland it is most frequent on grassy road-verges. The specific epithet is in recognition of the considerable help given by the author’s wife.

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REFERENCES

- DUDMAN, A. A. & RICHARDS, A. J. (1997). *Dandelions of Great Britain and Ireland*. London.
 MARGETTS, L. J. (1988). *The difficult and critical plants of the Lizard district of Cornwall*. Bristol.
 MARGETTS, L. J. & DAVID, R. W. (1981). *A review of the Cornish flora 1980*. Redruth.
 MARGETTS, L. J. & SPURGIN, K. L. (1991). *The Cornish Flora Supplement 1981–1990*. Zennor.
 RICHARDS, A. J. (1972). The *Taraxacum* Flora of the British Isles. *Watsonia* **9** (supplement): 1–141.
 RICHARDS, A. J. (1981). New species of *Taraxacum* from the British Isles. *Watsonia* **13**: 185–193.

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Notes

A FOURTH LIST OF BRITISH SPECIES OF *RUBUS* L. (ROSACEAE)
IN NORTH-WEST FRANCE

Since the publication of the third list in this series (Allen 2002) two further visits to northern France to sample its *Rubus* flora have taken place: in 2004 a three-day return one to Cherbourg and its environs, and in 2005 a week each in the *départements* of Eure-et-Loir (south-west of Paris) and Pas-de-Calais. Neither of the latter appear to have been investigated previously, at any rate more than fleetingly, by a specialist in the group based on the British side of the Channel.

Unfortunately, hotter-than-normal temperatures in preceding weeks had left most *Rubus* species past flowering and wholly into fruit by the third week in July even as far north and west as Cherbourg, while even the beginning of that month proved almost disastrously late for the visit to Eure-et-Loir. Only for the Pas-de-Calais did the second week in July turn out to be satisfactory timing. Twenty years earlier the brambles were scarcely into flower in late June in the hinterland of Cherbourg, but it remains to be seen whether this marked forward shift in the group's flowering period is a lasting phenomenon. Inevitably, the mistimed visits prevented the fieldwork in the two areas affected from being as thorough as it could otherwise have been.

In this latest list, as in its two predecessors, species recorded for the first time from mainland Europe are highlighted with an asterisk (*), while an obelisk (†) indicates the material from the locality cited has been examined, and my determination assented to, by A. Newton. Specimens have all been donated to **BM** except for some Pas-de-Calais duplicates donated to H. Vannerom (Diest, Belgium). Dated records indicate herbarium determinations made subsequent to the previous list.

R. plymensis (Focke) Edees & Newton
Manche: patch in shady lane just above Le Becquet, nr. Cherbourg†. Second record for the Cotentin Peninsula (and for mainland Europe).

R. elegantispinosus (A. Schumach.) H. E. Weber
Eure-et-Loir: Grand Bois de Dangeau†, also a bush at foot of railway

embankment, Marboué. Apparently the first French records for this species.

R. rubritinctus W. C. R. Watson
Eure-et-Loir: surprisingly widely scattered – for a western species – in woods in the south of the *département*.

R. subinermoides Druce
Pas-de-Calais: Forêt de Desvres, locally common on clay; Bois de Campaigneulles, nr. Montreuil, one bush on roadside margin. Conspicuously absent from the Forêt d'Hesdin and perhaps restricted to the parts nearest to Kent (where this species is abundant round Canterbury). Though now known to be not uncommon in north Belgium and the southern Netherlands, previously known in France only as a single colony in north-east Manche (Allen 1996).

R. adscitus Genev.
Pas-de-Calais: locally common to dominant in every piece of woodland investigated – in surprising contrast to its rarity or absence in southern England east of Hampshire.

[*R. longus* (Rogers & Ley) Newton must be deleted as an extra-British species. Further fieldwork in the far north of Manche has shown the specimen cited in the previous list (Allen 2002) to belong to a closely-allied, apparently undescribed member of series *Vestiti*, "C80", locally frequent in shady places round Cherbourg.]

R. trichodes W. C. R. Watson
Pas-de-Calais: Forêt de Desvres, two patches†. Second French record.

**R. wedgwoodiae* Barton & Riddelsd.
Pas-de-Calais: Forêt d'Hesdin, one clump†. Hitherto believed endemic to west Surrey and the bordering parts of the adjoining counties.

R. formidabilis Lef. & P. J. Mueller
Eure-et-Loir: occasional to rare in woodland. Pas-de-Calais: common in Forêt d'Hesdin, but not seen elsewhere.

R. botryeros (Focke ex Rogers) Rogers
Sarthe: la Hammerie, St-Poenvace, 1905–1906, A. Henry, *Bat. Eur.* 465, as *R. micans* subsp.

subrotundus var. *granulatifrons* Sudre†. A southwards extension into Anjou of the range of this western species, recently detected in France in the far north of Manche and found to have been collected in 1897 just inside Côtes-du-Nord.

R. longithyriger Lees ex Focke Eure-et-Loir: Grand Bois de Dangeau, nr. Bonneval, one patch; Bois Bertrand, nr. Châteaudin, one bush. The farthest east in France this western species has been detected so far.

R. asperidens (Sudre ex Bouvet) Bouvet Orne: locally common in wood south of Château de Sassy. Eure-et-Loir: colony round entrance to Grand Bois de Dangeau, nr. Bonneval: wood on D12 at north end of Rouvray St-Florentin. These further finds bridge the gap between the headquarters of this species in Anjou and records for Oise far to the east.

R. bercheriensis (Druce ex Rogers) Rogers Orne: one bush on a field hedge south of Manoir de Lys, outside Bagnoles-de-L'Orne, 1999†. Second record for France and mainland Europe.

**R. naldretti* (J. W. White) W. C. R. Watson Indre-et-Loire: Forêt de Chinon, one patch, 1994†. Ille-et-Vilaine: roadside north-west of Paimpont village, Forêt de Paimpont, 1994†. Manche: grounds of Château de Ravenel and

hedge of lane to west, Tourlaville, Cherbourg†. This apparently very sparse and scattered range is in marked contrast to the near-restriction of this species in Britain to the west half of Sussex (where it is locally abundant).

R. britannicus Rogers Pas-de-Calais: common and widespread in the Forêt d'Hesdin† but not seen in the mainly more basic Forêt de Desvres, closer to the coast. First French record, though in recent years found to be common in northern Belgium, continuing into the southern Netherlands. For those who do not accept that the original Munstead (Surrey) plant so named by Rogers is just a shade form of one and the same taxon, *R. luticola* Beek is an alternative name usable for this wide-ranging trans-Channel species.

Also worthy of mention is an apparently undescribed member of series *Hystrix* found on the south and west outskirts of Cherbourg which has proved to be identical with a bramble ("Sa25", now in BM) collected in 1978 from a deserted garden in the centre of Guernsey, "seemingly intrusive and probably a lately-arrived French species" (Allen 1981). By reason of being known from only a single spot this was excluded from the fuller *Rubus* list for Guernsey published subsequently (Allen 2001). The plant is not unlike *R. anglofuscus* Eedes but the very broad mucronate leaflets make it distinct at a glance.

REFERENCES

- ALLEN, D. E. (1981). Brambles of Guernsey and Sark. *Société Guernsiaisie Report & Transactions* **20**: 609–615.
 ALLEN, D. E. (1996). British species of *Rubus* L. (Rosaceae) in the Cotentin Peninsula of Normandy. *Watsonia* **21**: 129–133.
 ALLEN, D. E. (2001). Brambles (*Rubus* L. sect. *Rubus* and sect. *Corylifolii* Lindley, Rosaceae) of the Channel Islands. *Watsonia* **23**: 421–435.
 ALLEN, D. E. (2002). A third list of British species of *Rubus* L. (Rosaceae) in north-west France. *Watsonia* **24**: 220–222.

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ERICA × *WILLIAMSII* DRUCE (*E. TETRALIX* L. × *VAGANS* L.):
A NOTE ON TYPIFICATION

A single plant of this natural hybrid was found by P. D. Williams on The Lizard, Cornwall, sometime in the early 1900s. Williams “had the good fortune to rediscover it ... [during] the last week in October” 1910 (Davey 1910), and on 3 November 1910 collected specimens from the plant. He sent “two flowering shoots” to F. Hamilton Davey, who postulated that the heath was the progeny of *Erica vagans* and *E. cinerea* L.: “superficially it looks like a plant of the former bearing flowers of the latter” (Davey 1910). Having examined the specimens, Davey (1910) published a description under the subheading “ERICA VAGANS × CINEREA”.

One specimen, labelled in Davey’s handwriting, is in Davey’s herbarium, Royal Cornwall Museum, Truro (TRU): the label reads “*Erica vagans* × *cinerea* ... Lane between Bochym & Goonhilly Downs ... Cornwall ... November 3rd 1910.” This locality was noted by Davey (1911) in an illustrated account of the hybrid, also using the formula *E. vagans* × *cinerea*. However, as pointed out by Turpin (1988), this locality does not agree with details provided by Williams in the early 1920s (Turrill 1922); using these, Coombe calculated that Williams’ plant came from “ $\frac{1}{3}$ of a mile N. W. of Trelan ... on the edge of the rough heath on the Goonhilly (Helston) side of Trelan” at grid reference SW743193 (see Nelson 2007).

Williams also sent a specimen to the Royal Botanic Gardens, Kew (K), which Turrill (1911) examined. He correctly surmised that it represented a hybrid between *Erica tetralix* and *E. vagans*. A sheet (with two specimens) labelled “*Erica tetralix* × *vagans*. Comm. Mr P. D. Williams Oct. 1911 coll. on moorland nr. Lanarth, St. Keverne” is in K(!).

During the summer of 1911, when the International Phytogeographical Excursion was in Cornwall, Williams brought Drs Druce, Schröter and Graebner to see the plant *in situ* “on the downs near St. Keverne” (Druce 1911b) – Williams also “motored” the three botanists to Lanarth, “his beautiful grounds where he [had] a plant [of *Erica* × *williamsii*] in cultivation” (Druce 1911b: 316). The botanists agreed that the plant was a hybrid and that it must have *E. tetralix*, not *E. cinerea*, as one of the parents because “the glandular hairs must have come from the former species” (Druce 1911b). There is a specimen, labelled “*Erica*

tetralix × *vagans*”, in the Fielding-Druce Herbarium, Oxford (OXF!), collected “Near Lanarth Cornwall with Mr. P. Williams Aug. 29 1911 Dr Graebner & Dr. Schroeter. G. C. Druce”.

On 2 December 1911 in *The gardeners’ chronicle*, Druce (1911a) published a brief account of *Erica tetralix* × *vagans* which concluded: “It is greatly to be hoped that Mr. Williams will be able to propagate this new hybrid, which should bear his name × *Erica Williamsii*.” At the start of this note Druce (1911) had stated: “Under the name *E. cinerea* × *vagans* this interesting hybrid Heath was described last year in the *Journal of Botany* by Mr. F. H. Davey.”

The *International code of botanical nomenclature (Vienna code)* (2006) Art. 32.5 states: “For the purpose of valid publication of a name, reference to a previously and effectively published description or diagnosis may be direct or indirect (Art. 32.6) ...”. Art. 32.6 states: “An indirect reference is a clear (if cryptic) indication, by an author citation or in some other way, that a previously and effectively published description or diagnosis applies.” Druce’s indirect but clear reference to Davey’s note in the *Journal of botany* validates the binomial *Erica* × *williamsii*, even though Davey (1910) postulated the wrong parentage.

In the report of the International Phytogeographical Excursion, Druce (1911b) included a Latin diagnosis and this cross-reference: “I have named it (*Gard. Chron.*, Dec. 2nd, 1911) × *E. Williamsii* after its discoverer.” This clearly indicates that Druce’s note in *The gardeners’ chronicle* was published first and has priority: in fact, the issue of the *New phytologist* containing the Excursion report was issued three weeks later, on 23 December 1911.

Under *ICBN (Vienna code)* (2006) Art. 7.7, “A name validly published by reference to a previously and effectively published description or diagnosis ... is to be typified by an element selected from the context of the validating description or diagnosis, unless the validating author has definitely designated a different type ...”. Given that Druce did not designate any type, nor refer to examining or possessing any herbarium specimens – he saw living plants, one *in situ* and one in Williams’

garden – and that the validating description was Davey's (1910), the specimen from Davey's herbarium has to be designated as the lectotype of *Erica* × *williamsii* Druce.

Erica × *williamsii* Druce, *The gardeners' chronicle*, series 3, **50**: 388 (2 December 1911).

E. vagans × *cinerea* [sic] F. H. Davey, *Journal of botany* **48** (12, December): 333–334 (1910).

Type: "Erica vagans × cinerea ... Lane between Bochym & Goonhilly Downs ... Cornwall ... November 3rd 1910. Legit P. D. Williams."; lecto. **TRU** (ex Herb Fred. Hamilton Davey) *hic designatus*.

Erica × *williamsii* is known in the wild only from The Lizard; for accounts of subsequent collections in the area see McClintock (1974, 1998), Turpin (1984) and Nelson (2007). However, the hybrid has been synthesized – by Dr John Griffiths (1985, 1987) in Yorkshire, England, and by Mr David Wilson in British

Columbia, Canada (McClintock 1992) – by deliberate cross-pollination of specially chosen clones of *E. tetralix* and *E. vagans*. Eleven cultivars, nine being wild-collected clones, are listed by Nelson & Small (2000).

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REFERENCES

- DAVEY, F. H. (1910) *Erica vagans* × *cinerea*. *Journal of botany* **48**: 333–334.
- DAVEY, F. H. (1911) A botanical report for 1909, 1910 ... *Erica vagans* × *cinerea*. *Journal of the Royal Institution of Cornwall* **18**: 383.
- DRUCE, G. C. (1911a) New or noteworthy plants. *Erica tetralix* × *vagans*. *The gardeners' chronicle*, series 3, **50**: 388.
- DRUCE, G. C. (1911b) The International Phytogeographical Excursion to the British Isles III The floristic results. *Erica tetralix* × *vagans* nov. hybr. *New phytologist* **10**: 315–316.
- DRUCE, G. C. (1912) Plant notes for 1911: 1665 ×. *Erica tetralix* × *vagans* = × *E. Williamsii* Druce. *Report of the Botanical Exchange Club of the British Isles* **3**: 24.
- GRIFFITHS, J. (1985) Hybridisation of the hardy ericas. *Yearbook of The Heather Society* **3** (3): 17–34.
- GRIFFITHS, J. (1987) Hybridisation of the hardy ericas. Part 2, *E.* × *williamsii*, *E.* × *watsonii*, and new hybrids from *E. manipuliiflora*. *Yearbook of The Heather Society* **3** (5): 42–50.
- MCCCLINTOCK, D. (1974) The Cornish hybrid heath *Erica* × *williamsii* Druce. *The Lizard (Proceedings of The Lizard Field Club)* **5** (2): 3–5.
- MCCCLINTOCK, D. (1992) David Wilson's hybridisations. *Yearbook of The Heather Society* **3** (10): 51–53.
- MCCCLINTOCK, D. (1998) *Heathers of The Lizard*. The Cornwall Garden Society.
- NELSON, E. C. (2007) Williams's heath: the wild-collected clones. *Heathers* **4**: 45–56.
- NELSON, E. C. & SMALL, D. J. (2000) *International register of heather names*. Volume **1**. The Heather Society.
- TURPIN, P. G. (1984) The heather species, hybrids and varieties of The Lizard district of Cornwall. *Cornish studies Journal of the Institute of Cornish Studies* **10** (for 1982): 5–17, plates 1–4.
- TURRILL, W. B. (1911) A hybrid heath. *Bulletin of miscellaneous information* **1911**: 378–379.
- TURRILL, W. B. (1922) *Erica vagans*, L., var. *kevernensis*, Turpill. *Bulletin of miscellaneous information* **1922**: 175–176.

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AN EARLY SPECIMEN OF *CYSTOPTERIS DIAPHANA* (BORY) BLASDELL SUPPORTS ITS NATIVE STATUS

Cystopteris diaphana (Bory) Blasdel was confirmed as British by Murphy & Rumsey (2005), although the lack of historical records backed by herbarium specimens was felt to weaken the case for its consideration as a native plant.

Many named cultivars of the *Cystopteris fragilis* group were grown during the Victorian fern craze. One name widely used in the 19th Century fern literature is "*sempervirens*". This has often been equated with *C. diaphana* and Macaronesian specimens from this period are usually so named. Moore (1860) stated of *sempervirens*, that, "the reputed British plant has been found at Tunbridge Wells, and is in cultivation from this source, but there are rumours of it having been planted there; it is further stated to have been found in Devonshire, but this is also open to suspicion, the garden whence it has been distributed having been enriched by importations from Madeira." This latter record referred to a find made by the Rev. J. M. Chanter, near Ilfracombe (Keys 1871). At the time of publication, Murphy & Rumsey (2005) had not located this, or other material that might prove the presence of *C. diaphana* in the British Isles before 1961, when a *Cystopteris* now known to be *C. diaphana* was first spotted at Penjerrick. Investigation of the Thomas Moore fern herbarium at **K** has, however, helped to throw some light on this matter. Present in one of the "*Cystopteris fragilis* vars." folders is a herbarium specimen, collected by Chanter in 1869, with an accompanying note documenting where he had found the plant, "not a mile from my own house, by the turnpike road in a hedgebank...". However, the plant, although attributed to *sempervirens* by Moore, lacks the characteristic venation of *C. diaphana* and is best referred to *C. fragilis*.

More interesting, though, is the presence of two sheets, labelled "Harrison's Rocks, nr. Tunbridge Wells, Kent", one sheet marked "cult. 1853-4", the other "cult. 1855". The collector's initials I had difficulty deciphering. These specimens clearly are nice material of good, well-grown *C. diaphana*. In their *Flora of Kent*, Hanbury & Marshall (1899) list "*C. fragilis* b, *dentata*" as present at Tunbridge Wells, citing Pratt and noting that "Mr. Wollaston also marks it for this district."

George Buchanan Wollaston was a very competent botanist and a keen cultivator of ferns – could the specimens in the Moore herbarium have originated with him? He also botanised in Madeira (where he is commemorated in the spectacular endangered endemic *Musschia wollastonii* Lowe). Could this connection suggest an accidental introduction, or confusion once into cultivation, reflected in Moore's (1860) comment? Wolley-Dod (1937) records *Cystopteris fragilis* as having been collected at Harrison's Rocks by William Borrer, the material preserved in Herb. F. Roper, then held at Brighton. He also cites W. W. Reeves as saying of *Cystopteris fragilis* at this site, "I fear that this should have a * [i.e. be an introduction] as it is not the British form of the plant".

While an unlikely site for the calcicolous *C. fragilis*, these sheltered Wealden sandstone outcrops do harbour a range of Atlantic species, such as *Hymenophyllum tunbrigense*, and therefore suggest suitability for *C. diaphana*. Although not listed in Arnold (1907), and not noted by Jenner (1845), or Forster (1816) before him, there are, however, even earlier records of *Cystopteris* from the sand-rocks in the Tunbridge Wells area. *Cystopteris* had first been collected by a Mr. Thorpe, "nr. Tunbridge", along with *Asplenium obovatum* subsp. *lanceolatum*. Hanbury and Marshall (1899) cite these as the first collections from Kent of both species, but wrongly identify (P. lxvii) the collector as John Thorpe of Bexley (1714–1792), who provided the first printed Kentish records of *Corylus avellana* and *Betula verrucosa*, in the late 1760's. This is perplexing as they later (Pp. 421; 424) cite the collection date for the ferns as c. 1700, before their alleged collector's birth. (Wolley-Dod (1937) gives the date of collection as c. 1706). ; Clearly another Mr. Thorpe was responsible. The specimens were indisputably in the possession of the Rev. A. Buddle, then working on a (sadly unfinished) *British Flora*, some while before his untimely death in 1715. His very impressive herbarium was purchased, after his death, by Sir Hans Sloane. Sloane's collection in turn was to form the basis of the herbarium at **BM**, where Buddle's material now resides. Wolley-Dod (1937) clearly regarded the material in Sloane's herbarium as

inconclusive. Examination of the appropriate folio revealed that at the base of the page in Herb. Buddle, iii, 31 are five rather immature fern fronds, representing several species, collectively labelled "*Filix rarabilis omnium minima elegantissima*". The second from left of these, identified by a later pencilled "6", is a young *Cystopteris* frond, that from its venation can be clearly identified as *C. diaphana*. While it is not possible to be precise as to the exact date of these specimens' collection, they

clearly pre-date the death of Buddle in 1715. The presence of this species at this early date, and in an ecologically plausible environment, adds compellingly to the species' claim to be regarded as native.

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I am grateful to Peter Edwards (Kew) for making available, and his assistance with, the Thomas Moore Herbarium.

REFERENCES

- ARNOLD, F. H. (1907). *Flora of Sussex*. Simpkin, Marshall, Hamilton, Kent & Co. Ltd., London.
 FORSTER, T. F. (1816). *Flora Tonbrigensis or, A Catalogue of plants growing wild in the Neighbourhood of Tonbridge Wells*. R. & A. Taylor, London.
 HANBURY, F. J. & MARSHALL, E. S. (1899). *Flora of Kent*. F. J. Hanbury, London.
 JENNER, E. (1845). *A Flora of Tunbridge Wells*. J. Colbran, Tunbridge Wells.
 KEYS, I. W. N. (1871). *Flora of Devon and Cornwall*. Plymouth, Privately published.
 MOORE, T. (1860). *The octavo nature-printed British ferns: Vol. II Athyrium to Ophioglossum*. Bradbury & Evans, London.
 MURPHY, R. J. & RUMSEY, F. J. (2005). *Cystopteris diaphana* (Bory) Blasdel (Woodsiaceae) – an overlooked native new to the British Isles? *Watsonia* **25**: 255–263.
 WOLLEY-DOD, A. H. (1937). *Flora of Sussex*. Kenneth Saville, Hastings

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THE BRITISH ENDEMIC *HIERACIUM CAMBRICOGOTHICUM* (ASTERACEAE) IS PROBABLY EXTINCT

Hieracium cambricogothicum Pugsley (Asteraceae), Llanfairfechan Hawkweed, is a rare British endemic (Sell & Murrell 2006). It is a member of *Hieracium* Section *Tridentata* (Fr.) Arv.-Touv. which was first described by Pugsley (1948) when he split the rather variable *H. gothicum* Fries *sensu lato* into nine taxa. Furthermore, Pugsley described two varieties: var. *cambricogothicum* from Llanfairfechan, and var. *glandulosum* from South Wales (the latter is now included in *H. scabrisetum* (Zahn) Roffey and is not discussed further). Key identification features of *H. cambricogothicum* are that it is robust, with stems densely hairy below with simple eglandular hairs, has 10–15 stem leaves, the lower elliptic to ovate-lanceolate, glabrescent above and with simple eglandular hairs below, has a racemose-corymbose inflorescence with straight, erect to spreading branches, has 5–12 medium-sized capitula, has blackish-green, broad involucre bracts with a few, dark, glandular hairs along the median line, and has fuscous styles (Pugsley 1948).

Hieracium cambricogothicum has been recorded from four, disjunct localities in England, Scotland and Wales (Sell & Murrell 1968). It is a Red Data Book species (Wigginton 1999), and as very little information was known about it, surveys were carried out in 2004 and 2006 to provide information for its conservation. The results of our surveys are briefly summarised below (see Rich 2004 and Sawtschuk 2006 for full details).

RIVERHEAD, SEVENOAKS, KENT (V.C. 16)

Hieracium cambricogothicum was first found in this area in 1952 by C. West (cited as Dunton Green; CGE), and it was subsequently reported in at least three sites; Shoreham Lane (especially around the railway bridge), Riverhead Inn, and Worships Hill. The most recent specimen we have seen was collected on 27 July 1970 by J. N. Mills and C. West (MANCH).

The three areas were searched on 8 July 2004 by T. Rich and on 31 July 2006 by J. Sawtschuk. A few plants of *H. cantianum* Hanbury occurred amongst frequent *H.*

sabaudum L. at Shoreham Lane (NMW), but no *Hieracium* was found elsewhere. A comparison of the type specimen of *H. cambricogothicum* with material labelled as *H. cambricogothicum* from Riverhead suggests that the latter is more similar to *H. cantianum*.

BECKENHAM, KENT (V.C. 16)

Hieracium cambricogothicum was recorded from a railway bank at Beckenham Hill (Sell & West 1968); we have seen no material. Burton (1983) reported that the site where it used to grow was covered with sycamore and snow-berry, and we have not searched it again.

LLANFAIRFECHAN, CARNARVONSHIRE (V.C. 49)

Hieracium cambricogothicum was described from walls at Llanfairfechan by H. W. Pugsley who had first seen it in 1903, and again in 1921 and 1922 (BM, the latter is the Holotype). It was last collected on 26 June 1955, C. A. E. Andrews (BIRM).

The village and adjacent roads within 2 km were searched on 12 July 2004 by T. Rich, and the village was searched again on 29 July 2006 by J. Sawtschuk, without success. Although many walls had vegetation, some were completely bare, a few had been sprayed with herbicide, some had been repointed, and the new A55 road had destroyed others. *Hieracium vagum* Jord. and *H. argillaceum* Jord. were scattered along the north wall of the railway line (NMW).

FORRES, MORAY (V.C. 95)

It was reported from the right bank of the River Findhorn, Greshop Wood, Forres, September 1953 (Sell & West 1968; Webster 1978), but we have not traced any specimens.

The site was visited by I. Green on four occasions in 2004, including two specific searches for *H. cambricogothicum*, without success. *Hieracium sabaudum* and another *Hieracium* species were still present but the river wall has been realigned (NMW).

Thus it now appears that *H. cambricogothicum* can be classified as 'Extinct (EX)' under the IUCN (2001) threat categories. The last time it was recorded for certain was 1955 at the type locality. Although some doubt exists about the identification of material from Kent (and possibly Forres in the absence of a specimen), no *H. cambricogothicum* could be found there either. No live material is known to remain in cultivation or in seed banks.

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REFERENCES

- BURTON, R. M. (1983). *Flora of the London area*. London Natural History Society, London.
 IUCN (2001). *IUCN Red List Categories and Criteria: Version 3.1*. IUCN Species Survival Commission, Gland, Switzerland.
 PUGSLEY, H. W. (1948). A prodromus of the British *Hieracia*. *Journal of the Linnean Society of London (Botany)* **54**: 1–356.
 RICH, T. C. G. (2004). Collection and determination of apomictic plant taxa in Wales. Background information on *Hieracium cacuminum*, *Hieracium cambricogothicum*, *Hieracium pachyphylloides* and *Hieracium pseudoleyi*. Unpublished contract report to Countryside Council for Wales, March 2004.
 SAWTSCHUK, J. (2006). Conservation of endemic *Hieracium* species in the British Isles and assessment of four Welsh species: *Hieracium pachyphylloides*, *Hieracium pseudoleyi*, *Hieracium rectulum* and *Hieracium cambricogothicum*. ESEB Masters Thesis, Université de Rouen, France.
 SELL, P. D. & MURRELL, G. (2006). *Flora of Great Britain and Ireland*. Volume 4. Cambridge University Press, Cambridge.
 SELL, P. D. & WEST, C. (1968). *Hieracium* L., in PERRING, F. H., ed., *Critical Supplement to the Atlas of the British flora*. B.S.B.I., London.
 WEBSTER, MCC. M (1978). *Flora of Moray, Nairn & East Inverness*. Aberdeen University Press, Aberdeen.
 WIGGINTON, M. J., ed. (1999). *British Red Data Books. 1. Vascular Plants*. 3rd ed. Joint Nature Conservation Committee, Peterborough.

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Plant Records

Records for publication must be submitted to the appropriate Vice-county Recorder (see *BSBI Year Book 2005*), and not to the Editors. Following publication of the *New Atlas of the British & Irish Flora* and the *Vice-county Census Catalogue*, new criteria have been drawn up for the inclusion of records in *Plant Records*. (See *BSBI News* no. 95, January 2004 pp10 & 11). These are outlined below:

- First records of **all** taxa (species, subspecies and hybrids) included in the VCCC, designated as native, archaeophyte, neophyte or casual.
- First record since 1970 of the taxa above, except in the case of *Rubus*, *Hieracium* and *Taraxacum*.
- Records demonstrating the rediscovery of all taxa published as extinct in the VCCC or subsequently.
- Newly reported definite extinctions.
- Deletions from the VCCC (e.g. through the discovery of errors, the redetermination of specimens etc.) **NB** – only those errors affecting VCCC entry.
- New 10km square records for Rare and Scarce plants, defined as those species in the *New Atlas* mapped in the British Isles in 100 10km squares or fewer. (See *BSBI News* no. 95, January 2004 pp 36-43).

Records for the subdivisions of vice-counties will not be treated separately; they must therefore be records for the vice-county as a whole. However, records will be accepted for the major islands in v.cc. 102-104, 110 and 113.

In the following list, records are arranged in the order given in the *List of Vascular Plants of the British Isles* and its supplements by D.H. Kent (1992), from which the species' numbers, taxonomy and nomenclature are taken. The Ordnance Survey national grid reference follows the habitat and locality. With the exception of collectors' initials, herbarium abbreviations are those used in *British and Irish Herbaria* by D.H. Kent & D.E. Allen (1984). Records are field records if no other source is stated. For all records 'det.' or 'conf.' appear after the herbarium if the determination was based on material already in an institutional herbarium, otherwise before the herbarium.

The following signs are used:

* before the vice-county number: to indicate a new vice-county record.

† before the species number: to indicate that the plant is an archaeophyte.

‡ before the species number: to indicate that the plant is a neophyte.

© before the species number: to indicate that the plant is a casual.

The above 3 signs may also be used before the vice-county number to indicate the status of the plant in that vice-county.

® before the vice-county number: to indicate that this is an additional hectad for a Rare or Scarce plant.

Ø at end of entry: established taxon not in Vice-County Census Catalogue.

[] enclosing a previously published record: to indicate that that record should be deleted or changed.

The following list contains the first set of records up to and including the year 2006. Further records for this period will be published in the next issue of *Watsonia*.

Huperzia selago 1/1.1. 58, Cheshire: moorland, Shining Tor, SJ997745, D. Shaw, 2005. 1st record since 1900 (in same area).

Equisetum × **litorale** (**E. fluviatile** × **E. arvense**) 4/1.4×5. 10, Wight: in valley marsh, America Wood, Shanklin, SZ5682, P. J. Acock, 2006, **herb. P. J. Acock**. Seen on a field meeting of British Pteridological Society. 1st record since 1970.

Equisetum × **willmotii** (**E. fluviatile** × **E. telmateia**) 4/1.4×9. *10, Wight: roadside verge, Beacon Alley, Godshill, SZ5181, P. D. Stanley, 2005, det. P. J. Acock.

Equisetum × *font-queri* (*E. palustre* × *E. telmateia*) 4/1.8×9. *10, Wight: flushed coastal ledge, St Catherine's Point, SZ4975, P. D. Stanley, 2005, det. P. J. Acock, **herb. C. R. Pope**.

Adiantum capillus-veneris 7/3.1. *‡62, N. E. Yorks.: several colonies on N facing brick wall, rear of Broomfield Terrace, Whitby, NZ894105, V. Jones, 2003.

Polypodium × *mantoniae* (*P. vulgare* × *P. interjectum*) 11/1.1×2. *10, Wight: sunken laneside, Beacon Alley, Godshill, SZ5181, A. M. Paul, **BM**. Seen on a field meeting of British Pteridological Society. *12, N. Hants.: on bank of sunken lane, Wishanger, SU820384, S. Clark & A. R. G. Mundell 2003, det. R. J. Cooke, **HCMS, herb. A.R.G.M.**

‡*Onoclea sensibilis* 16/2.1. *67, S. Northumb.: Belsay Hall, NZ0878, J. L. Durkin, 2005.

Polystichum aculeatum 17/1.2. *10, Wight: plantation woodland, Brighstone Forest, SZ4284, P. D. Stanley, 2005, det. A. M. Paul, **herb. C. R. Pope**.

Dryopteris affinis subsp. *cambrensis* 17/3.3b. *62, N. E. Yorks.: woodland, Wood Head, Great Fryup Dale, NZ7003, K. Trewren, 1996.

Dryopteris × *deweveri* (*D. carthusiana* × *D. dilatata*) 17/3.8×9. 11, S. Hants.: ancient woodland, Spearywell Wood, Mottisfont, SU311279, Hampshire Flora Group, 2005, det. M. W. Rand. 1st record since 1970.

Dryopteris expansa 17/3.10. *62, N. E. Yorks.: one plant in coniferous woodland, Roppa Wood near Helmsley, SE590910, K. Trewren, 2005. Confirmed by chromosome count.

‡*Abies grandis* 20/1.2. *12, N. Hants.: Ecchinswell, SU56A, P. R. Brough, 1987.

‡*Cedrus atlantica* 20/6.2. *12, N. Hants.: BTCV site, Butcher's Copse, Micheldever, SU527383, M. W. Rand, 2003.

‡*Taxodium distichum* (L.) Rich 20A/TAX.dis. *12, N. Hants.: area between road and church, Nether Wallop, SU305365, V. Scott & P. Selby, 1997. Ø

‡*Nuphar advena* 26/2.3. *11, S. Hants.: pond, Swanwick NR, SU508100, D. R. Allan & J. A. Norton, 2004, det. E. J. Clement.

‡*Helleborus orientalis* 28/3.3. *12, N. Hants.: one clump on roadside, Upper Common, Ellisfield, SU632454, E. J. Clement & P. D. Stanley, 1997.

‡*Helleborus argutifolius* 28/3.arg. *12, N. Hants.: E bank of A34, South Wonston, Christmas Hill, SU459358, M. W. Rand, 2004, **HCMS, herb. A.R.G.M.**

‡*Aconitum* × *cammarum* (*A. napellus* × *A. variegatum*) 28/6.1×var. *62, N. E. Yorks.: edge of stream, Waytail Beck, Skinningrove, NZ712193, V. Jones, 2001.

‡*Consolida ajacis* 28/7.1. 113(S), Channel Is. (Sark): on mound of ?introduced soil, La Valette campsite, WV473763, R. M. Veall, 2006, **SARK**. 1st record for Sark since 1953.

©*Anemone blanda* 28/9.bla. *62, N. E. Yorks.: scattered plants in wasteland, near Cheshire Home, Marske, NZ634223, V. Jones, 2001.

‡*Clematis tangutica* 28/12.3. *58, Cheshire: dumped soil, Appleton, SJ659823, G. M. Kay, 2006, **herb. G.M.K.**

©*Clematis montana* 28/12.4. *62, N. E. Yorks.: self-seeding in wasteland, near station, Malton, SE786713, V. Jones & W. A. Thompson, 2006.

‡*Clematis viticella* 28/12.5. *10, Wight: well established in coastal scrub, Hamstead Duver, Newtown, SZ4191, H. Higgins, 2006, det. C. R. Pope, photograph C. R. Pope. Some distance from habitation.

Aquilegia vulgaris 28/16.1. 113(S), Channel Is. (Sark): non-flowering plant by roadside, outside garden of house (Port à la Jument), WV459761, R. M. Veall, 2006, **SARK**. 1st record for Sark since 1953.

‡*Berberis darwinii* 29/1.9. *58, Cheshire: ten self-sown plants in wood, Parkgate, SJ286791, R. F. Goodchild, 2000.

‡*Berberis verruculosa* 29/1.ver. *11, S. Hants.: one bird-sown bush on SW edge of Crooked Hays Copse, Marchwood, SU389101, P. A. Budd, 2005, conf. E. J. Clement, **herb. E. J. Clement**.

‡*Papaver atlanticum* 30/1.2. *©38, Warks.: well established and re-seeding on roadside, Oak Street, Rugby, SP503745, A. L. Primavesi, 2006, conf. J. W. Partridge, **WARMS**.

‡*Corydalis cheilanthifolia* 31/2.3. *62, N. E. Yorks.: several plants in cracks in wall, Thirsk, SE427824, V. Jones & W. A. Thompson, 2006.

‡*Pseudofumaria alba* 31/3.2. *38, Warks.: one clump on wall in alley, Beaconsfield Street, Leamington Spa, SP321654, J. W. Partridge, 2005, conf. M. J. Senior, **WARMS**. Growing with *P. lutea*.

†*Fumaria officinalis* 31/5.7. *58, Cheshire: disturbed verge, Over Winsford, SJ632654, J. H. Clarke, 2004, det. G. M. Kay.

Fumaria densiflora 31/5.8. 10, Wight, arable field edge, Bowcombe Down, SZ4687, P. D. Stanley, 2005, **herb. C. R. Pope**. 1st record since 1970.

†*Fumaria vaillantii* 31/5.10. *11, S. Hants.: arable on chalk, Buckholt Farm, Broughton, SU280325, R. M. Veall, 2004, **herb. M. W. Rand**.

Ulmus × ?*elegantissima* (*U. glabra* × *U. plotii*) 33/1.1×4. *12, N. Hants.: in hedge along track, Coopers in the Wood Farm, St Mary Bourne, SU451511, R. P. Bowman, 1984, **HCMS**.

†*Ficus carica* 35/2.1. *38, Warks.: one plant 3 metres tall established in stonework of bridge, The Dell, Leamington Spa, SP313660, J. W. Partridge, 2006, conf. J. R. Roberts. Spread by birds?

Urtica dioica subsp. *galeopsifolia* 36/1.1b. *58, Cheshire: Eastham, SJ38, J. A. Wheldon, 1901, det. D. V. Geltman, **LIV**. Originally determined as *Urtica dioica* var. *angustifolia*.

†*Urtica membranacea* Poir. ex Savigny 36/1.mem. *38, Warks.: more than a hundred plants in pavement at base of walls, Swan Street, Warwick, SP281648, A. M. Boucher, 2006, conf. E. J. Clement, **WARMS**. Apparently 1st record for British Isles. Ø

†*Juglans regia* 37/1.1. *58, Cheshire: hedgerow in field, Hurleston, SJ634554, Cheshire Recording Group, 2006, det. G. M. Kay. 1st record in wild location.

†*Nothofagus alpina* 39/2.2. *12, N. Hants.: Blackmoor Estate, SW of Blackmoor Road, SU783323, A. R. G. Mundell, 2006, det. E. J. Clement, **HCMS, herb. A.R.G.M.** Presumably planted but in a 'wild' situation, surrounded by native species, on boundary of top-soil recycling centre.

Alnus × *hybrida* (*A. glutinosa* × *A. incana*) 40/2.1×2. *58, Cheshire: one small tree, with both parents, by pool, Pikelow Farm, Marton, SJ858689, G. M. Kay, 2006.

†*Alnus viridis* (Chaix) DC 40/2.vir. *63, S. W. Yorks.: Shaftholme tip, Barnsley, SE5608, G. T. D. Wilmore, 2004. Ø

†*Phytolacca polyandra* 41/1.pol. *63, S. W. Yorks.: verge, near Austerfield, SK6694, G. Coles, 2006, conf. E. J. Clement.

†*Delosperma nubigenum* (Schlechter) L. Bolus 42/DEL.nub. *11, S. Hants.: footway verge, Petersfield, SU740232, C. Wain, 2005, conf. A. R. G. Mundell & M. W. Rand. Documentary photographs held by A. R. G. Mundell but no suitable voucher material surviving at 10 July 2005. Ø Apparently 1st record for British Isles.

†*Chenopodium capitatum* 43/1.3. *17, Surrey: Barnes WWT Wetlands Centre, TQ230770, R. J. Bullock, 1997.

†*Chenopodium glaucum* 43/1.5. ®©39, Staffs.: two plants on soil-covered bank near massive road works, Stoke, SJ880451, I. J. Hopkins, 2006. *©80, Roxburghs.: shoreline, Barons Folly Loch, NT640264, L. W. Gaskell, 2006, det. J. R. Akeroyd, **E, herb. R.W.M.C.** With *Chenopodium rubrum*.

†*Chenopodium polyspermum* 43/1.8. ©81, Berwicks.: two plants in potato field with soya bean waste manure, Hutton, NT909539, M. E. Braithwaite, 2006. 1st record since 1873.

©*Chenopodium urbicum* 43/1.11. *12, N. Hants.: Silchester area, SU66, R. S. Hill, 1836. GR implied.

†*Chenopodium probstii* 43/1.prb. *©81, Berwicks.: one plant in potato field with soya bean waste manure, Hutton, NT909539, M. E. Braithwaite, 2006.

©*Chenopodium quinoa* Willd. 43/1.qui. *63, S. W. Yorks.: road verge, near Brodsworth SE5108, G. T. D. Wilmore, 2006. Ø

†*Atriplex* × *gustafsoniana* (*A. prostrata* × *A. longipes*) 43/3.2×4. *©38, Warks.: one plant in park, Jepson Gardens, Leamington Spa, SP323657, J. W. Partridge, 2005, conf. J. K. Akeroyd, **WARMS**. From bird seed?

Atriplex littoralis 43/3.6. *©38, Warks.: roadside, A47 Washwood Heath, Birmingham, SP096888, J. W. Partridge, 2006, conf. M. W. Poulton, **WARMS**. Birmingham and the Black Country Recording Scheme.

Salicornia ramosissima 43/6.2. *108, W. Sutherland: saltmarsh, Port Chamuill, Loch Eriboll, NC4361, P. A. & I. M. Evans, 2006, det. I. K. Ferguson.

†*Amaranthus retroflexus* 44/1.1. *©81, Berwicks.: three hundred plants in potato field with soya bean waste manure, Hutton, NT909539, M. E. Braithwaite & W. D. Gill, 2006.

†*Amaranthus cruentus* 44/1.3. *12, N. Hants.: railway sidings, Alton area, SU7239, V. Leather, 1959, det. M. McCallum-Webster [Nominal GR] as *A. hybridus* L. subsp. *cruentus*.

‡*Amaranthus bouchonii* 44/1.4. *©39, Staffs.: garden, Wombourne, SO872924, C. B. Westall, 2006. Bird seed alien.

©*Amaranthus blitoides* 44/1.bls. *38, Warks.: garden, St Andrew's Road, Leamington Spa, SP325683, P. Davies, 2005, det. J. W. Partridge, conf. J. L. Mason, **WARMS**. From bird seed.

Herniaria glabra 46/13.1. ®©39, Staffs.: waste ground, in an area of demolished housing, near Seven Arches, Stoke, SJ881453, I. J. Hopkins, 2004.

Illecebrum verticillatum 46/14.1. ®11, S. Hants.: forestry track on sand, Avon Common Peat, SZ135984, SZ135988, R. M. Walls, 2004. *12, N. Hants.: on wet sandy tracks, east of Long Valley, SU842522, C. R. Hall, 2005, conf. A. R. G. Mundell, **HCM**. SSU84285225 to SU84115217 also SU84005227 to SU83875246. Though not continuous certainly several hundreds.

Polycarpon tetraphyllum 46/15.1. *©39, Staffs.: abundant on garden patio, Wombourne, SO872924, C. B. Westall, 2006. Origin unknown.

‡*Lychnis chalconica* 46/18.cha. *©63, S. W. Yorks.: Maltby Far Common, SK5591, G. T. D. Wilmore, 2006. ©83, Midlothian: rough grass by wall of walled garden, Commo Country Park, Edinburgh, NT177746, D. R. McKean, 2005. 1st record since 1970.

‡*Silene armeria* 46/20.7. *10, Wight: roadside pavement crack, Newport, SZ4988, B. Shepard, 2006, det. C. R. Pope.

‡*Persicaria capitata* 47/1.cap. *12, N. Hants.: growing from pavement crack at the end of Conifer Close, Church Crookham, SU810520, C. R. Hall & A. R. G. Mundell, 2005, det. J. R. Akeroyd. *83, Midlothian: about a dozen plants, some flowering, in gutter and pavement, Warriston Gardens, Edinburgh, NT248756, D. R. McKean, 2006, E.

‡*Fallopia* × *bohemica* (*F. japonica* × *F. sachalinensis*) 47/5.1×2. *10, Wight: roadside verge, Sandown, SZ5984, P. R. Green, 2005.

Rumex acetosella subsp. *pyrenaicus* 47/8.1b. *12, N. Hants.: on small spoil heap, S of Easton, Larkwhistle Farm, SU515301, R. M. Veall, 2003. Recorded at species level only in VCCC.

Rumex × *propinquus* (*R. longifolius* × *R. crispus*) 47/8.8×13. ©81, Berwicks.: trackside near Hen Toe Bridge, NT754603, M. E. Braithwaite, 2006. 1st localised record and 1st since before 1970.

‡*Rumex cristatus* 47/8.11. *23, Oxon: two good plants in field, N of Thame Lane, Culham, SU517958, H. J. Killick, 2006, conf. J. R. Akeroyd, **OXF**.

‡*Rumex patientia* 47/8.12. ®64, Mid-W. Yorks.: spreading for c.20 m along top of riverbank, Allerton Bywater, SE410280, Bradford Botany Group, 2006.

Rumex × *ruhmeri* (*R. conglomeratus* × *R. sanguineus*) 47/8.14×15. *11, S. Hants.: disturbed ground, Priestlands School, Lymington, SZ315951, M. W. Rowe, 2004, det. J. R. Akeroyd.

‡*Hypericum hircinum* 51/1.4. *12, N. Hants.: one mature plant with tiny seedling beside it, Noar Hill HWT reserve, SU741318, A. R. G. Mundell, 2002, **HCMS**. First found here by S. Clark. *39, Staffs.: large bush on abandoned railway near Penkridge, SJ919130, I. J. Hopkins, 2006.

‡*Malva alcea* 53/1.2. *12, N. Hants.: one large plant, Morn Hill, Winchester, SU517292, P. Budd, 2003. *38, Warks.: path between houses, Court Farm Road, Erdington, Birmingham, SP100927, M. W. Poulton, 2006, conf. J. W. Partridge, **WARMS**. Birmingham and the Black Country Recording Scheme.

‡*Lavatera arborea* 53/2.1. 67, S. Northumb.: derelict caravan park, South Beach, Blyth, NZ3179, A. & G. Young, 2005. 1st record since 1970.

‡*Lavatera cretica* 53/2.2. *11, S. Hants.: grassy verge near Cleveland Road, Gosport, SZ607994, D. R. Allan, E. J. Clement & J. A. Norton 2004, det. E. J. Clement, **herb. M. W. Rand**.

Viola × *bavarica* (*V. riviniana* × *V. reichenbachiana*) 57/1.4×5. *11, S. Hants.: woodland edge, Sladford Copse, SU516211, M. W. Rand, 2006. Confirmed microscopically from pollen; male sterile. ®64, Mid-W. Yorks.: woodland, Grass Wood, Grassington, SD992649, Bradford Botany Group, 2006, det. P. P. Abbott.

Viola × *intersita* (*V. riviniana* × *V. canina*) 57/1.4×6. *12, N. Hants.: Chilbolton / West Down area, SU33Z, A. B. M. Brewis, 1972, **HCMS**. Still present there in 2002.

Viola canina × *lactea* 57/1.6×7. *12, N. Hants.: Fleet Pond, SU85H, H. C. Watson, 1875, conf. F. Townsend. Recorded in Townsend as 'Hybrid. *V. intermedia*' with text 'Mr Watson kindly sent me in 1876 an interesting series of specimens, gathered in 1875 at Fleet Pond, which show that in leaf character *V. lactea* approaches *V. canina* through his *V. intermedia*.....'.

Viola × *contempta* (*V. tricolor* × *V. arvensis*) 57/1.12×13. *93, N. Aberdeen: track by arable field, Tullo, NJ807308, I. P. Green, 2006.

†*Salix* × *rubens* (*S. fragilis* × *S. alba*) 61/2.2×3. 113(S), Channel Is. (Sark): wet ground near stream, Harbour Hill, WV473757, R. M. Veall, 2006, **SARK**. 1st record for Sark since 1957. (Specimen in **SARK** from 1957 labelled *S. fragilis* but re-determined as *S. × rubens* by R. D. Meikle).

Salix × *holosericea* (*S. viminalis* × *S. cinerea*) 61/2.9×11. *93, N. Aberdeen: hedgerow, Newburgh, NJ997260, D. Welch, 2006, det. R. D. Meikle, **herb. D. Welch**.

Salix × *strepida* (*S. cinerea* × *S. myrsinifolia*) 61/2.11×14. *81, Berwicks.: several bushes, with both parents, on rocky islets in river, Whiteadder Water below Wild Wood, NT772604, M. E. Braithwaite, 2006, det. R. D. Meikle.

‡*Sisymbrium altissimum* 62/1.5. 65, N. W. Yorks.: landfill in silage field, West Burton, Bishopdale, SE014877, C. Helm & D. Millward, 2006. Growing with other aliens. 1st record since 1970.

‡*Barbarea intermedia* 62/11.3. *108, W. Sutherland: top of soil bank above new sea defences, road to cemetery, Scourie, NC149446, I. M. Evans, 2006.

Rorippa × *armoracioides* (*R. sylvestris* × *R. austriaca*) 62/12.5×7. *38, Warks.: small clump in field ditch, Clifton, Rugby, SP529760, J. W. Partridge & A. L. Primavesi, 2005, det. T. C. G. Rich, **WARMS**. Neither parent present.

‡*Cardamine corymbosa* 62/14.cor. *10, Wight: garden centre, Ventnor Botanic Gardens, SZ5476, P. D. Stanley, 2004, det. E. J. Clement.

‡*Arabis turrita* 62/15.3. *83, Midlothian: basalt cliffs, Salisbury Crags, Edinburgh, NT27, J. Hope, 1765. Record from Woodforde's Flora 1824.

‡*Arabis caucasica* 62/15.5. *12, N. Hants.: wall and verge of road, Wishanger, SU831388, D. L. Brookman & A. R. G. Mundell, 2003.

Cochlearia danica 62/23.5. *‡80, Roxburghs.: a few small colonies on edge of A7 near turning to Appletreehall, N. of Hawick, NT509175, M. E. Braithwaite, 2006, **herb. R.W.M.C.**

‡*Coronopus didymus* 62/31.2. *107, E. Sutherland: deciduous woodland, next to W Drummuie Plant Nursery, Golspie, NC833002, P. Eaglesfield, 2006, det. M. E. Murray.

©*Diplotaxis tenuifolia* 62/33.1. 10, Wight: waste ground, Bembridge Fort, SZ6288, C. Lipscombe, 2005, **herb. C. R. Pope**. 1st record since 1970.

‡*Diplotaxis muralis* 62/33.2. 113(S), Channel Is. (Sark): seven plants on stony ground between paving stones, La Clôture de Bas, WV458736, S. Syknott, 2006, **SARK**. 1st record for Sark.

‡*Diplotaxis erucoides* 62/33.eru. 10, Wight: bare ground above coastal revetment, Lake beach, SZ5983, V. Barnett, 2006, det. E. J. Clement, **herb. C. R. Pope**. 1st record since 1970.

©*Brassica napus* subsp. *rapifera* 62/34.2b. *62, N. E. Yorks.: field edge, Riccal Dale, SE622862, V. Jones, 2001.

©*Brassica carinata* 62/34.car. *12, N. Hants.: Meon Hill, SU345359, T. D. Dines, E. Hammler & R. M. Walls, 1997. Voucher taken [location not specified].

©*Raphanus sativus* 62/42.sat. *12, N. Hants.: Cowdown Farm, Andover, SU381432, B. & J. Goater, 1999.

‡*Reseda alba* 63/1.2. *12, N. Hants.: Noar Hill, Selborne, SU741318, S. M. Povey, 1983. Not seen since mid-80s.

©*Reseda odorata* 63/1.odo. *63, S. W. Yorks.: Heeley, Sheffield, SK3484, K. Balkow & G. T. D. Wilmore, 2003.

Daboecia cantabrica 65/6.1. *‡62, N. E. Yorks.: two plants among *Calluna* at edge of moorland track, Rollgate Bank, N of Helmsley, SE633908, H. Burrow & J. Gibson, 2005, det. T. F. Medd, **herb. V. Jones**.

Pyrola rotundifolia subsp. *maritima* 66/1.3b. *17, Surrey: patch c 3m across with 30 flowering spikes, under birch, Riddlesdown Chalkpit, TQ337594, M. Jennings, J. McLauchlin & A. Scott, 1999. Considered native here. *58, Cheshire: moist sandy meadow, Moore Reserve, SJ592860, M. Mulholland, 2004, det. G. M. Kay.

‡*Cyclamen hederifolium* 69/3.1. *62, N. E. Yorks.: abundant, long-established on grassland under trees, by lane side, Chapelgarth, near Great Broughton, NZ559067, V. Jones, 2000... **113(S)**, Channel Is. (Sark): roadside hedgebank, Rue Hotton, WV470760, R. M. Veall, 2006, **SARK**. 1st published record for Sark.

‡*Cyclamen coum* 69/3.2. *12, N. Hants.: plentiful in churchyard, escaping on to adjacent roadside bank, Winchfield churchyard, SU767536, A. R. G. Mundell *et al*, 2004, **HCMS**, **herb. A.R.G.M.**

*62, N. E. Yorks.: long-established on grassland under trees, by lane side, Chapelgarth, near Great Broughton, NZ560067, V. Jones, 2000.

‡*Cyclamen repandum* 69/3.rep. *12, N. Hants.: Conde Way, Bordon, SU796346, P. Budd, 2003.

Lysimachia thyrsiflora 69/4.7. *‡60, W. Lancs.: fen, Marton Mere, Blackpool, SD3435, J. Steeden, 2006. Known for 3-4 years. Natural spread?

†*Anagallis arvensis* subsp. *foemina* 69/6.2b. ©11, S. Hants.: disturbed ground, near balancing pond, Green Close, Fair Oak, SU484182, P. A. Budd, 2004, det. E. J. Clement. 1st record since 1970.

Crassula tillaea 73/1.1. *‡93, N. Aberdeen: trampled soil by sheds, W of hall, Leith Hall, NJ540297, S. D. S. Bosanquet & C. D. Preston, 2006.

‡*Astilbe japonica* 74/1.1. *64, Mid-W. Yorks.: large patch at top of roadside ditch, altitude 398m, in remote area, Greenhow, SE118631, P. P. Abbott & N. Vernon, 2006.

‡*Tellima grandiflora* 74/8.1. *68, N. Northumb.: quarry, Earle, NT9826, F. M. Aungier, Q. J. Groom & P. Johnson, 2006, **herb. G. A. Swan**. Also at NT995536, Berwick, P. Johnson 2006.

‡*Sorbaria tomentosa* 75/1.2. *38, Warks.: non-flowering plants on walls on both sides of road, Oak Street, Rugby, SP503745, J. W. Partridge & A. L. Primavesi, 2005, conf. E. J. Clement, **WARMS**. Flowering in nearby garden.

‡*Spiraea salicifolia* 75/3.1. *81, Berwicks.: suckering patch by River Tweed above Coldstream Bridge, NT847400, M. E. Braithwaite, 2006.

‡*Kerria japonica* 75/7.1. *©81, Berwicks.: one plant by River Tweed, below Ladykirk House, NT887455, M. E. Braithwaite, 2006. *Flore pleno*.

‡*Rubus tricolor* 75/8.2. *10, Wight: bankside stream, Bow Bridge, Freshwater, SZ3487, G. N. Toone, 2006, det. E. J. Clement, **herb. G. N. Toone**. Well established but probably originally planted.

‡*Rubus phoenicolasius* 75/8.8. *11, S. Hants.: woodland edge, Portland Coppice, Purbrook, SU656082, I. Thirlwell, 2005, conf. E. J. Clement.

[*Rubus incurvatus* 75/8.106. 12, N. Hants.: delete record in *Watsonia* 26: 184 (2006). Error for a hybrid of *R. ulmifolius*, det. D. E. Allen.]

Rubus ulmifolius × *R. vestitus* 75/8.142×163. *38, Warks.: roadside, Hampton-in-Arden, SP207808, S. M. Apted, 1987, det. A. Newton, **WARMS**. Ø *39, Staffs.: Napley, SJ7038, D. P. & J. Earl, 2006.

Rubus griffithianus 75/8.185. *11, S. Hants.: heavy scrub, Ampfield Wood, SU409244, D. E. Allen, 2001, conf. A. Newton, **BM**. *12, N. Hants.: hedge of lane, one-time Froxfield Common, near Selborne, SU7028, D. E. Allen & B. Goater, 2003, conf. A. Newton, **BM**, **HCMS**.

Rubus longithyriger 75/8.242. *39, Staffs.: trackside scrub, Coldridge Wood, SO800821, R. Maskew & A. Newton, 2000.

Rubus hylocharis 75/8.270. 38, Warks.: Hay Wood, Wroxhall, SP206708, M. M. Burgoine, 1989, det. A. Newton, **WARMS**. 1st record since 1879.

Rubus angloserpens 75/8.295. *39, Staffs.: Arley, SO7679, D. P. & J. Earl, 2006.

Rubus hylonomus 75/8.296. *12, N. Hants.: Chawton Park Wood, Four Marks, SU673363, D. E. Allen, 2006, conf. A. Newton, **BM**, **HCMS**, **NMW**.

Rubus cerdicii D. E. Allen 75/8.cer. *12, N. Hants.: open scrub, St. Giles's Hill, Winchester, SU489292, D. E. Allen, 2005, **HCMS**. Ø

©*Potentilla inclinata* 75/9.6. *12, N. Hants.: pavement weed, Longstock Nurseries, SU368387, B. Goater & M. W. Rand, 2006. Also pot weed at SU367389.

‡*Potentilla eriocarpa* Wall. ex Lehm. 75/9.eri. *63, S. W. Yorks.: Wrose, Bradford, SE157372, B. K. Byrne & B. A. Tregale, 2006. Ø

Alchemilla filicaulis subsp. *filicaulis* 75/19.10a. *62, N. E. Yorks.: limestone grassland, Murton Bank, Hawaby, SE538884, V. Jones, 2002.

Rosa spinosissima 75/21.5. *†12, N. Hants.: West Down, Chilbolton, SU3838, V. Scott & P. Selby, 1998.

†*Rosa ferruginea* 75/21.8. *38, Warks.: single plant in fruit on derelict building site off Wood Street, Dudley, SP505760, J. W. Partridge, 2006, conf. A. L. Primavesi, **WARMS**.

†*Rosa virginiana* 75/21.9. *12, N. Hants.: Dummer old orchard, SU585458, P. Budd, 2002.

Rosa × *toddiae* (*R. canina* × *R. micrantha*) 75/21.12×19. *10, Wight: hedgerow, Chale Green, SZ4779, P. D. Stanley, 2006, det. R. Maskew. 38, Warks.: hedgerow, Astley Hall Farm, Bedworth, SP326867, J. W. Partridge & B. Proctor, 2005, det. R. Maskew & A. L. Primavesi, **WARMS**. 1st record since 1887.

Rosa × *bishopii* (*R. micrantha* × *R. agrestis*) 75/21.19×20. *12, N. Hants.: with several bushes that are clearly *R. agrestis* nearby, Isle of Wight Hill, Porton Ranges, SU253374, P. D. Stanley *et al*, 2005, det. R. Maskew, **HCMS**.

Rosa agrestis × *R. canina* 75/21.20×12. *12, N. Hants.: near 'Horshoe Pit', Noar Hill, Selborne, SU740318, P. Budd, 1997, det. R. Maskew, **HCMS**. Originally recorded as *R. agrestis* but a specimen from the bush was determined as this hybrid by R. Maskew. Ø

†*Prunus persica* 75/22.1. *39, Staffs.: waste ground on trading estate, Kingswinford, SO898894, C. B. Westall, 2005. Presumably from a discarded fruit stone.

†*Prunus serotina* 75/22.12. *63, S. W. Yorks.: Bolton Lane, Bradford, SE164350, B. A. Tregale, 2006.

†*Cotoneaster salicifolius* 75/32.10. *62, N. E. Yorks.: several bird-sown plants in old coal bunkers near station, Great Ayton, NZ573108, V. Jones, 2004.

†*Cotoneaster* × *suecicus* (*C. dammeri* × *C. conspicuus*) 75/32.11×18. *62, N. E. Yorks.: one bird-sown plant in wasteland, Warrenby, NZ585251, V. Jones, 2003, conf. W. A. Thompson.

†*Cotoneaster lacteus* 75/32.13. *39, Staffs.: verge on central reservation of ring road, Wolverhampton, SO918985, C. B. Westall, 2006. Not planted.

†*Cotoneaster conspicuus* 75/32.18. *38, Warks.: limestone quarry, Bishop's Itchington, SP393584, J. W. Partridge, 2005, conf. J. Fryer, **WARMS**. *62, N. E. Yorks.: woodland, by Hodge Beck, Cockayne, Bransdale, SE622985, V. Jones, 2004, conf. J. Fryer, **herb. V. Jones**.

†*Cotoneaster divaricatus* 75/32.26. *62, N. E. Yorks.: one bird-sown plant by edge of footpath, Ormesby, NZ533166, V. Jones & W. A. Thompson, 2006.

†*Cotoneaster bullatus* 75/32.34. *38, Warks.: tall shrub in limestone quarry, Bishop's Itchington, SP393584, J. W. Partridge, 2005, conf. J. Fryer, **WARMS**. *62, N. E. Yorks.: one bird-sown plant on top of wall, Pickering, SE799827, V. Jones & W. A. Thompson, 2005.

†*Cotoneaster rehderi* 75/32.35. *62, N. E. Yorks.: grassland, Beck Dale, Helmsley, SE607843, V. Jones, 1996.

†*Cotoneaster splendens* 75/32.38. *63, S. W. Yorks.: Bolling Road, Bradford, SE169317, B. A. Tregale, 2006, det. J. Fryer.

†*Cotoneaster franchetii* 75/32.39. *62, N. E. Yorks.: one bird-sown plant on top of wall, Pickering, SE799827, V. Jones & W. A. Thompson, 2005.

†×*Crataepilus grandiflora* (*Mespilus germanica* × *Crataegus laevigata*) 75/34×35.1×8. *38, Warks.: established in ditch in urban recreation ground, Short Heath Park, Birmingham, SP100923, J. W. Partridge & M. W. Poulton, 2006, conf. S. J. Falk, **WARMS**. No planted trees near.

†*Crataegus heterophylla* 75/35.9. *12, N. Hants.: Fyfield, Littleton Farm, SU289475, M. Wildish, 1997.

©*Stephanandra incisa* (Thunb.) Zabel 75/STE.inc. *©63, S. W. Yorks.: Forster Square, Bradford SE164335, B. A. Tregale, 1995, det. E. J. Clement. Ø

Lotus angustissimus 77/8.5. *†10, Wight: set aside land, Presford Farm, Shorwell, SZ4682, G. N. Toone, 2005, det. F. J. Rumsey, **herb. C. R. Pope**.

†*Lathyrus rotundifolius* Willd. 77/15.rot. *12, N. Hants.: established in hedge outside Fawknors Cottage, Axford, SU610429, B. & J. Goater, 2002. Ø

Ononis × *pseudohircina* (*O. spinosa* × *O. repens*) 77/16.3×4. *12, N. Hants.: on chalky hummocks in alluvial pasture, Bransbury Common, SU416417, R. P. Bowman, 1988, **HCMS**.

†*Melilotus albus* 77/17.2. ©81, Berwicks.: twenty plants in game strip near Broomdykes, NT886540, M. E. Braithwaite, 2006. 1st record since 1956.

†*Melilotus officinalis* 77/17.3. ©81, Berwicks.: six plants in game strip near Broomdykes, NT886540, M. E. Braithwaite, 2006. 1st record since 1962.

- Medicago sativa** subsp. **varia** 77/18.2b. *©81, Berwicks.: one plant on wall top, Upsettlington, NT886484, M. E. Braithwaite, 2006.
- Genista pilosa** 77/25.3. *©63, S. W. Yorks.: Wheatley, Doncaster, SE5904, L. A. Hill, 2006.
- ©**Glycine max** 77/GLC.max. *58, Cheshire: five plants in disturbed ground, Bidston Dock, SJ298909, R. F. Goodchild, 2003.
- ©**Pisum sativum** 77/PIS.sat. *63, S. W. Yorks.: Trafalgar St, Bradford, SE161337, B. A. Tregale, 2006.
- ©**Trigonella foenum-graecum** 77/TRI.foe. *38, Warks.: one plant in car park, Leamington Spa, SP309656, K. Davies, 1986, det. J. W. Partridge, **WARMS**. From bird seed?
- ‡**Eucalyptus gunnii** 83/2.gun. *63, S. W. Yorks.: regenerating seedling, Bawtry Plantation SK6294, G. Coles, 2006.
- Epilobium** × **erroneum** (**E. hirsutum** × **E. montanum**) 84/1.1×3. *62, N. E. Yorks.: waste field, Skelton, NZ62P, V. Jones, 2001, conf. G. D. Kitchener, **herb. V. Jones**.
- Epilobium** × **brevipilum** (**E. hirsutum** × **E. tetragonum**) 84/1.1×5. *62, N. E. Yorks.: waste field, Skelton, NZ62P, V. Jones, 2001, conf. G. D. Kitchener, **herb. V. Jones**.
- Epilobium** × **novae-civitat** (**Epilobium hirsutum** × **E. ciliatum**) 84/1.1×8. *39, Staffs.: two plants in roadside paving, E of Pheasey, SP075954, E. V. J. Cohn, M. W. Poulton & I. C. Trueman, 2006.
- Epilobium** × **limosum** (**E. parviflorum** × **E. montanum**) 84/1.2×3. *62, N. E. Yorks.: old railway, Robin Hood's Bay, NZ964023, V. Jones & W. A. Thompson, 2005, **herb. V. Jones**.
- Epilobium** × **dacicum** (**E. parviflorum** × **E. obscurum**) 84/1.2×6. *62, N. E. Yorks.: chalk field, near Stonegrave, SE 656784, V. Jones, 2003, conf. G. D. Kitchener, **herb. V. Jones**.
- Epilobium** × **floridulum** (**E. parviflorum** × **E. ciliatum**) 84/1.2×8. *12, N. Hants.: beside heap of old straw near small spoil heap, S of Easton, Larkwhistle Farm, SU515301, R. M. Veall, 2003. *62, N. E. Yorks.: floor of old quarry, Ash Dale, Helmsley, SE68C, V. Jones, 2001, conf. G. D. Kitchener, **herb. V. Jones**.
- Epilobium** × **haussknechtianum** (**E. montanum** × **E. tetragonum**) 84/1.3×5. *62, N. E. Yorks.: waste field, Skelton, NZ62P, V. Jones, 2001, conf. G. D. Kitchener, **herb. V. Jones**.
- Epilobium** × **aggregatum** (**E. montanum** × **E. obscurum**) 84/1.3×6. *62, N. E. Yorks.: garden weed, Robin Hood's Bay, NZ951055, V. Jones & W. A. Thompson, 2005, conf. G. D. Kitchener, **herb. V. Jones**.
- Epilobium lanceolatum** 84/1.4. 10, Wight: garden, Shanklin, SZ5881, V. Barnett, 2006, det. E. J. Clement, **herb. C. R. Pope**. Long established in this garden. 1st record since 1970.
- Epilobium** × **mentiens** (**E. tetragonum** × **E. ciliatum**) 84/1.5×8. *62, N. E. Yorks.: garden weed, Botanic Centre, Acklam, Middlesbrough, NZ 495156, V. Jones, 2005, conf. G. D. Kitchener, **herb. V. Jones**.
- Epilobium** × **vicinum** (**E. obscurum** × **E. ciliatum**) 84/1.6×8. *62, N. E. Yorks.: garden weed, Ingleby Greenhow, NZ581064, V. Jones, 2004, conf. G. D. Kitchener, **herb. V. Jones**.
- Epilobium roseum** 84/1.7. *68, N. Northumb.: Gainslow Circuit, Whiteadder, NT955553, M. E. Braithwaite, 2003.
- ‡**Oenothera biennis** 84/4.3. 68, N. Northumb.: Holy Island, NU14SW, A. & G. Young, 2005. 1st record since 1970.
- ‡**Cornus mas** 85/1.4. *62, N. E. Yorks.: a few trees in woodland by R. Esk, Lealholm, NZ762076, V. Jones, 1993.
- ‡**Griselinia littoralis** 85/3.1. *12, N. Hants.: beside track, Alresford, SU588331, A. R. G. Mundell *et al.*, 2003.
- ‡**Euphorbia maculata** 91/2.2. *12, N. Hants.: a common weed in the larger pots of olive trees etc, Longstock Park Nursery, SU367388, B. Goater & A. R. G. Mundell, 2006, det. E. J. Clement, **HCMS, herb. A.R.G.M.** Prostrate growth with leaves sometimes spotted and sometimes not. The sheet contains two specimens, the larger one det. by E. J. Clement as *E. maculata*, but the smaller one from another pot, det. E. J. Clement, November 2006 as 'suggestive of *Euphorbia thymifolia*'.
- ‡**Euphorbia lathyris** 91/2.9. ‡81, Berwicks.: good colony at foot of town wall, Coldstream, NT844399, M. E. & P. F. Braithwaite, 2006. 1st record since 1951.
- Euphorbia paralias** 91/2.13. *75, Ayr.: on sand dune, Stevenston Beach Local Nature Reserve, NS263409, C. Sharpe, 2005, conf. D. A. Lang. 1st record for v.c. spotted by Local Authority Outreach Ranger and confirmed by site visit by vice-county recorder and Scottish Wildlife Trust. Photograph with vice-county recorder.

‡**Euphorbia** × **pseudoesula** (**E. esula** × **E. cyparissias**) 91/2.14×15. *12, N. Hants.: well-established patch c.7 x 5 metres at Hollybush Hill in grassland capping former tip, Hollybush Park, Blackwater Valley, SU8852, C. R. Hall, 2004. GR inferred.

©**Euphorbia esula** × **E. boissieriana** 91/2.14×boi. *38, Warks.: railway sidings, Small Heath, Birmingham, SP095872, J. W. Partridge, 1989, det. A. Radcliffe-Smith, **WARMS**. *E. boissieriana* not present. Ø Apparently 1st and only record for British Isles.

‡**Euphorbia amygdaloides** subsp. **robbiae** 91/2.16b. *58, Cheshire: old railway, Parkgate, SJ280788, R. F. Goodchild, 2003.

‡**Euphorbia oblongata** 91/2.obl. *12, N. Hants.: in ballast, Longstock Nurseries, SU367389, B. Goater & M. W. Rand, 2006.

Rhamnus cathartica 92/1.1. ‡83, Midlothian: overgrown hedge, by steps above Duddingston Loch, NT284725, J. Muscott, 2005, conf. M. Gardener & D. R. McKean. Specimen in E from a hedge in this locality in 1834! 1st record since 1970.

‡**Parthenocissus inserta** 93/2.2. *12, N. Hants.: dozens of young plants running across ground beneath a pine tree beside Shoe Lane, Watts Common, Farnborough, SU862529, A. R. G. Mundell, 2002. *63, S. W. Yorks.: Dowley Gap Bridge, Bingley SE121383, B. A. Tregale & G. T. D. Wilmore, 2006.

‡**Linum perenne** 94/1.3. *12, N. Hants.: Hares Farm, Hartley Wintney, SU7657, H. J. M. Bowen, 1988.

‡**Ailanthus altissima** 101/1.1. *38, Warks.: self-sown in garage forecourt, Regent Place, Leamington Spa, SP320653, J. W. Partridge, 2005, conf. S. J. Falk, **WARMS**. Trees planted in Leamington Spa since 1973.

‡**Ruta graveolens** L. 101A/RUT.gra. *12, N. Hants.: in Woolmer Trading Estate, Bordon, SU7836, A. B. M. Brewis, 1997. Ø

‡**Oxalis dillenii** 102/1.5. *17, Surrey: at bottom of brick wall behind a wayside border, Ham House, Richmond, TQ1773, E. Norman, 2006. Seeds with white spot.

‡**Geranium** × **magnificum** (**G. ibericum** × **G. platypetalum**) 103/1.13×pla. *38, Warks.: large, well established clump on soil dump from quarry, Griff Hollow, Nuneaton, SP361893, J. W. Partridge & B. Proctor, 2005, conf. M. J. Senior, **WARMS**.

‡**Geranium potentilloides** L'Her.ex D.C. 103/1.pot. *12, N. Hants.: near station, Bordon (N) area, Whitehill, SU73Y, A. B. M. Brewis & F. Rose, 1972, **HCMS**. GR inferred. Ø

Erodium maritimum 103/2.1. *©12, N. Hants.: Headley, SU83, F. Davidson, 1922. In Rayner's 1929 supplement to Townsend's Flora.

†**Erodium moschatum** 103/2.2. 60, W. Lancs.: central reservation of A6, Preston, SD552288, P. Jepson, 2006. 1st record since 1931.

©**Erodium brachycarpum** 103/2.bra. *12, N. Hants.: in raspberry crop manured with shoddy, Blackmoor Estate, Blackmoor, SU7732, S. R. Davey, 1972, det. A. B. M. Brewis, **HCMS**. Recorded as *Erodium obtusiplicatum*.

‡**Limnanthes douglasii** 103A/LIM.dou. *12, N. Hants.: Magdalen Hill Down, SU514291, P. Budd, 1999.

©**Tropaeolum majus** 104/1.maj. *65, N. W. Yorks.: landfill in silage field, West Burton, Bishopdale, SE014877, C. Helm & D. Millward, 2006. Growing with other aliens.

‡**Hydrocotyle ranunculoides** 107/1.ran. *©38, Warks.: in man-made pond, Wixford, Alcester, SP086545, N. Walker, 2005, conf. S. J. Whild.

©**Coriandrum sativum** 107/9.1. *12, N. Hants.: Nuthanger Farm, SU496584, E. A. Burrows, 1955.

[**Apium nodiflorum** × **A. repens** 107/28.2×3. 38, Warks. No trace of this in records or herbarium. Possible confusion with *Apium* × *moorei*. Delete.]

Apium × **moorei** (**A. nodiflorum** × **A. inundatum**) 107/28.2×4. *38, Warks.: salty pool, Flecknoe, SP500643, J. R. Sharpe, 1964, det. R. D. Meikle, **WARMS**.

‡**Ferula communis** 107/FER.com. *©63, S. W. Yorks.: Catcliffe, Sheffield, SK4389, E. Ellis, 2006, conf. G. T. D. Wilmore.

‡**Physalis alkekengi** 110/6.1. *38, Warks.: on wall, path between houses, Chattack Close, Hodge Hill, Birmingham, SP130891, J. W. Partridge, 2006, conf. M. W. Poulton, **WARMS**. Birmingham and the Black Country Recording Scheme.

‡**Solanum nigrum** subsp. **schultesii** 110/8.1b. *12, N. Hants.: in pots mostly of imported trees, Longstock Nurseries, SU368387, B. Goater & M. W. Rand, 2006.

‡**Solanum tuberosum** 110/8.7. *68, N. Northumb.: near Tiptoe, NT913415, F. M. Aungier & C. Kanefsky, 2003.

©**Solanum rostratum** 110/8.ros. *60, W. Lancs.: tow path, Lancaster Canal, Lancaster, SD481668, J. H. Clarke, 2006, det. E. J. Clement. *65, N. W. Yorks.: landfill in silage field, West Burton, Bishopdale, SE014877, C. Helm & D. Millward, 2006. Growing with other aliens.

‡**Datura ferox** 110/9.fer. ©11, S. Hants.: barrier bank of imported earth, Gilkicker, Gosport, SZ601982, D. R. Allan & J. A. Norton, 2004, det. E. J. Clement. 1st record since 1970.

©**Petunia** × **hybrida** (**P. axillaris** × **P. integrifolia**) 110/PET.axi×int. *12, N. Hants.: on dumped soil by new cycle path on north side of road, A327 Hornley Common, SU827576, P. Budd, 2003.

‡**Calystegia silvatica** subsp. **disjuncta** Brummitt 111/3.4b. *12, N. Hants.: Shipton Bellinger, SU236457, P. Billingham, 2002. Ø

Polemonium caeruleum 114/1.1. *©12, N. Hants.: Ashford Hill / Haughurst Hill area, SU5662, V. Field 1979. GR inferred.

‡**Phlox paniculata** 114/PHL.pan. *©63, S. W. Yorks.: roadside verge, Edlington, SK5495, G. Coles, E. Ellis & G. T. D. Wilmore, 2006.

‡**Echium pininana** 116/2.4. *58, Cheshire: twenty plants on waste heaps and surrounding area, Ness Gardens, SJ302755, R. F. Goodchild, 2003. May prove established but not the choicest of records.

‡**Symphytum asperum** 116/4.2. *12, N. Hants.: W side of track leading to Butterfly Conservation Reserve by cemetery, No Mans Land, Winchester, SU511293, B. Goater, 1995.

‡**Symphytum bulbosum** 116/4.8. *12, N. Hants.: large colony a little off the road under trees, Ashford Chase - by road, SU737262, P. Budd, 2006.

‡**Brunnera macrophylla** 116/5.1. *62, N. E. Yorks.: one well-established plant, woodland edge, Gillamoor, SE683899, V. Jones, 2005.

‡**Amsinckia micrantha** 116/12.2. *10, Wight: several plants in sand dunes, St Helen's Duver, SZ6388, G. N. Toone, 2006, det. E. J. Clement, photograph C. R. Pope.

‡**Amsinckia retrorsa** Suksd. 116/12.ret. *83, Midlothian: Leith Docks, Edinburgh, NT2776, J. Fraser, 1907, conf. Per Lassen, E. Ø

©**Amsinckia tessellata** A. Gray 116/12.tes. *83, Midlothian: Leith Docks, Edinburgh, NT2776, J. Fraser, 1909, conf. Per Lassen, E. Originally det. as likely *A. douglasiana*. Ø

©**Cerithe major** L.116/CER.maj. *38, Warks.: single plant in allotment, Spring Estate, Clifford Bridge Road, Coventry, SP377793, J. Brown, 2006, conf. J. W. Partridge, WARMS. Not sown. *62, N. E. Yorks.: regularly self-seeding in pavement cracks, by Conservative Club, Great Ayton, NZ656107, V. Jones, 2003.

113(S), Channel Is. (Sark): several plants self-seeded on roadside bank from nearby garden, Mill Lane, WV464758, R. M. Veall, 2006. 1st record for Sark. Ø

‡**Verbena rigida** 117/1.rig. *10, Wight: single plant in disturbed ground in woodland, Bouldnor Copse, SZ3890, D. T. Biggs, 2006, det. C. R. Pope. Well away from habitation.

‡**Stachys byzantina** 118/1.2. *38, Warks.: building site, Radnor Drive, Nuneaton, SP343908, B. Proctor, 2005, conf. M. J. Senior, WARMS.

‡**Ballota nigra** 118/2.1. 113(S), Channel Is. (Sark): scrub behind toilet, Visitor Centre, WV466758, R. M. Veall, 2006, SARK. 1st record for Sark since 1957.

‡**Lamiastrum galeobdolon** subsp. **argentatum** 118/4.1c. 113(S), Channel Is. (Sark): several plants on verge on west side of lane near La Valette de Bas, WV471760, R. M. Veall, 2006, SARK. 1st record for Sark. (Probably spread from nearby garden).

Melittis melissophyllum 118/8.1. *12, N. Hants.: Ovington, SU5631, W. A. Bromfield, 1850. GR inferred. In Townsend's 1883 *Flora of Hampshire* he states 'At Ovington Dr Bromfield states the flowers are sometimes nearly white'.

‡**Teucrium chamaedrys** 118/11.2. ©38, Warks.: pavement, Walsgrave on Sowe, SP377805, M. J. Senior, 2003, conf. J. W. Partridge. 1st record since 1962.

Clinopodium calamintha 118/18.3. *©63, S. W. Yorks.: waste ground, Chapeltown SK3596, K. Balkow, 2006, conf. G. T. D. Wilmore.

‡**Mentha** × **rotundifolia** (**M. suaveolens** × **M. longifolia**) 118/23.4×lon. *12, N. Hants.: waste by river, Monxton area, SU34C, G. D. Field, 1984.

Salvia verbenaca 118/25.4. **113(S)**, Channel Is. (Sark): vegetable garden, La Seigneurie Gardens, WV483764, M. L. Long, 2006, **SARK**. 1st record for Sark. Additional plant found at edge of woodland outside vegetable garden.

‡**Salvia viridis** 118/25.5. ***12**, N. Hants.: Whitchurch, SU469483, R. P. Bowman, 1966.

‡**Salvia verticillata** 118/25.6. ©**12**, N. Hants.: nine flower spikes on disused railway, E of Longparish, SU448448, J. Moon, 2004, det. A. R. G. Mundell. 1st record since 1932.

©**Agastache rugosa** Kuntze 118/AGA.rug. ***62**, N. E. Yorks.: one plant among nettles, in caravan site, Lebbeston, TA0882, J. Clarke, 2003, det. E. J. Clement, **herb. E. J. Clement**. See *BSBI News* 99: 46 (2005). Ø

‡**Fraxinus ornus** L. 123/2.orn. ***12**, N. Hants.: Hurstbourne Park, Whitchurch, SU4447, H. J. M. Bowen & F. Rose 1986. Ø

‡**Jasminum nudiflorum** 123/JAS.nud. ***60**, W. Lancs.: roadside verge, Galgate, Ellel, Lancaster, SD476552, M. Wilcox, 2006.

‡**Verbascum blattaria** 124/1.1. ***58**, Cheshire: two plants on road verge, Hurleston, SJ633548, Cheshire Recording Group, 2006, det. G. M. Kay. Presumably garden escapes. Flowers pink.

‡**Scrophularia vernalis** 124/2.5. **11**, S. Hants.: churchyard and hedgebanks, East Tytherley, SU291290, G. D. Field, 2005. 1st record since 1970.

‡**Veronica peregrina** 124/16.18. ***12**, N. Hants.: plentiful as a weed along a damp gravel pathway at Longstock Park Nurseries, SU366388, B. & J. Goater, 2006, det. M. W. Rand. First reported by P. R. Green in 2005.

Euphrasia nemorosa × **E. pseudokernerii** 124/20.7×8. ***12**, N. Hants.: S. facing steep slope below Coombe Gibbett at c. 850 ft, among hawthorns, in pasture grazed by cows, Inkpen Hill, Combe, SU366620, P. F. Yeo, 1974. A few yards from a colony of *Polygala calcarea*.

Rhinanthus minor subsp. **calcareus** 124/24.2d. ***12**, N. Hants.: Magdalen North Down, SU507292, A. R. G. Mundell & M. W. Rand, 2006, **HCMS, herb. A.R.G.M.** This area has been sown with seed taken from Salisbury Plain - a stronghold for this subspecies. (There was an earlier 1981 record by Dr Francis Rose and Lady Anne Brewis for East of South Tidworth, SU24N, where presumably native, but they omitted it from their *Flora of Hampshire* with the comment that the subspecies can intergrade).

©**Rhinanthus alectorolophus** (Scop.) Pollich 124/24.ale. ***38**, Warks.: persisted for 2-3 years on seeded roadside but now gone, Wellesbourne bypass, SP272549, J. W. Partridge, 1992, det. D. J. Hambler, **herb. D.J.H.** Apparently 1st and only record for British Isles. Ø

‡**Nemesia strumosa** Benth. 124/NEM.str. *©**63**, S. W. Yorks.: Kings Road, Bradford, SE163345, B. A. Tregale, 2005. Ø

‡**Lathraea clandestina** 125/1.2. ***38**, Warks.: on willow by R. Blythe, Malvern Park, Solihull, SP156788, W. A. Seaby, 1983, conf. P. J. Copson. Planted in 1978, established and seen at two further sites on R. Blythe in 1990 and 1999.

Orobanche hederæ 125/2.8. ***58**, Cheshire: four spikes in part of garden overgrown with *Hedera helix*, Gayton, Wirral, SJ284804, E. F. Greenwood, 2005.

‡**Acanthus mollis** 127/1.1. *©**62**, N. E. Yorks.: cracks in steps, St. Olave's church, York, SE598522, V. Jones & W. A. Thompson, 2006.

‡**Acanthus spinosus** 127/1.2. ***12**, N. Hants.: South Wonston - South, SU479353, P. Budd, 2002.

©**Campanula medium** 129/1.5. ***62**, N. E. Yorks.: wasteland, Dean Road, Scarborough, TA038888, V. Jones & W. A. Thompson, 2005.

‡**Campanula cochleariifolia** 129/1.coc. ***62**, N. E. Yorks.: well-established on wall, near bus station, Whitby, NZ897108, V. Jones & W. A. Thompson, 2005.

‡**Pratia pedunculata** (R.Br.) Benth. 129/8.pra. ***10**, Wight: garden lawn, Brighstone, SZ4282, P. D. Stanley, 2005, det. E. J. Clement. Ø

Galium parisiense 130/6.14. *‡**11**, S. Hants.: road verge, HMS Sultan, Gosport, SU593010, E. J. Clement, 2005.

‡**Symphoricarpos** × **chenaultii** (**S. orbiculatus** × **S. microphyllus**) 131/3.orb×mic. ***93**, N. Aberdeen: roadside bank, Daviot, NJ7526, I. P. Green, 2006.

‡**Lonicera pileata** 131/6.1. ***12**, N. Hants.: Swarraton, SU582377, M. W. Rand, 2003.

‡**Lonicera japonica** 131/6.6. ***58**, Cheshire: hedgerow, West Kirby, SJ225847, R. F. Goodchild, 2004.

‡*Lonicera* × *italica* (*L. caprifolium* × *L. etrusca*) 131/6.8×etr. *11, S. Hants.: scrubby woodland edge, Fritham, SU231139, M. W. Rand, 2006.

‡*Lonicera morrowii* (hybrid of) 131/6.mor× *©80, Roxburghs.: one long established bush on riverside, Ale Water at Ancrum old church, NT621248, J. Mercer, 2006, det. D. R. McKean & D. Chamberlain, E, herb. R.W.M.C. Parentage unknown.

‡*Scabiosa atropurpurea* 134/5.2. *©80, Roxburghs.: old quarry above road S.W. of Colmsliehill, NT506405, J. Mercer, 2006, det R. W. M. Corner. Garden throw-out.

‡*Echinops exaltatus* 135/1.2. *62, N. E. Yorks.: long-established in waste grassland, Battersby, NZ596076, V. Jones, 1999. *©63, S. W. Yorks.: Middlewood, Sheffield SK3191, K. Balkow, 2006.

‡*Echinops bannaticus* 135/1.3. *10, Wight: woodland edge, Newchurch, SZ5685, D. T. Biggs, 2006, det. C. R. Pope. *68, N. Northumb.: opposite golf-course, Berwick, NU172359, A. & G. Young, 2005.

Arctium × *nothum* (*A. lappa* × *A. minus*) 135/3.1×2. *58, Cheshire: on field edge with both parents, Hurleston, SJ631556, Cheshire Recording Group, 2006, det. G. M. Kay.

Cirsium × *boulayi* (*C. acaule* × *C. arvense*) 135/6.8×10. *12, N. Hants.: on corner of track, Porton Down, SU248393, A. R. G. Mundell, 2002, det. K. Walker, HCMS.

‡*Centaurea macrocephala* 135/11.mac. *38, Warks.: well established in roadside ditch, Broad Lane, Hockley, Coventry, SP271798, M. J. Senior, 2005, conf. E. J. Clement, WARMS.

‡*Cichorium intybus* 135/12.1. *107, E. Sutherland: conifer plantation by upstream bridge on forest walk, Skelbo Wood, near Dornoch, NH777945, M. E. Murray, 2006.

‡*Pilosella flagellaris* subsp. *flagellaris* 135/27.3a. 11, S. Hants.: grassy verges, Hightown and Thornhill, Southampton, SU466199, SU470117, P. A. Budd, 2004. 1st record since 1970.

[*Hieracium rubiginosum* 135/28.63. 39, Staffs.: Peaseland Rocks & Wetton Mill, SK05, 1884 & 1954, CGE. Delete. The specimens have been re-determined as *H. peccense* by P. D. Sell. No later records are known.]

[*Hieracium maculatum* 135/28.74. 39, Staffs.: Codsall & Alstonefield, SJ80, SK15, 1852 & 1899, CGE. Delete. The specimens have been re-determined as *H. spilophaem* & *H. fictum*, respectively, by P. D. Sell.]

Hieracium holophyllum 135/28.148. *39, Staffs.: Peaseland Rocks, Dove Dale, SK1456, 1884, det. P. D. Sell, CGE. Specimen previously labelled as *H. caledonicum*.

[*Hieracium subplanifolium* 135/28.174. 39, Staffs.: Wetton Valley, Alstonefield, SK15, 1877, CGE. Delete. The specimen has been re-determined as *H. dalense*, by P. D. Sell.]

‡*Hieracium argillaceum* Jord. 135/28.arg. *39, Staffs.: Swynnerton, Hanchurch Hills, SJ8340, 1948, det. P. D. Sell, CGE. Specimen previously labelled as *H. acuminatum*. *63, S. W. Yorks.: Thackley disused railway, Bradford, SE176389, B. A. Tregale, 2004, det. V. Jones. Ø

Hieracium aterrimum Hyl. 135/28.ate. *17, Surrey: on chalk rubble, near Juniper Hall, Mickleham, TQ171524, J. H. P. Sankey, 1956, CGE, det. P. D. Sell (1999). Ø

‡*Hieracium aviicolia* Jord. ex Boreau 135/28.avi. *39, Staffs.: Red Hurst, Wetton, SK05, 1888, det. D. J. McCosh, BM. Specimen previously labelled as *H. acuminatum*. Ø

Hieracium consociatum Jord. ex Boreau 135/28.con. *39, Staffs.: a few on laneside bank SW of Flash, SK012663, J. E. Hawksford & W. A. Thompson, 2004. Ø

Hieracium daedalolepioides (Zahn) Roffey 135/28.dae. *39, Staffs.: Alstonefield, SK15, 1951, det. P. D. Sell, CGE. Specimen previously labelled as *H. diaphanum*. Ø

Hieracium dalense P. D. Sell 135/28.dal. *39, Staffs.: Wetton Valley, Alstonefield, SK15, 1877, det. P. D. Sell, CGE. Specimen previously labelled as *H. subplanifolium*. Ø

Hieracium dentulum (E. F. Linton) P. D. Sell 135/28.den. *39, Staffs.: Mill Dale, SK1354, 1893, det. P. D. Sell, CGE. Specimen previously labelled as *H. caledonicum*. Ø

‡*Hieracium fictum* Jord. ex Boreau 135/28.fic. *39, Staffs.: near Alstonefield Vicarage, SK15, 1899, det. P. D. Sell, CGE. Specimen previously labelled as *H. maculatum*. Ø

Hieracium koehleri Dahlst. 135/28.koe. *17, Surrey: on chalk rubble near Juniper Hall, Mickleham, TQ171524, J. H. P. Sankey, 1956, CGE, det. P. D. Sell. Ø

Hieracium peccense (W. R. Linton) P. D. Sell 135/28.pec. *39, Staffs.: Peaseland Rocks, Dove Dale, SK1456, 1884, det. P. D. Sell, CGE. Specimen previously labelled as *H. rubiginosum*. Ø

‡*Hieracium spilophaeum* Jord. ex Boreau 135/28.spi. *39, Staffs.: Codsall & Alstonefield, SJ8603, 1852, det. P. D. Sell, CGE. Specimen previously labelled as *H. maculatum*. Ø

‡*Hieracium subaequialtum* Hyl. 135/28.sub. *39, Staffs.: by River Manifold, near Wetton, SK05, 1954, det. P. D. Sell, **CGE**. Ø

Filago minima 135/30.4. 83, Midlothian: past industrial site, Newton Grange, NT332632, C. Dixon, 2006, conf. D. R. McKean, **E**. 1st record since 1970.

‡*Gnaphalium luteoalbum* 135/33.6. ®‡11, S. Hants.: occurring as a weed in municipal flowerbeds, Lower Gardens, Bournemouth, SZ088909, F. J. Rumsey, 2005. *‡60, W. Lancs.: car park, Fishergate, Preston, SD536288, P. Jepson, 2006.

‡*Inula helenium* 135/35.1. 113(S), Channel Is. (Sark): four flowering plants at foot of garden wall by roadside, near La Ville Roussel, WV469763, R. M. Veall, 2006. **SARK**. 1st record for Sark.

‡*Dittrichia graveolens* 135/36.gra. *11, S. Hants.: verge of A31, Ashley, Ringwood, SU1304, A. Lewis, 2006. Now recorded from many other stations in VC11 by P. A. Budd, S. J. Leach and M. W. Rand.

‡*Solidago gigantea* 135/40.4. *93, N. Aberdeen: roadside, Old Meldrum, NJ834285, I. P. Green, 2006.

‡*Aster novae-angliae* 135/41.2. *62, N. E. Yorks.: wasteland, old coal yards, Pickering, SE796839, V. Jones & W. A. Thompson, 2005.

‡*Aster* × *versicolor* (*A. laevis* × *A. novi-belgii*) 135/41.3×4. *62, N. E. Yorks.: several plants in rough grassland by R. Tees, Middlesbrough, NZ41U, V. Jones, 2002, conf. P. F. Yeo, **herb. V. Jones**.

‡*Erigeron karvinskianus* 135/43.4. *62, N. E. Yorks.: base of wall, Saltburn, NZ664214, P. D. Law, 1995, conf. M. J. Yates.

©*Conyza canadensis* 135/44.1. *68, N. Northumb.: one very small garden plant, Craster, NU2419, E. M. Craster, 2005, det. G. Halliday, A. J. Richards & G. A. Swan.

‡*Conyza sumatrensis* 135/44.2. *23, Oxon: a few by R. Cherwell, Oxford University Parks, SP519072, H. J. Killick, 2006. *58, Cheshire: sandy verge, Sandbach, SJ738611, G. M. Kay & M. P. G. Tolfree, 2006, det. E. J. Clement. *60, W. Lancs.: waste ground, Lancaster Business Park, SD492640, J. H. Clarke, 2006, det. E. J. Clement, **LIV**.

‡*Conyza bilbaoana* 135/44.bil. *39, Staffs.: pavement, Banners Gate, Sutton Coldfield, SP089954, J. Hardwick & M. W. Poulton, 2006. *58, Cheshire: sandy verge, Sandbach, SJ738611, G. M. Kay, 2006, conf. E. J. Clement, **herb. G.M.K.**

‡*Conyza bonariensis* 135/44.bon. *38, Warks.: one plant in pavement, 2 Church Terrace, Leamington Spa, SP321654, J. W. Partridge, 2005, conf. E. J. Clement, **WARMS**.

‡*Olearia macrodonta* 135/45.2. *©63, S. W. Yorks.: Ellesmere, Sheffield, SK3688, Sheffield Ecology Unit, 2004.

Artemisia × *wurzellii* (*A. vulgaris* × *A. verlotiorum*) 135/50.1×2. *©38, Warks.: roadside/railway sidings, Washwood Heath, Birmingham, SP106894, J. W. Partridge, 2006, conf. B. S. Wurzell, **WARMS**. Birmingham and the Black Country Recording Scheme.

©*Anthemis tinctoria* 135/55.4. ®64, Mid-W. Yorks.: calcareous grassland, Allerton Bywater, SE421276, Bradford Botany Group, 2006. Probably introduced during landscaping of old opencast coal mine site.

©*Glebionis coronaria* 135/56.cor. *60, W. Lancs.: tow path, Lancaster Canal, Lancaster, SD481668, J. H. Clarke, 2006, det. E. J. Clement.

‡*Leucanthemum paludosum* (Poir.) Bonnet & Barratte 135/58.pal. *12, N. Hants.: in pavement cracks outside Alresford Gallery, Alresford, SU587326, A. R. G. Mundell, 2003, det. E. J. Clement, **HCMS, herb. A.R.G.M. Ø**

‡*Cotula squalida* 135/61.4. *65, N. W. Yorks.: bare, sandy, peaty track, Masham Moor, SE170760, B. Byrne & R. Woodhall, 2004.

Senecio × *albescens* (*S. cinerea* × *S. jacobaea*) 135/62.1×10. *38, Warks.: one sterile plant on golf course, Maxstoke, SP226887, J. W. Partridge & D. Porter, 2004, det. J. C. H. Alexander, **WARMS**.

‡*Senecio inaequidens* 135/62.3. *23, Oxon: one large clump at edge of Oxford Brookes football pitch, SP532062, D. Woodford, 2006, **OXF**. This is the 1st record for v.c.23, that in the VCCC being an error. *39, Staffs.: frequent on canal towpath, Old Moxley, SO969956, A. P. Daly, M. W. Poulton & I. C. Trueman, 2004, det. E. J. Clement.

‡*Delairea odorata* 135/65.1. *10, Wight: waste ground, Seaview, SZ6391, D. T. Biggs, 2005, det. E. J. Clement.

- ‡*Brachyglottis* 'Sunshine' (*B. compacta* × *B. laxifolia*) 135/66.com×lax. *62, N. E. Yorks.: cliff grassland, Robin Hood's Bay, NZ952051, V. Jones, 2001.
- ‡*Rudbeckia hirta* 135/78.1. *©60, W. Lancs.: tow path, Lancaster Canal, Lancaster, SD481668, J. H. Clarke, 2006, det. E. J. Clement.
- ©*Helianthus annuus* 135/79.1. *67, S. Northumb.: rubbish dump in layby off A69 near Throckley, NZ154677, R. & J. Bowyer, 2006.
- ‡*Helianthus* × *laetiflorus* (*H. tuberosus* × *H. pauciflorus*) 135/79.2×pau. *12, N. Hants.: in old chalk pit near roadside, East Woodhay, SU406601, R. P. Bowman, 1979, det. E. J. Clement, HCMS.
- ‡*Helianthus rigidus* Desf. 135/79.rig. *12, N. Hants.: Greatham (SW), SU7730, A. B. M. Brewis, 1960. Ø
- ©*Bidens ferulifolia* (Jacq.) DC. 135/81.fer. *62, N. E. Yorks.: pavement cracks, Higher Market Place, Kirbymoorside, SE695886, W. A. Thompson, 2005. *©63, S. W. Yorks.: Bolton Road, Bradford, SE169349, B. A. Tregale, 2003, det. E. J. Clement. Ø
- ‡*Coreopsis tinctoria* Nutt. 135/82.tin. *©60, W. Lancs.: tow path, Lancaster Canal, Lancaster, SD481668, J. H. Clarke, 2006, det. E. J. Clement. Ø
- ‡*Coreopsis verticillata* L. 135/82.ver. *12, N. Hants.: Church Crookham, near Gelvert Stream, SU831531, T. Dove, 1983, det. A. R. G. Mundell. A garden escape far from houses. It just survived the building of a new track but succumbed to birch scrub growth c.1988. Ø
- ©*Calotis hispidula* (F. Muell.) F. Muell. 135/CAI.his. *12, N. Hants.: wool adventive amongst young apple trees, Benham's Fruit Farm, Blackmoor, SU7731, B. & J. Goater, 1969. Ø
- ‡*Liatris spicata* (L.) Willd. 135/LIA.spi. *©63, S. W. Yorks.: Nailers Rough, Bradford, SE119359, B. A. Tregale, 2004, det. E. J. Clement. Ø
- ‡*Melampodium montanum* Benth. 135/MEL.mon. *10, Wight: several self-seeded plants in full bloom in roadside pavement cracks, Shanklin, SZ5881, D. T. Biggs, 2006, det. E. J. Clement, photograph C. R. Pope. See *BSBI News* 94: 30 (2003). Ø
- ‡*Osteospermum jucundum* 135/OST.juc. *11, S. Hants.: disturbed ground, Throop, SZ1095, R. M. Walls, 2006.
- ‡*Tagetes erecta* 135/TAG.ere. *©39, Staffs.: dozens of plants on recently disturbed open ground near River Tame, Two Gates, SK211015, R. D. Martin, 2006.
- ‡*Tagetes patula* 135/TAG.pat. *©39, Staffs.: a few plants on disturbed ground, Wolverhampton, SO933997, P. Newton, 2000.
- ‡*Aponogeton distachyos* 139/1.1. *12, N. Hants.: twenty plants established and probably increasing in River Blackwater on both sides of footbridge near Government Road, Aldershot, SU885519, C. R. Hall, 2004. Known here since 1997.
- ‡*Lysichiton americanus* 147/2.1. *10, Wight: well established and spreading by streamside in wood, Saltmoor Copse, SZ5387, C. R. Pope, 2006.
- ‡*Calla palustris* 147/3.1. *12, N. Hants.: small plant in large flooded sand pit, MOD Longmoor, SU808305, A. R. G. Mundell, 2003, HCMS, herb. A.R.G.M. Specimen kept (herb. A.R.G.M.)
- Arum maculatum* × *A. italicum* 147/5.1×2. *12, N. Hants.: Ashford Lodge, Ashford Chace, SU746266, A. B. M. Brewis, 1964. Recorded as 'hybrid', listed under *A. italicum* subsp. *italicum*, with comment 'Hybrid also seen, outside Ashford Lodge, at road junction [SU]746266'.
- ©*Pistia stratiotes* L. 147/PIS.str. *12, N. Hants.: Basingstoke Canal, Pondtail Flash and scattered in canal channel for 300m to E, in quantity, SU8253, C. R. Hall, 1995. GR inferred. It did not survive the winter. Ø
- Juncus ambiguus* 151/1.8. *93, N. Aberdeen: flat floor of quarry once used for salt storage, Aikey Bray, W of Old Deer, NJ962478, S. D. S. Bosanquet & C. D. Preston, 2006.
- Juncus* × *kern-reichgeltii* (*J. effusus* × *J. conglomeratus*) 151/1.26×27. *12, N. Hants.: The Warren, SE of Oakhanger, SU7735, F. Rose, 1989. *63, S. W. Yorks.: Maltby Low Common SK5491, G. T. D. Wilmore, 2006.
- ‡*Juncus ensifolius* Wikstr. 151/1.ens. *11, S. Hants.: pond, Fair Oak, SU483142, J. P. Poland, 2004, conf. E. J. Clement. *12, N. Hants.: Longstock Park Nursery, SU367388, B. Goater & A. R. G. Mundell, 2006, det. E. J. Clement, HCMS, herb. A.R.G.M. Growing as a weed in a pot of *Iris pseudacorus*. Ø
- Eleocharis palustris* × *uniglumis* 151/3.1×3. *12, N. Hants.: River Test, Wherwell to Chilbolton, SU3840, F. Rose, 1984.

©*Cyperus eragrostis* 152/11.2. *62, N. E. Yorks.: several plants at base of wall, Thirsk, SE434822, V. Jones & W. A. Thompson, 2006.

‡*Carex vulpinoidea* 152/16.6. *58, Cheshire: reclaimed sand quarry, Moore Reserve, SJ590860, G. M. Kay, 2004, det. A. O. Chater, **herb. G.M.K.**

Carex divisa 152/16.13. *58, Cheshire: damp coastal field, Meols, SJ244908, E. F. Greenwood, 2006, **LIV.**

Carex humilis 152/16.50. *10, Wight: several long-established patches in chalk grassland, Afton Down, SZ3685, P. D. Stanley, 2006, det. D. A. Pearman, **herb. C. R. Pope**. Previously overlooked!

Carex × *turfosa* (*C. nigra* × *C. elata*) 152/16.67×68. *60, W. Lancs.: alder willow carr, with both parents nearby, Little Hawes Water, Yealand Redmayne, SD479768, E. F. Greenwood & M. S. Porter, 2006. See Wheldon & Wilson 1907.

‡*Stipa neesiana* 153/9.1. ©63, S. W. Yorks.: Bradford City Centre, SE164335, B. A. Tregale, 1995, det. E. J. Clement. 1st record since 1970.

‡*Stipa gigantea* Link 153/9.gig. *©63, S. W. Yorks.: Filey Street, Bradford, SE169327, B. A. Tregale, 2005, det. E. J. Clement. Ø 1st record for B.I.?

‡*Stipa tenuissima* Trin.153/9.ten. *12, N. Hants.: several young plants seeded into gravel path, Longstock Nurseries, SU367389, B. Goater & A. R. G. Mundell, 2006, det. E. J. Clement, **HCMS, herb. A.R.G.M.** With abundant *Polypogon viridis*. Ø

‡*Oryzopsis miliacea* var. *thomasi* 153/10.1. *38, Warks.: 50 Brandon Parade, Leamington Spa, SP321659, J. W. Partridge, 2005, conf. species, det. variety T. B. Ryves, **WARMS.**

Festuca × *fleischeri* (*F. arundinacea* × *F. gigantea*) 153/12.2×3 *12, N. Hants.: in field at Conecroft Bottom, Selborne, SU731335, P. D. Stanley, 1998, det. T. A. Cope, **HCMS.**

Festuca arenaria 153/12.6. 10, Wight: sand dunes, Norton Spit, SZ3589, P. D. Stanley, 2004, det. M. Wilcox. 1st record since 1970.

©*Lolium multiflorum* × *L. rigidum* 153/13.2×rig. *12, N. Hants.: Blackmoor area, SU73R, J. E. Lousley, 1960, det. E. E. Terrell. An article by A. Melderis states 'When examining British material of *Lolium* at the British Museum (Natural History), Dr E. E. Terrell.... identified a specimen collected by J. E. Lousley atand distributed in his *Wool Adventive Flora of Britain* under the name *L. rigidum*, as *L. multiflorum* × *rigidum*, which has not been previously recorded from Britain'. Ø

†*Vulpia myuros* 153/14.3. *68, N. Northumb.: at base of fence near police station, Wooler, NT992281, Q. J. Groom, 2006, **herb. G. A. Swan.**

Puccinellia distans 153/16.2. *‡23, Oxon: thirty plants on S side of A415 at Culham, SU505954, H. J. Killick, 2006.

†*Briza minor* 153/17.2. *58, Cheshire: disturbed land, Heswall, SJ2680, E. F. Greenwood, 2006, **LIV.**

‡*Briza maxima* 153/17.3. 83, Midlothian: gutter and outer edge of pavement, Craigleith Hill, Edinburgh, NT228748, E. A. Pilling, 2006, conf. D. R. McKean, **E.** 1st record since 1970.

‡*Poa palustris* 153/18.10. *80, Roxburghs.: edge of pool, Banks of Tweed at Monksford Bank, NT583324, R. W. M. Corner, 2006, **herb. R.W.M.C.** 1st record in a natural habitat since 1913.

Poa bulbosa 153/18.13. ©11, S. Hants.: gravel bank of car park, Hatchet Pond, East Boldre, SU369016, BSBI Field Meeting, 2005, det. M. W. Rand & R. M. Walls. Possibly introduced with the gravel used to make the barrier.

Agrostis × *murbeckii* (*A. capillaris* × *A. stolonifera*) 153/39.1×4. *63, S. W. Yorks.: Valley sidings, Bradford, SE159345, B. A. Tregale, 2005, det. T. A. Cope.

‡*Polypogon viridis* 153/46.2. 38, Warks.: alley pavement, Clarendon Street, Leamington Spa, SP330662, J. W. Partridge, 2005, conf. T. B. Ryves, **WARMS.** 1st record since 1932. *58, Cheshire: pavement weed, Bowden, SJ759868, G. M. Kay, 2006, conf. A. Lockton & M. W. Rand, **herb. G.M.K.** *60, W. Lancs.: ditch, Westby landfill site, SD355311, P. Jepson, 2006, **LIV.**

†*Bromus secalinus* 153/50.7. ©©39, Staffs.: many on field margin, Alrewas Hayes, SK134145, M. E. Smith & D. Wall, 2005. ©©39, Staffs.: scattered through large wheat field, Pound Green, SO757798, J. E. Hawksford, 2006.

‡*Anisantha tectorum* 153/52.4. ©10, Wight: sown lawn, St Mary's Hospital, Newport, SZ4990, P. D. Stanley, 2004. 1st record since 1970.

Elytrigia × *acuta* nothosubsp. *obtusiuscula* (*Elytrigia atherica* × *E. juncea* subsp. *boreoatlantica*) 153/56.2×3a. **10**, Wight: rather frequent in sand dunes, St Helen's Duver, SZ6389, P. D. Stanley, 2006, det. T. A. Cope. 1st record since 1970.

‡*Cortaderia selloana* 153/62.1. ***38**, Warks.: large clump in rough grass, Lea Marston purification lake, SP314950, M. A. Arnold, 2005, conf. J. W. Partridge. ***62**, N. E. Yorks.: one plant self-sown in pavement crack, Hutton Rudby, NZ467066, V. Jones & W. A. Thompson, 2006.

‡*Cortaderia richardii* 153/62.1c. ***83**, Midlothian: about 6 plants in roof guttering of house in Ferry Road, Edinburgh NT243759, D. R. McKean, 2005.

‡*Echinochloa crus-galli* 153/68.1. **65**, N. W. Yorks.: landfill in silage field, West Burton, Bishopdale, SE014877, C. Helm & D. Millward, 2006. Growing with other aliens. 1st record since 1970. ***81**, Berwicks.: one hundred plants in potato field with soya bean waste manure, Hutton, NT909539, M. E. Braithwaite & W. D. Gill, 2006.

‡*Setaria italica* 153/70.ita. ***81**, Berwicks.: ten plants in potato field with soya bean waste manure, Hutton, NT909539, M. E. Braithwaite, 2006.

‡*Setaria pumila* 153/70.pum. ***81**, Berwicks.: two plants in potato field with soya bean waste manure, Hutton, NT909539, L. W. Gaskell, 2006, det M. E. Braithwaite.

‡*Setaria verticillata* 153/70.ver. ***81**, Berwicks.: thirty plants in potato field with soya bean waste manure, Hutton, NT909539, M. E. Braithwaite, 2006.

‡*Digitaria ischaemum* 153/71.1. **12**, N. Hants.: the dominant grass, partly buried in pure sand, beside numerous tracks used by military vehicles, Slab, Bordon, SU783355, A. R. G. Mundell, 2005, det. T. B. Ryves. Not extinct as stated in 1996 *Flora of Hampshire*. Really abundant, e.g. patch 15 m across at SU78323554, but on many other tracks in the area, mostly small non-flowering plants.

©*Digitaria sanguinalis* 153/71.san. ***62**, N. E. Yorks.: several plants in pavement cracks, by church, Whip-Ma-Whop-Ma-Gate, York, SE605518, V. Jones & W. A. Thompson, 2006, **herb. V. Jones**. ***67**, S. Northumb.: Bedford Strut, North Shields, NZ355683, A. & G. Young, 2006, **herb. G. A. Swan**.

©*Anemanthele lessoniana* (Steud.) Veldkamp 153/ANE.les. ***38**, Warks.: four clumps in pavement, alley, Leamington Spa, SP318648, J. W. Partridge, 2005, det. T. B. Ryves, **WARMS**. Growing in nearby garden. Ø

‡*Pennisetum villosum* R. Br. ex Fresen. 153/PEN.vil. ***11**, S. Hants.: road verge, Eastern Parade, Southsea, SZ6698, G. Hounsborne, 2006, det. T. B. Ryves. Ø Apparently 1st record for British Isles.

Typha × *glaucha* (*T. latifolia* × *T. angustifolia*) 155/1.1×2. *‡**38**, Warks.: established on eutrophic lakeside, Edgbaston Pool, Birmingham, SP054841, D. A. Broughton, 2006, conf. J. Southey. Natural England survey. ***60**, W. Lancs.: with both parents on margin of pond (old gravel pit), N. Pond, Brockholes Quarry, Preston, SD579311, E. F. Greenwood, 2006. Pollen not stained with anthocyanin. Morphologically intermediate.

‡*Hemerocallis fulva* 158/5.1. ***12**, N. Hants.: garden discard on wasteland, River Road, Yateley, SU808615, D. L. Brookman & A. R. G. Mundell, 2003. ***93**, N. Aberdeen: roadside, Old Meldrum, NJ833285, I. P. Green, 2006.

Convallaria majalis 158/13.1. ‡**113(S)**, Channel Is. (Sark): in ditch outside garden wall, Le Petit Beauregard, WV458757, M. L. Long, 2006. 1st record for Sark.

‡*Chionodoxa forbesii* 158/22.1. ***12**, N. Hants.: Hurstbourne Tarrant, Netherton Bottom, SU389549, P. Billingham, 1997. Presumably garden escape.

‡*Chionodoxa sardensis* 158/22.2. ***62**, N. E. Yorks.: several self-sown plants on grassy bank, near church, Ingleby Greenhow, NZ582063, V. Jones, 1998.

‡*Chionodoxa luciliae* 158/22.luc. ***62**, N. E. Yorks.: a few plants in woodland, Bassleton Wood, Thornaby, NZ446159, V. Jones, 2001.

‡*Muscari armeniacum* 158/23.2. ***93**, N. Aberdeen: woodand, Pitcaple, NJ7425, I. P. Green, 2006.

‡*Allium roseum* 158/24.3. ***12**, N. Hants.: small patch (c. 12 plants) on roadside bank opposite entrance of Ashford Chace, SU740265, D. Ball, 1994.

‡*Allium neopolitanum* 158/24.4. ***38**, Warks.: clump 1 metre square in hedge, alley off Wathen Road, Leamington Spa, SP324667, J. W. Partridge, 2006, conf. J. R. Roberts, **WARMS**.

‡*Allium subhirsutum* 158/24.5. ***12**, N. Hants.: Wishanger, SU838385, A. R. G. Mundell, 2003, det. B. Matthews, **HCMS, herb. A.R.G.M.** Site bulldozed a few weeks later, but some plants survived

‡*Allium triquetrum* 158/24.7. *38, Warks.: several clumps by footpath, Tachbrook Road, Leamington Spa, SP318649, J. W. Partridge, 2005, conf. E. J. Clement, **WARMS**.

‡*Allium paradoxum* 158/24.9. *38, Warks.: more than 100 plants in abandoned garden, St Mary's Road, Leamington Spa, SP326655, J. W. Partridge, 2005, conf. E. J. Clement, **WARMS**.

‡*Galanthus nivalis* × *plicatus* 158/32.1×3. *81, Berwicks.: one clump near River Tweed, Clinthill, NT605324, M. E. Braithwaite, 2006.

‡*Galanthus elwesii* 158/32.2. *39, Staffs.: grass verge, Wombourne, SO875930, C. B. Westall, 2006. Present for many years on the roadside, sheltered by road signs from mowing.

‡*Galanthus woronowii* 158/32.wor. *12, N. Hants.: single very large clump beside boundary path on west side of Tadley Common, SU606621, I. & W. G. Helyar & A. R. G. Mundell, 2003, det. R. Baker, **HCMS**. Shown to A. R. G. Mundell by finder W. G. Helyar. Determined *in situ* in flower on 21 Feb 2004 by invited *Galanthus* expert.

‡*Narcissus poeticus* 158/33.3. *67, S. Northumb.: Howford Banks, NY9166, A. & G. Young, 2006. Has been present for at least 10 years.

‡*Narcissus cyclamineus* 158/33.6. *11, S. Hants.: woodland, Trodds Copse, Ampfield, SU420227, P. Marston, 2006. In NE finger of woodland, having spread from a nearby garden.

‡*Erythronium dens-canis* 158/ERY.den. *67, S. Northumb.: Jesmond Dene, Newcastle, NZ26NE, A. & G. Young, 2004.

‡*Sisyrinchium californicum* 159/2.3. *©39, Staffs.: three plants in paving cracks on Hundred Acre Road, NE of Pheasey, SP077968, M. W. Poulton, P. Reade & I. C. Trueman, 2006.

‡*Sisyrinchium striatum* 159/2.5. *12, N. Hants.: Sheet, SU7524, A. Knapp & D. Nelson, 1999.

‡*Iris germanica* 159/5.1. *67, S. Northumb.: Seaton Sluice, NZ337768, J. L. Durkin, 2005.

‡*Iris orientalis* 159/5.7. *10, Wight: well-established in roadside ditch, Brook, SZ3883, M. J. Burnhill, 2006, det. C. R. Pope.

Iris foetidissima 159/5.8. *‡60, W. Lancs.: roadside verge, Silverdale, SD473759, P. Jepson, 2006. *‡81, Berwicks.: well-established clump in policies, The Hirsell, NT830409, M. E. & P. F. Braithwaite, 2006. ‡83, Midlothian: railway embankment, 200 m east of Bonnington Bridge above walkway, Edinburgh, NT264763, H. S. McHaffie & D. R. McKean, 2005. 1st record since 1970.

‡*Crocus speciosus* 159/8.8. *©11, S. Hants.: made earth bank near Brockishill Road, Bartley, SU298117, M. W. Rand, 2005. Introduced with landfill to remake bank of Forest car park. *12, N. Hants.: N side of track on grassy bank outside fenced garden, Pamber Heath, SU610618, W. G. Helyar, 2001, conf. A. R. G. Mundell. *62, N. E. Yorks.: a few plants in rough grassland, Grey Towers, Nunthorpe, NZ537133, V. Jones, 2001.

‡*Freesia* × *hybrida* 159/12.1. *©63, S. W. Yorks.: waste ground, Thorpe Salvin, SK5082, W. A. Ely, 2004, conf. J. R. Comley.

Epipactis phyllanthus var. *vectensis* 162/3.7. 10, Wight: ancient woodland on chalk, Eaglehead Copse, Ashy, SZ5887, P. Jupp, 2005, det. A. J. Richards. First appeared in 2003 but confirmed 2005. 1st record since 1970.

×*Gymnaglossum jacksonii* (*Gymnadenia conopsea* × *Coeloglossum viride*) 162/16×17.1×1 *12, N. Hants.: Noar Hill, Selborne, SU7431, M. Oates, 1975. One plant in late 1970s noted in management plan appendix.

Dactylorhiza × *hallii* (*D. maculata* × *D. praetermissa*) 162/18.2×4. *12, N. Hants.: Conford Moor, West Fen, SU8133, F. Rose, 1992.

Dactylorhiza incarnata subsp. *coccinea* 162/18.3b. *63, S. W. Yorks.: Woodhall Quarry, near Calverley, SE197353, B. A. Tregale & G. T. D. Wilmore, 2002.

Dactylorhiza × *wintoni* (*D. incarnata* × *D. praetermissa*) 162/18.3×4. *12, N. Hants.: Humbly Grove area, N of Powntley Copse, SU74C, J. E. Lousley, 1980. Recorded as '*Dactylorhiza incarnata* × *praetermissa* = *D. wintonii*'.

Dactylorhiza × *latirella* (*D. incarnata* × *D. purpurella*) 162/18.3×5. 64, Mid-W. Yorks.: with both parents in flushed marshy area beside outflow stream from Malham Tarn, altitude 385 m, Malham, SD893658, P. P. Abbott, 2006, conf. N. Barrett. 1st record since 1970.

Dactylorhiza purpurella × *D. traunsteinerioides* 162/18.5×7. *62, N. E. Yorks.: one plant in calcareous marsh, Sand Dale, Dalby Forest, SE858848, V. Jones, 2003, conf. R. D. Bateman. Ø

Orchis purpurea 162/20.5. *12, N. Hants.: a fine plant with three flowering spikes and a dead one from previous year in Isle of Wight woods, Porton Down, SU251373, L. Delve *et al.*, 2003, conf. A. R. G. Mundell.

Ophrys apifera 162/23.3. *75, Ayrshire: on re-vegetated bit of bog, Barony Colliery, New Cumnock, NS525218, B. Laney, 2003, conf. D. A. Lang. 1st confirmed record. See *BSBI News* No. 95: 30 (2004). Still present in 2005. Photograph with vice-county recorder.

Obituaries

VERA GORDON 1918–2006

With the death of Vera Gordon on 14 September 2006 the Liverpool botanical community and the North West of England more widely have lost someone who for very many years has been a pivotal figure, just as the B.S.B.I. too has lost one of its longest-serving vice-county Recorders as well as one of its newest Honorary Members.

Born on 25 May 1918, Vera was brought up in Liverpool's northern suburbs, first in Bootle and later in Waterloo, and continued to live at the same address in the second of those for almost her entire adult life. To the warmth, helpfulness and lively humour for which that city is renowned she added the specially personal qualities of immense physical energy and a tirelessly enquiring mind. Both her parents and her only brother were keen ramblers and through that she was introduced to the countryside at an early age, acquiring an interest in wild flowers during family holidays in the Lake District and North Wales. The South Lancashire sand dunes, with their magnificently rich flora, also lay within easy walking distance of the family home.

From primary school in Bootle she won a scholarship to the grammar school there, and she would surely have gone on to university had she been born half a century later. As it was, her formal education ended at sixteen and she went to work in the accounts department of a local firm of dry-cleaners. When the Second World War broke out she fondly eyed the Women's Land Army as her way of contributing to the war effort but she was deeply disappointed that her accounting experience proved to have earmarked her inescapably for similar office work in the Royal Ordnance Department. The obverse of that coin, however, was that she acquired the security of the Civil Service thereby, which subsequently enabled her to transfer to a career more to her liking as administrative officer in the local magistrates court, where she remained till her retirement.

Meanwhile, her father's membership of a photographic society had brought him the acquaintance of Dr C. Theodore Green, the author in 1933 of a second edition of the *Flora of the Liverpool District*, and at the latter's instance Vera was encouraged to join the city's long-standing Botanical Society. Barely eighteen then, she must have found that body

initially rather awesome, with its goodly sprinkling of Edwardian veterans who had built up over the years a breadth of expertise quite normal in their day, but by then becoming all too rare. The doyen, W. G. Travis, a collaborator in his youth of the by that time legendary J. A. Wheldon, was typical in being as well-versed in bryophytes, lichens and microfungi as he was in flowering plants and ferns; for thirty years he had been compiling on the Society's collective behalf a much-needed flora of South Lancashire, the densely-populated (and long well-botanised) vice-county 59. A young enthusiast with energy to spare was nevertheless more than welcome, and the very next year she found herself elected to the Society's Council and the year after that one of two Honorary Secretaries. Sixty-two years later she was still serving in that second capacity, a record of continuity interrupted only by an eventual term as President in 1952–1953 followed by three years as Vice-President. Throughout that exceptionally long period she played the principal part in holding that small society together, for without her efficiency and friendly informality it might well have petered out.

In 1950, on the top of a swaying double-decker bus bound for the advertised venue of one of the Society's field meetings, for which we were the only two to have braved the heavy rain, Vera learned of the recrudescence that the Botanical Exchange Club had recently undergone in its new guise as the BSBI. In common with many field botanists in the North, the Liverpool ones had long held aloof from the BEC on account of its lingering identification in their eyes with the 19th century tradition of reckless collecting; once Vera joined the B.S.B.I. however, and began passing around her copies of the new BSBI publications, all the other leading members speedily followed her example.

Thereafter Vera was a frequent attendee, and always active participant, at BSBI field meetings, enlivening them with her infectious laughter and exemplary persistence in recording however atrocious the weather. One that proved particularly memorable for her was that in West Cork in 1964. To get there, she had to make a lengthy journey by bus on which to her delight she found herself engulfed in inimitable Irish rustic chatter; then, once the meeting was under

way, her sharp eyes spotted an unfamiliar plant with small white flowers which was to turn out to be another native Sandwort, *Minuartia recurva*, new to the British Isles list.

By then her BSBI involvement had been substantially extended by her appointment as Recorder for South Lancashire, in which increasingly onerous capacity – coinciding as it did with the 1950s Distribution Maps Scheme – she was to serve for thirty-six years. Additionally, when a short-lived tier of ‘District Secretaries’ was introduced in 1960 to deal with the growing flood of enquiries of a less strictly scientific nature, she willingly shouldered responsibility for that secondary task in the group of vice-counties that made up the ‘Mersey’ Province.

Around the same time the teaching of plant taxonomy at Liverpool University experienced a marked revival, consequent upon the appointment to the staff of Dr Vernon Heywood and his very active involvement in the massive *Flora Europaea* project. This intensified the need for a guide to the local flora for placing in the hands of students, and as a result the long-accumulating Flora of South Lancashire, which had been languishing because of the latterly frail health and then decease of Travis, had new life vigorously breathed into it. Vera was the natural choice as secretary of a new committee charged with the daunting task of using the manuscript left by Travis as the basis for a volume of a more modern character that was more realistically publishable. To her also fell much of the time-consuming checking of the many post-1939 records and the rounding-up of additional ones that were found to be needed, though that formed only one ingredient in the eventually seven years of combined effort out of which the much-modified Flora at last emerged into print, in 1963, with Vera’s name justly featuring alongside those of Heywood and Dr J. P. Savidge as joint editors.

Such was the ability and care Vera had displayed in that prolonged undertaking that the University saw her as the obvious person to revitalise and curate its herbarium; but on being sounded out she reluctantly concluded that, with a non-transferable Civil Service pension in prospect, such a move involved too great a sacrifice financially. The University was not to forget her, however, for two decades later, in 1987, it conferred on her an honorary M.Sc. Legend has it that the University’s imposing Daimler sent to her home to convey

her to the degree ceremony created almost more of a sensation locally that the honour itself.

Further recognition followed. In 2001 Vera finally allowed the Liverpool Botanical Society to elect her to honorary membership, and four years after that the BSBI honoured her similarly – appropriately at an A.G.M. held in Wales, over the north of which she had spent a great part of her life enquiringly striding.

It was as a great walker, indeed, that Vera will probably be remembered by the greatest number of people above anything else. As the years went by. Britain proved too confining for her energies and many parts of the world, as distant as Australia and as remote as the Caucasus, attracted her as well. Often that was with a botanical group, in which her untiring assistance and increasingly very wide knowledge was ever at her companions’ disposal; but botanizing, with its unavoidably slow pace, was not enough to absorb her seemingly inexhaustible energeticness and she varied those occasions with more arduous challenges such as the famously testing Appalachian Trail. Other favourite outlets were Scottish dancing (at which she was accomplished enough to become a teacher of it at evening classes), gardening (alpines were a speciality) and photography, this last an enthusiasm passed on to her by her father and at which, like him, she came to excel.

Alert and reasonably active almost to the end, Vera was able to attend an indoor meeting of her beloved ‘L.B.S.’ as late as six months before her death. Four further months were then spared her before finally having to exchange her house for a nursing home near Ormskirk, where, not long afterwards, her death took place. Her extensive herbarium of British plants, together with numerous specimens collected from around the world, had been donated by her to Liverpool Museum (now World Museum Liverpool) (LIV) some years before. Her large collection of 35 mm slides has joined those, at the wish of her executors, who have also presented to the library of the Liverpool Botanical Society most of her botanical books.

For many of the details in this account I am indebted to Vera’s brother, Ron Gordon, and LBS members, in particular Susan Taylor, Joan Vincent and Eric Greenwood.

DAVID ALLEN

ROBERT ALAN FINCH
1939–2006

Dr Bob Finch, who died of cancer on 18 December 2006, was by profession a plant cytologist and by inclination a botanist whose wide-ranging interests included fungi, lichens and bryophytes as well as vascular plants. His particular speciality was in the genus *Leontodon*, of which he contributed accounts to the standard reference works.

Born on 20 April 1939, Bob showed an interest in natural history from a very early age. This interest was encouraged by one of the masters at Hastings Grammar School, Dougie Brightmore, a keen botanist. Bob's records of flowering plants appeared annually in the records section of the *Hastings and East Sussex Naturalist* from 1957 until 1975 (excepting only 1972–1973). It was in this journal that he published his first paper at the age of only 19, a survey of the vascular plants and bryophytes of six roadside clinker heaps, undertaken in 1956–1957 (Finch 1958). Clinker was used in those days for gritting roads in winter. Bob went on to Pembroke College, Oxford, where E. F. Warburg, then Britain's leading bryologist as well as a one of the authors of 'CTW', was another major influence. In 1963, soon after completing his degree, Bob published a detailed paper on the bryophytes of the Hastings area (Finch 1963).

Bob had arranged to follow his degree with a research studentship under Warburg's supervision, but the head of department, C. D. Darlington, insisted that Bob should be his student, threatening to make departmental life unpleasant for both him and Warburg unless he did so. Bob felt that he had to comply with Darlington's wishes, although it would be difficult to imagine a less congenial supervisor for the mild-mannered and unassuming Bob. Indeed Darlington told Bob outright that he was stupid – it was only when he read a biography of Darlington 40 years later that Bob discovered, to his great relief, that Darlington had written in his diary that "At the age of 18 most of the world seemed stupid and annoyed me; at 24 I know it is stupid and it ceases to worry me" (Harman 2004).

Despite the temperamental gulf between them, Bob completed a successful D.Phil. thesis at Oxford on the cytology of the genus *Leontodon* (Finch 1966). He later wrote it up as a paper during a year's temporary lectureship at

Newcastle (Finch 1967). During the fieldwork for his thesis he rediscovered the hybrid between *L. hispidus* and *L. saxatilis*, a plant hitherto reported in Britain only by another cytologist, K. B. Blackburn. Bob left Newcastle for a job as a plant cytogeneticist at the Plant Breeding Institute, Trumpington, near Cambridge, in 1967. He was recruited as a member of a new team set up to study barley, and during the course of his career he was co-author of over 30 papers on the cytology and genetics of barley. He continued to work in the Cytogenetics Department until he was made redundant in 1985, one of 42 departures in a year in which the PBI was being prepared for privatisation.

At Cambridge, Bob was able to pursue his interest in *Leontodon* with Peter Sell. Together, they undertook the difficult job of preparing an account for *Flora Europaea*, producing a radical revision in which many existing species were reduced to subspecies (Finch & Sell 1976a, 1976b). Bob had contributed the account of *Leontodon* to Stace's *Hybridization and the Flora of the British Isles* (Finch 1975) and later he and Peter Sell described *L. hispidus* × *saxatilis* as *L. × vegetus* in Sell & Murrell's (2006) *Flora of Great Britain and Ireland*. Bob also made use of the large living collection of *Hieracium* which had been built up by Peter Sell and Cyril West in the Cambridge Botanic Garden to investigate the cytology of apomixis in the genus. His observations are summarised in Sell & Murrell's account of *Hieracium*.

Bob was a very keen bryologist who collected two species new to Britain, *Tortula freibergii* in the Hastings area and *Bryum valparaisense* on St Agnes, Isles of Scilly (Preston 2007). Bob and his wife Jessica usually took their annual holiday on St Agnes, where he also rediscovered the lichen *Pseudocyphellaria aurata* at a time when it was feared extinct in Britain. He and Jessica shared other interests, including wildlife sound-recording and the poetry of the Northamptonshire poet John Clare.

Bob was an old-fashioned figure, quite out of sympathy with the prevailing attitudes of the late twentieth and early twenty-first centuries. He was modest and unassuming, incapable of pushing himself forward. At bryological meetings he was prepared when necessary to

devote all his time to beginners, helping them with a cogent exposition of the characters of the mosses they encountered. He would, however, never venture an opinion without outlining the reasons why he considered that he was really unqualified to express a view. Nevertheless, he could not conceal his wide-ranging botanical knowledge and a shrewd scientific intelligence. He was very much the absent-minded academic. The methodical, meticulous and cautious approach to scientific problems which served him well as a botanist was also applied to the lesser problems of everyday life. There can be few who, like Bob, feel the need to draw a sketch map of the position of his car in the carpark before entering a motorway service station. (He was, rather surprisingly until one remembered his

perfectionism, a committed member of the Institute of Advanced Motorists.) Thus, everyday tasks tended to be time-consuming and he was not always the most punctual of men. These foibles greatly endeared him to the friends who met him regularly on the field meetings of the British Bryological Society's Cambridgeshire and Norfolk & Suffolk groups, and provided the basis of many stories. Had his talents been combined with a more driven personality he would surely have achieved even more than he did, but it was clear from the large attendance at his funeral that it was just this character which had endeared him to his friends, and he introduced many younger people to the natural world he loved. I have never met anyone quite like Bob; he was a unique character and is already greatly missed.

REFERENCES

- FINCH, R. A. (1958). A list of the flowering plants and mosses found on roadside clinker heaps. *Hastings and East Sussex Naturalist* **9**: 1–3.
- FINCH, R. A. (1963). The bryophytes of the Hastings area. *Hastings and East Sussex Naturalist* **9**: 185–191.
- FINCH, R. A. (1966). *Chromosomal and morphological variation in the British flora*. D.Phil. thesis, University of Oxford.
- FINCH, R. A. (1967). Natural chromosome variation in *Leontodon*. *Heredity* **22**: 359–386.
- FINCH, R. A. (1975). *Leontodon* L. In: STACE, C. A., ed. *Hybridization and the flora of the British Isles*, pp. 429–430. London: Academic Press.
- FINCH, R. A. & SELL, P. D. (1976a). *Leontodon* L., in HEYWOOD, V. H. (ed.), *Flora Europaea notulae systematicae ad Floram Europaeam spectantes no. 19*. *Botanical Journal of the Linnean Society* **71**: 241–248.
- FINCH, R. A. & SELL, P. D. (1976b). *Leontodon* L., in TUTIN, T. G. et al. (eds), *Flora Europaea Volume 4 Plantaginaceae to Compositae (and Rubiaceae)*, pp. 310–315. Cambridge: Cambridge University Press.
- HARMAN, O. S. (2004). *The man who invented the chromosome: a life of Cyril Darlington*. Cambridge, Massachusetts: Harvard University Press.
- PRESTON, C. D. (2007). Obituary. Robert Alan Finch B.A., D.Phil. (1939–2006). *Journal of Bryology* **29** (in press).
- SELL, P. & MURRELL, G. (2006). *Flora of Great Britain and Ireland. Volume 4 Campanulaceae–Asteraceae*. Cambridge: Cambridge University Press.

C. D. PRESTON

FRANCIS ROSE

1921–2006

Francis Rose died on 15 July 2006, aged 84. He was unquestionably one of the finest field botanists of his generation and his knowledge of the flora of western Europe had few rivals.

Francis was born in south London in 1921 and he frequently told how his interest in botany was first awakened by a naturalist grandfather who took him for country walks at the early age of six. He claimed to possess a photo of himself, aged eight, collecting plants in the Alkham Valley in Kent, clutching a specimen of what was apparently *Mentha rotundifolia*. Although there was no biology taught at his Roman Catholic school Saint Francis Xavier College, he went up to London University to read Botany in 1938, first at the Chelsea Polytechnic and then Queen Mary College, from where he graduated in 1941. In 1947, after wartime work testing explosives at Woolwich Arsenal and a stint of teaching Engineering Science at Gravesend Technical School he arrived at Sir John Cass College as lecturer in botany. Two years later he moved to Bedford College, where he stayed for the next fifteen years.

Here he developed his early research interest in the ecology of lowland bogs and fens; he was awarded his PhD in 1953 for his thesis on *Researches on the Floral Ecology of British Lowland Bogs and Heaths* (Rose 1953). At this time he and his wife, Pauline Wendy, whom he had married in 1943, were living at East Malling, from where he explored the Kent and Sussex countryside, frequently in the company of the late E. C. (Ted) Wallace and R. A. (Ron) Boniface. He had already embarked upon a project to produce a new flora of the county, as none had appeared since the publication of Hanbury & Marshall's *Flora of Kent* in 1899 (Rose 1949, 1955). His publication of the Biological Flora of *Orchis purpurea*, in which he noted morphological differences between populations on either side of the Stour valley, had been an early contribution to the Kentish Flora (Rose 1948). An account of the remnant fens around Sandwich followed in 1950 (Rose 1950) and at the same time he had embarked upon a three part bryophyte Flora of the county, which he completed in 1951 (Rose 1949, 1950, 1951).

Francis maintained a continuing interest in mire ecology and was particularly fascinated by the East Anglian spring fens with their high number of what he regarded as late-glacial relic

bryophyte species. With the assistance of his research student, David Bellamy, he carried out comprehensive surveys of Redgrave and Lopham Fens, which paved the way for their declaration as National Nature Reserves (Bellamy and Rose 1961).

During this period he was closely involved with the emerging importance of the Field Study Council field centres. He co-directed, with Francis Butler, the University of London's Certificate of Proficiency in Field Biology and had particularly close relations with Juniper Hall and Flatford Mill Field Centres.

Orchids remained a particular interest. His very first paper described a new British species of *Epipactis*, *E. vectensis*, later submerged within *E. phyllanthos* (Brooke & Rose 1940), and he formally described the northern form of the Fragrant Orchid as a separate subspecies, *Gymnadenia conopsea* ssp. *borealis* (Rose 1991).

In 1964 Francis moved to King's College London as senior lecturer in Biogeography. He was appointed University Reader in 1975, a post that he occupied until his retirement in 1981. His botanical interests were essentially those of plant geography and phytosociology. He would not have claimed to be a classical taxonomist nor was he an experimental ecologist. He was fascinated with the interpretation and meanings of distribution patterns and this was combined with a formidable competence as a field botanist and an encyclopaedic knowledge of the west European flora.

Many would argue that his most influential contribution to British botany is *The Wild Flower Key*, first published in 1981 and continuously in print for over twenty-five years until the 2nd edition appeared shortly before his death, revised and updated by Clare O'Reilly. Easily the most popular and successful of plant field guides, it broke new ground with the incorporation of vegetative keys arranged by habitat. The success of these was yet further evidence of his extraordinary familiarity with the plants in the field. This was followed in 1989 by what had originally been intended as a companion volume, *Colour Identification Guide to the Grasses, Sedges, Rushes and Ferns of the British Isles and north-western Europe*. It was unfortunate that the relatively expensive, large format, hard-back edition put it beyond the reach of many students, as it, too, is still the best colour guide to these groups,

including as it does Claire Dalby's technically brilliant plates of the non-*Carex* Cyperaceae. Francis also became involved with that iconic series, the Observer's Books, revising *British ferns* (1965), *British grasses, sedges and rushes* (1965), *British wild flowers* (1978) and, with Kenneth Alvin, *Lichens* (1977).

It was natural that he would be drawn into the interest in disjunct distributions that had been stimulated by the B.S.B.I.'s 5th. conference report, particularly in relation to south-east England (Rose 1957). He developed the idea that distribution patterns were often explicable in the context of post-glacial history. Certain areas of the chalk had higher concentrations of local species than others and he noted that these were often in the vicinity of what could have acted as 'refugia' habitats, habitats that would have remained open during the Atlantic forest maximum. Similarly, the well-known concentration of oceanic species in the wooded ravines of the Central Weald, such as *Hymenophyllum tunbrigense* and *Dryopteris aemula*, were relics of the Atlantic period, surviving in a cool damp microclimate similar to that of the western seaboard.

He explored all the known outcrops of the Wealden sand rocks, refinding most of the bryophyte species recorded by W. E. Nicholson at the beginning of the last century and discovering new colonies of *Hymenophyllum*. He also demonstrated the widespread occurrence of *Dryopteris aemula* in these deep ravines, a plant that Wolley-Dod described as rare (Rose 1952; Pentecost and Rose 1985; Richardson, Rose & Rich 1985; Rose 1997).

Francis was also intrigued by the odd disjunct distributions shown by some species of the chalk of northern France and that of Britain that were absent from the North and South Downs but reappeared again north of the London Basin. His comparisons of the flora of S. E. England and northern France appeared in a number of papers in the *Bulletin de la Société de Botanique du Nord de la France* during the 1960's with his friend Prof. Jean-Marie Géhu. With Géhu's encouragement he also was intrepid enough to produce a paper on the identification of north-west European *Salicornia*! (Rose 1989)

Francis moved to Liss in the early 1960s, which was a convenient distance from the new field station at Rogate that King's College had recently opened. It was also from about the mid-1960s that his increasing interest in lichens developed, encouraged by the late T. D. V. (Dougal) Swinscow and Peter James. This

coincided with a further involvement in the use of plants as bio-indicators of past and present environmental conditions. With David Hawksworth, he was one of the first to demonstrate the value of lichens growing on tree trunks as sensitive indicators of specific levels of atmospheric sulphur pollution. (Rose & Hawksworth 1970; Hawksworth, Rose & Coppins 1973; Hawksworth and Rose 1976).

He also showed that forest lichens were not only sensitive to air quality. Certain species were only to be found in ancient undisturbed woodlands and this enabled him to construct a series of 'indices of ecological continuity', a technique that he later extended to higher plants. This work had important consequences for our interpretation of the nature of what Oliver Rackham has termed the 'wildwood', the presumed pre-agricultural forest cover of Britain. The richest sites were those with ancient trees set amid pasture grassland, such as old deer parks and parts of the New Forest, rather than continuous closed woodland. In this he anticipated by more than twenty-five years the recent theories of Franz Vera on the role of large herbivores.

His higher plant lists of ancient woodland indicator species are now widely adopted in woodland conservation assessment. Originally produced as a series of regional lists for use in lowland England, each list consisting of a hundred species, they inevitably prompted a debate on the objectivity of such indices as well as less successful attempts to produce similar indices for other habitats, such as old grassland (Hornby & Rose 1987; Rose 1999).

The move to Hampshire meant that the New Forest, as well as West Sussex were now much more accessible. There is no question that the New Forest held a special place in Francis' affections. He regarded it as the finest remaining example of lowland deciduous forest in western Europe. He was a strong supporter of the moves to establish the National Park and was hugely influential behind the scenes in helping to ensure sensitive management of the woodlands. Francis was the leading authority in western Europe on the lichen epiphytes of old forest and his 1974 paper, with Peter James, on the corticolous and lignicolous species of the New Forest was a major contribution.

The move to Hampshire also resulted in the plans to produce a Flora of Kent moving down the priority list and in the event it was never written, although he retained strong links with



Francis Rose photographing Military Orchid in the Chilterns in June 2004 (Photo: D. Streeter).

the county. However, work in Hampshire resulted in *The Flora of Hampshire*, with Lady Anne Brewis and Peter Bowman, published by Harley Books in 1996. Five introductory chapters contain a masterly account of the vegetational history and ecology of the county, in the same way that his account of the ecology of Sussex in his *Atlas of Sussex mosses, liverworts and lichens* with Rod Stern, Howard Matcham and Brian Coppins (1991) is by far the best that there is. The latter was published as a separate by the Booth Museum in 1996.

In all, Francis published over 140 books and papers, but arguably his most influential contribution lies in the countless unpublished reports for the Nature Conservancy and its successors, for local authorities and the Wildlife Trusts. The files of the old English Nature contain dozens of his reports that resulted in the original notification of a substantial proportion of all the Sites of Special Scientific Interest in southern England.

The raw material for all of this output resides in the evidence of the prodigious amount of time that he spent in the field and recorded in his field notebooks and record cards. The 200 or so notebooks, commencing in 1944 and containing about 250,000 individual records,

are held by the National Museum of Wales, together with the bulk of his herbarium, totalling over 18,000 specimens, and photographic slide collection. The note-books have been transcribed by Judith Church and computerised by the Sussex Biodiversity Records Centre. The rest of his archive (mostly lichens) is held by the Natural History Museum, and that relating to Kent by the Maidstone Museum.

In 1955 Francis was closely involved in the establishment of the Kent Field Club. For a number of years he had been botanical secretary of the South-Eastern Union of Scientific Societies, an archaic survivor of the heyday of Victorian natural history. As Director of Field Studies of the KFC, he established a number of long-term surveys, notably into the population dynamics of the Lady Orchid, *Orchis purpurea*, on the North Downs above Maidstone. He remained a staunch supporter of local natural history and was President of the Somerset Natural History and Archaeological Society in 1987.

Francis was deeply committed to the cause of conservation. He was a keynote speaker at the seminal conference held at the London Zoo in 1958 which established the County

Naturalists' Trusts in south-east England. He was the first Honorary Secretary of the Kent Trust and its Chairman from 1959–1965. He was an honorary member of both the Sussex and the Kent Trusts and a council member of the Hampshire and Isle of Wight Trust. He was a founder member of Plant Life and served on its Council. He campaigned vigorously for the proposed South Downs National Park until shortly before his death.

Francis joined the B.S.B.I. in 1944 and served on both the Council and the Conservation Committee. He also served on the Council of both the British Bryological Society and the British Lichen Society, being elected President of the latter for 1980–1982. He was elected an honorary member of all three societies, the only British botanist ever to be so honoured. He was appointed M.B.E. in 2000 and received the Wildlife Trust's Christopher Cadbury medal in the following year. In 2003 the Royal Botanic Gardens, Kew established the Francis Rose Reserve at Wakehurst Place, the first nature reserve in Europe to be dedicated to bryophytes, ferns and lichens. His name is celebrated in two species of lichens; *Phyllopsora rosei* and *Porina rosei*.

It is perhaps easy to forget that for the whole of his professional life, Francis was first and foremost a university academic. But his students won't forget, as a letter in the current edition of

Plantlife testifies (Spring 2007). He was an inspirational teacher and had an extraordinary gift of making even the common-place exciting and every fresh encounter with a familiar plant seem like a first meeting. His knowledge was encyclopaedic, not only about the plants themselves but about all that bore on their existence; art, history, culture, folklore. And he loved talking about them as anyone familiar with his telephone conversations will recall!

He was a larger than life character, great company with a sometimes wicked sense of humour as the story of the famous telegram sent to the late J. E. Lousley by Francis and Richard Fitter on their discovery in 1956 on the discovery of his secret Chilterns site of the Military Orchid, *Orchis militaris*, bears witness. Although, unless prompted, lunchtime might well be overlooked, opening time rarely was!

Throughout his life he enjoyed the support of his wife, Pauline Wendy. In his message to his 80th birthday conference at Cardiff he wrote that, 'without her help and encouragement over sixty years I would not have achieved very much'. To her and his four children we extend our condolences.

I would like to thank David Harper and Tim Rich for reading the draft of this obituary.

DAVID STREETER

Publications of Francis Rose (1921–2006)

Prepared by T. C. G. Rich

1940

Brooke, B. J. & Rose, F. (1940). A new British species of *Epipactis*. *Journal of Botany* **78**: 91–89.

1942

Rose, F. (1942). A note on the rediscovery of *Orchis simia* in Oxfordshire. *Journal of Botany* **80**: 102–104.

1945

Rose, F. (1945). Wild orchids of Britain. *Discovery* **6**(7): 207–211.

1946

Rose, F. (1946). The vegetation of the Weald. *South-eastern Naturalist and Antiquarian* **51**: 1–6.

1948

Rose, F. (1948). *Orchis purpurea* Huds. Biological Flora of the British Isles. *Journal of Ecology* **36**: 366–377.

1949

Rose, F. (1949). A bryophyte flora of Kent. I. Introduction and ecological notes. *Transactions British Bryological Society* **1**: 202–210.

Rose, F. (1949). Botanical records for metropolitan Kent 1942–1949. *London Naturalist* 1949: 15–20.

Rose, F. (1949). The flora of Kent. Address to the Botanical Section, S.E.U.S.S. *South-eastern Naturalist and Antiquarian* **54**: 39–40.

Rose, F. (1949). Excursions, 1947. September 5–8. Sandwich (Kent)., *Year Book Botanical Society of the British Isles*: 40–45.

1950

Rose, F. (1950). A bryophyte flora of Kent. II. Hepaticae. *Transactions British Bryological Society* **1**: 225–265.

Rose, F. (1950). The East Kent fens. *Journal of Ecology* **38**: 292–302.

1951

Rose, F. (1951). A bryophyte flora of Kent. III. Musci. *Transactions British Bryological Society* **1**: 427–464.

Rose, F. (1951). A note on *Atrichum undulatum* and *A. angustatum*. *Transactions British Bryological Society* **1**: 481–484.

Rose, F. (1951). Distribution maps of Kent plants. (Exhibit). In: *The Study of the Distribution of British Plants*. BSBI Conference Report no. **2**: 76–79. BSBI, London.

1952

Rose, F. (1952). Annual reports. Botanical Section. *South-eastern Naturalist and Antiquarian* **55**: xviii–xxii.

Rose, F. (1952). “Atlantic” species in the flora of the Weald. *South-eastern Naturalist and Antiquarian* **57**: 18–23.

Rose, F. (1952). Annual reports. Botanical Section. *South-eastern Naturalist and Antiquarian* **57**: xvii–xix.

Rose, F. (1952). A bryophyte flora of Kent. IV. Addenda. *Transactions British Bryological Society* **2**: 51–52.

1953

Rose, F. (1953). A survey of the ecology of the British lowland bogs. *Proceedings of the Linnean Society* **164**: 186–211.

Rose, F. (1953). Botanical records in Kent, Surrey and Sussex 1952–1953. *South-eastern Naturalist and Antiquarian* **58**: 18–24.

1954

Rose, F. (1954). Botanical records for Kent, Sussex and Surrey 1953–1954. *South-eastern Naturalist and Antiquarian* **59**: 21–25.

1955

Rose, F. (1955). The New Flora of Kent. Presidential address to the Botanical Section. *South-eastern Naturalist and Antiquarian* **60**: 9–19.

1956

Rose, F. (1956). Field Meetings, 1955. May 27th to 30th, 1955. Dover. *Botanical Society of the British Isles Proc.* **2**: 176–178

Rose, F. (1956). *Trientalis europaea* L. *Botanical Society of the British Isles Proc.* **2**: 21.

1957

Rose, F. (1957). Vegetation-history and environmental factors in the London area. *London Naturalist* **37**: 29–40.

Rose, F. (1957). The importance of the study of disjunct distributions to progress in understanding the British flora. *Progress in the study of the British flora*. BSBI Conference report, no. **5**: 61–78

1958

Rose, F. (1958). Exhibition Meeting, 1957. *Dryopteris aemula* in S.E. England. *Botanical Society of the British Isles Proc.* **3**: 100–101.

1959

Rose, F. (1959). Sussex records for 1958. *S.-E. Naturalist and Antiquarian* **63**: 14–16.

1960

Rose, F. (1960). The rediscovery of *Orchis simia* Lam. in Kent, 1. Foreword. *Transactions Kent Field Club* **1**: 50.

Rose, F. (1960). Botanical records for Kent, 1955–58. Vascular plants. *Transactions Kent Field Club* **1**: 56–65.

Rose, F. & Laflin, T. (1960). Kent bryophytes. *Transactions Kent Field Club* **1**: 66–78.

Rose, F. (1960). Records for 1960. *Bulletin Kent Field Club* **6**: 8–11.

Rose, F. (1960). The vegetation and flora of the Weald. *Botanical Society of the British Isles Proc.* **4**: 96–97.

Rose, F. (1960). *Tilia platyphyllos* Scop. in Kent. *Bulletin Kent Field Club* **5**: 29.

Rose, F. & Gehu, J. M. (1960). Comparison floristique entre les comtés anglais du Kent et du Sussex et le département français du Pas-de-Calais. *Bulletin de la Société de Botanique du Nord de la France* **13**: 125–139.

Rose, F. & Gehu, J. M. (1960). L'excursion de la 'Botanical Society of the British Isles' dans le Nord de la France; son apport a la connaissance de la flora et de la vegetation du Pas-de-Calais. *Bulletin de la Société de Botanique du Nord de la France* **13**: 1–12.

1961

Rose, F. (1961). The Burham Down Survey: 1. Vegetation in 1956. *Transactions Kent Field Club* **1**: 119–125.

Bellamy, D. J. & Rose, F. (1961). The Waveney-Ouse valley fens of the Suffolk-Norfolk border. *Trans. Suffolk Naturalists' Soc.* **11**: 367–385.

1962

Rose, F. (1962). Reports of Recorders: Botanical. *Bulletin Kent Field Club* **7**: 9.

1964

Rose, F. (1964). Compte rendu des Herborisations. II. Le Sud-Est de l'Angleterre (Comtés de Kent et Sussex). *Bulletin de la Société Botanique de France* **111**, **90e Session**: 30–37.

Rose, F. & Gehu, J. M. (1964). Essai de phytogéographie comparée. La végétation du Sud-Est de l'Angleterre et ses analogies avec celle du Nord de la France. *Bulletin de la Société Botanique de France* **111**, **90e Session**: 38–70.

Rose, F. (1964). Contribution pour une flore de Bryophytes de Nord de la France. *Bulletin de la Société Botanique de France* **111**, **90e Session**: 209–238.

1965

Rose, F. (1965). Comparaison phytogéographique entre les pelouses craueuses du *Meso-Xerobromium* des vallées de la Basse-Seine, de la Somme, de l'Authie, de la Cauche, de la Caesta Boulonnaise et du Sud-Est de l'Angleterre. *Revue des Sociétés Savantes de Haute-Normandie (Sciences)* **37**: 105–109.

Rose, F. (1965). *The Observer's book of British ferns*. Revised edition. Frederick Warne & Co, London.

Rose, F. (1965, 1974). *The Observer's book of British grasses, sedges and rushes*. Revised edition. Frederick Warne & Co, London.

1966

Rose, F. (1966). Reports of field meetings held in 1965. 2nd October – Oldbury Hill. *Bulletin Kent Field Club* **11**: 29–31. Lichens by F. H. Brightman.

1967

Rose, F. (1967). Reports of field meetings held in 1966. 23rd April – Biddenden area. *Bulletin Kent Field Club* **12**: i–iii.

Rose, F. (1967). Reports of field meetings held in 1966. 23rd October – Hythe area. *Bulletin Kent Field Club* **12**: iii–iv.

Rose, F. (1967). *Eriophorum gracile* Roth new to Ireland. *Irish Naturalists' Journal* **15**: 361–362.

1968

Rose, F. (1968). Reports of field meetings held in 1967. 14th October – Fairlight, East Sussex. *Bulletin Kent Field Club* **13**: 35–38.

Rose, F. (1968). Woodland ecology and conservation. *Journal of the Arboricultural Society* (publication untraced).

1969

Barkman, J. J., Rose, F. & Westhoff, V. (1969). The effects of air pollution on non-vascular plants. In: *Air pollution. Proceedings of the First European Congress on the Influence of Air pollution on Plants and Animals*. Wageningen 1968. Centre for Agricultural Publishing and Documentation, Wageningen, pp. 237–241.

Rose, F. & Bailey, R. H. (1969). Lichens from the Forest of Dean – new or otherwise interesting records. *Journal Gloucestershire Naturalists Field Club* **20**: 77–79.

Rose, F. & Hawksworth, D. L. (1969). A note on the lichens and bryophytes of the Wyre Forest. *Proceedings Birmingham Natural History and Philosophical Society* **21**: 191–197.

Rose, F. (1969). Reports of field meetings. 20th April – Combwell Wood, Goudhurst. *Bulletin Kent Field Club* **14**: 15–18.

1970

Rose, F., Hawksworth, D. L. & Coppins, B. J. (1970): A lichenological excursion through the north of England. *Naturalist [Hull]* **95**: 49–55.

Rose, F. (1970). Lichens as pollution indicators. *Your Environment* **1**: 185–189.

Rose, F. (1970). Plant life section (c. 60,000 words) In: *Shell Natural history of Britain*, ed. M. Burton. M. Joseph, London.

- Rose, F. & Hawksworth, D. L. (1970). Qualitative scale for estimating sulphur dioxide air pollution in England and Wales using epiphytic lichens. *Nature* **227**: 145–148.
- McClintock, D. & Rose, F. (1970). Cornish heath in Ireland. *Irish Naturalists' Journal* **16**: 387–390.
- 1972
- Rose, F. (1972). Floristic connections between South-east England and North France. *Taxonomy Phytogeography and Evolution*. BSBI Conference Report no.12: pp. 363–379.
- 1973
- Rose, F. (1973): Detailed mapping in south-east England. In: B. W. Ferry, M. S. Baddeley & D. L. Hawksworth (eds.): *Air Pollution and Lichens*. University of Toronto Press, Toronto, pp. 77–88..
- Hawksworth, D. L., Rose, F. & Coppins, B. J. (1973): Changes in the lichen flora of England and Wales attributable to pollution of the air by sulphur dioxide. In: B. W. Ferry, M. S. Baddeley & D. L. Hawksworth (eds.): *Air Pollution and Lichens*. University of Toronto Press, Toronto, pp. 330–367.
- Rose, F. (1973). A mobile lichen – in which grid square? *Bulletin British Lichen Society* **33**: 13.
- 1974
- Rose, F. & Wallace, E. C. (1974). Changes in the bryophyte flora of Britain. In: Hawksworth, D. L. ed., *The changing flora and fauna of Britain*. pp. 27–46. Systematics Association Special Volume no. 6. Academic Press, London.
- Hawksworth, D. L., Coppins, B. J. & Rose, F. (1974). Changes in the British lichen flora. In: Hawksworth, D. L. ed., *The changing flora and fauna of Britain*. pp. 47–78. Systematics Association Special Volume no. 6. Academic press, London.
- Rose, F. & James, P. W. (1974): Regional studies on the British lichen flora I. The corticolous and lignicolous species of the New Forest, Hampshire. *Lichenologist* **6**: 1–72.
- Rose, F. (1974). The epiphytes of oak. In: *The British Oak: Its History and Natural History*. Ed. M. G. Morris, & F. H. Perring. BSBI Conference Report no.14: 250–273. E. W. Classey, Faringdon.
- 1975
- Rose, F. (1975). The lichens of the Gwaun Valley. *Nature in Wales* **14**: 186–189.
- Rose, F. (1975). The vegetation and flora of Tycanol Wood. *Nature in Wales* **14**: 178–185.
- 1976
- Rose, F. (1976). Lichenological indicators of age and environmental continuity in woodlands. In: Brown, D. H., Hawksworth, D. L. & Bailey, R. H. *Lichenology: progress and problems*. Pp 279–308. Systematics Association Special volume no. 8. Academic press, London.
- Hawksworth, D. L. & Rose, F. (1976). *Lichens as pollution monitors*. Institute of Biology series no. 66. Pp 60. Edward Arnold, London.
- James, P. W. & Rose, F. (1976). *Survey of lichen habitats in N.W. Sutherland*. NCC CST Report, No. 112. NCC, Peterborough.
- 1977
- James, P. W., Hawksworth, D. L. & Rose, F. (1977). Lichen communities in the British Isles: a preliminary conspectus. In: Seaward, M. R. D., ed., *Lichen Ecology*. Pp 295–413. Academic Press, London.
- Alvin, K. & Rose, F. (1977). *The Observer's book of lichens*. Revised edition. Frederick Warne & Co, London.
- 1978
- Rose, F. (1978). *The Observer's book of British wild flowers*. Revised edition. Frederick Warne & Co, London.
- Bülow-Olsen, A. (1978). *Plant Communities* (edited and adapted by F. Rose). Penguin Nature Guides. Penguin Books, Harmondsworth.
- Harding, P. & Rose, F. (1978). *Pasture woodlands in lowland Britain and their importance for the conservation of the epiphytes and invertebrates associated with old trees*. NCC CST Report No. 211. Institute of Terrestrial Ecology & Kings College, London.
- Rose, F. (1978). *Report on the present state of the Solway mosses and recommendations on their conservation*. NCC CST Report No. 224. NCC, Peterborough.
- 1979
- Rose, F., van Haluwyn, C. & Lerond, M. (1979): Itineraire lichenologique en Normandie armoricaine 28 juillet - 1er aout 1978. *Actes du Museum de Rouen* **8**: 83–99.
- Christiansen, M. S., Ramkaer, K., Rose, F. & Søchting, U. (1979): Additions to the Danish lichen flora. *Botanisk Tidsskrift* **74**: 89–115.

1980

Rose, F. (1980). Life style that must survive. *Geographical Magazine*, June 1980 **52** (9): 628–635.

1981

Rose, F. (1981, 2nd edition 1990). *The Wild Flower Key*. British Isles – NW Europe. pp. 480. Frederick Warne London.

1982

Rose, F. & Roux, C. (1982). *Porina stoechadiana* Rose et Roux sp. nov.. *Bulletin du Musee d'Histoire Naturelle de Marseille* **42**: 69–74.

1983

Rose, F. & Coppins, B. J. (1983). Lichens of Colonsay. *Proceedings of the Royal Society of Edinburgh, Section B* **83**: 403–413.

Rose, F. (1983). *The vegetative key to wild flowers*. Fredrick Warne, London, pp. 48.

1984

Rose, F. (1984). Lichens in Somerset. *Nature in Somerset*, March 1984: 13–15.

Rose, F. (1984). Obituary – Charles Antony Lister. *Bulletin Kent Field Club* **29**: 36.

Rose, F. & Wolseley, P. A. (1984). Nettlecombe Park – its history and its epiphytic lichens: an attempt at correlation. *Field Studies* **6**: 117–148.

1985

Coppins, B. J., Rose, F. & Tittensor, R. M. (1985). Lichens from a 16th century Sussex cottage. *Lichenologist* **17**: 297–314.

Pentecost, A. & Rose, F. (1985). Changes in the cryptogam flora of the Wealden sandrocks, 1688–1984. *Botanical Journal of the Linnean Society* **90**: 217–230.

1986

Harding, P. & Rose, F. (1986). *Pastures-woodlands in lowland Britain: a review of their importance for wildlife conservation*. Institute of Terrestrial Ecology, NERC, Huntingdon. pp. 89.

1987

Rose, F. (1987). Obituaries: Ronald Archie Boniface (1913–1985). *Watsonia* **16**: 353.

Hornby, R. J. & Rose, F. (1987). *The use of vascular plants in evaluation of ancient woodlands for nature conservation in southern Britain*. NCC report.

1988

Rose, F. (1988). Phytogeographical and ecological aspects of *Lobarion* communities in Europe. *Bot. J. Linn. Soc.* **96**: 69–79.

Rose, F. (1988). Obituaries. Edward Charles Wallace (1909–1986). *Watsonia* **17**: 116–117.

Rose, F. (1988). Pitfalls of tetrad recording. *B.S.B.I. News* **48**: 18–19.

Rose, F. (1988). Plants to look for in the British Isles some of which might be expected to occur as natives. *B.S.B.I. News* **49**: 11–12.

Rose, F. (1988). *Gymnadenia conopsea* (L.) R.Br. In: Rich, T. C. G. & Rich, M. B. D., eds., *Plant Crib*. pp. 118–119. BSBI, London.

Rose, F. & Walls, R. M. (1988). *Oenanthe* L., fine-leaved species. In: Rich, T. C. G. & Rich, M. B. D., eds., *Plant Crib*. pp. 62–63. BSBI, London.

Rose, F., Watson, M. F. & Hawksworth, D. L. (1988). Lichens on elms in the British Isles and the effects of Dutch Elm disease on their status. *Lichenologist* **20**: 327–352.

Ferry, B. & Rose, F. (1988). The Dungeness shingle. *Ecos* **9**: 22–24.

Rose, F. & Brewis, A. (1988). *Cephalanthera rubra* (L.) Rich. in Hampshire. *Watsonia* **17**: 176–177.

Rose, F. (1988). The Great Storm of 16 October 1987 and its effect on the corticolous lichen flora of south-east England. *Bulletin British Lichen Society* **63**: 1–2.

1989

Rose, F. (1989). *Colour identification guide to the grasses, sedges, rushes and ferns of the British Isles and north-western Europe*. Viking, London. pp. 240.

Rose, F. (1989). *Colour identification guide to the grasses, sedges, rushes and ferns of the British Isles*. pp. 240. Viking Penguin, London.

Rose, F. (1989). Key to annual *Salicornia* species of south England and north France (modified from a key by

Prof. Gehu (1979) by Dr. F. Rose with some additional material). *B.S.B.I. News* **53**: 12–16.

Rose, F. (1989). Obituary. Alice Gertrude Side (1911–1988). *Trans. Kent Field Club* **11**: 47–49.

1990

Rose, F. & Boissiere, J. C. (1990). Catalogue raisonné des lichens du massif de Fontainebleau et des Trois Pignons. Les enseignements de cette étude. *Bulletin de la Société Botanique de France, Lettres Botaniques* **137**(2/3): 173.

- Rose, F. (1990). The epiphytic (corticolous and lignicolous) lichen flora of the Forêt de Fontainbleau. *Bulletin de la Société Botanique de France, Lettres Botaniques* **137**(2/3): 197–209.
- 1991
- Rose, F., Stern, R. C., Matcham, H. W. & Coppins, B. J. (1991). *Atlas of Sussex mosses, liverworts and lichens*. Booth Museum, Brighton.
- Rose, F. (1991). A new subspecies of *Gymnadenia conopsea* (L.) R. Br. *Watsonia* **18**: 319–320.
- Rose, F. (1991). Neolithic trees on West Sussex Downs. *B.S.B.I. News* **57**: 10–11.
- 1992
- Rose, F. (1992). Temperate forest management; its effects on bryophyte and lichen floras and habitats. In: Bates, J. & Farmer, A. M. eds., *Bryophytes and lichens in a changing environment*. pp. 211–233. Clarendon Press, Oxford.
- Coppins, B. J. & Rose, F. (1992). Maps of *Pannariaceae*. In: Seaward, M. R. D. (1999). *Lichen Atlas of the British Isles*. Part 4. British Lichen Society, London.
- Purvis, O. W. & Rose, F. (1992). Maps of *Lecanactis*. In: Purvis, O. W., Coppins, B. J., Hawksworth, D. L., James, P. J. & Moore, D. M. (1992). *The lichen flora of Great Britain and Ireland*. pp. 281–285. Natural History Museum Publications/British Lichen Society, London.
- Rose, F. & James, P. W. (1992). *Pachyphiale*. In: Purvis, O. W., Coppins, B. J., Hawksworth, D. L., James, P. J. & Moore, D. M. (1992). *The lichen flora of Great Britain and Ireland*. pp. 417–418. Natural History Museum Publications/British Lichen Society, London.
- Rose, F. (1992). *Report on the remaining heathlands of West Sussex 1991–92*. West Sussex Heathland Forum. West Sussex County Council, Chichester. pp. 48.
- 1993
- Rose, F. (1993). Ancient British woodlands and their epiphytes. *British Wildlife* **5**(2): 83–95.
- Rose, F. (1993). *Report on the bryophytes and lichens in chalk grassland in West Sussex*. Sussex Downs Conservation Board & West Sussex County Council. pp. 48.
- McClintock, D. & Rose, F. (1993). Obituaries. Hector Wilks 1919–1992. *Transactions Kent Field Club* **13**: 59–60.
- Rose, F. (1993). Ancient British woodlands and their epiphytes. *British Wildlife* **5**: 83–93.
- Rose, F. (1993). Obituary. Thomas Douglas (Dougal) Victor Swinscow (1917–1992). *Journal of Bryology* **17**: 699–700.
- 1994
- Rose, F. (1994). Ancient British woodlands and their epiphytes. *British Wildlife* **5**: 83–93.
- Rose, F. & James, P. (1994). Lichens rock on at Stonehenge. *Plantlife autumn/winter 1994*: 8–9.
- 1995
- Rose, F. (1995). Maps of 46 *Parmelia* species. In: Seaward, M. R. D. (1995). *Lichen Atlas of the British Isles*. Part 1. British Lichen Society, London.
- Richardson, S.J., Rose, F., Rich, T.C.G. (1995). The distribution and ecology of Tunbridge Filmy Fern (*Hymenophyllum tunbrigense* (L.) Smith): Hymenophyllaceae in south-east England in 1994., *Plantlife 'Back from the Brink' Project Report*, 43: pp. 22. Plantlife, London.
- Rich, T.C.G. & Rose, F. (1995). Tower Mustard (*Arabis glabra*) in Hampshire in 1995. *Plantlife 'Back from the Brink' Project Report no. 61*. Plantlife, London.
- Rich, T.C.G., Richardson, S.J. & Rose, F. (1995). Tunbridge Filmy-fern, *Hymenophyllum tunbrigense* (Hymenophyllaceae: Pteridophyta) in south-east England in 1994/1995. *Fern Gazette* **15**: 51–63.
- 1996
- Brewis, A., Bowman, & Rose, F. (1996). *The Flora of Hampshire* pp. 386. Harley Books, Colchester.
- Rose, F. & Davey, S.R. (1996). The three forms of Fragrant Orchid. *B.S.B.I. News* **72**: 71.
- Rose, F. (1996). The return of the elm. *Plantlife spring/summer 1996*: 8–9.
- Rose, F. (1996). *The habitats and vegetation of Sussex*. pp. 1–27. Booth Museum of Natural History, Brighton.
- 1997
- Rose, F. (1997). The current status and conservation issues of cryptogams in the High Weald. In: Jackson, A. & Flannagan, M. eds. 1997. *Conservation of cryptogams in the Weald*. pp. 19–21. Royal Botanic Gardens, Kew.
- 1999
- Rose, F. & Coppins, B. J. (1999). Maps of *Degelia* (3 accounts). In: Seaward, M. R. D., ed. (1999). *Lichen Atlas of the British Isles*. Part 4. British Lichen Society, London.
- Rose, F. (1999). Indicators of ancient woodland – the use of vascular plants in evaluating ancient woods for nature conservation. *British Wildlife* **10**: 241–251.

- Rose, F. (1999). The interesting plant life of MOD heathland areas in Hampshire. *Sanctuary* **28**: 20–21.
- 2000
- Rose, F. (2000). Changes in vegetation and flora in the past 1000 years. *Transactions of the Suffolk Naturalists' Society* **36**: 19–28.
- Abraham, F. & Rose, F. (2000). Large-leaved limes on the South Downs. *British Wildlife* **12**: 86–90.
- 2001
- Coppins, B. J., Hawksworth, D. L. & F. Rose (2001). Lichens. Pp 126–147 in Hawksworth, D. L., ed., *The changing wildlife of Great Britain and Ireland*. The Systematics Association special volume series 62. Taylor & Francis, London.
- Rose, F. (2001). Finding refuge in God's acre. *Plantlife* autumn 2001: 8–9.
- 2002
- Rose, F. (2002). Living in interesting times. *Plantlife* spring 2002: 10–11.
- 2006
- Rose, F. & O'Reilly, C. (2006, revised and expanded edition). *The Wild Flower Key*. pp. 576. Frederick Warne, London.

UNPUBLISHED REPORTS AND SURVEYS ETC.

- 1968
- Rose, F. & Showell, J. (1968). *Windsor Forest, 17/2/68*. Manuscript. Report to the Nature Conservancy.
- Rose, F. (1968). *Corticolous and lignicolous lichens of Staverton Park*. Manuscript. Pp 4. Nature Conservancy.
- Rose, F. (1968). *Preliminary report on deciduous woodlands and old parklands containing fragments of old deciduous woodland, in Norfolk and Suffolk. I Suffolk. II Norfolk*. Pp 20. Manuscript. Report to the Nature Conservancy.
- Rose, F. (1968). *Report on survey carried out in the Forest of Dean, April and May, 1968*. Manuscript. Report to the Nature Conservancy.
- Rose, F. (1968). *Survey report on woodland and forest relict areas of the Wealden region*. Manuscript. pp. 27. Report to the Nature Conservancy.
- Rose, F. (1968). *Wood south-east of Alcester. Great Wood, Vowchurch. Moccas Park. Banses Wood, south-east of Cockyard*. Manuscript. Report to the Nature Conservancy.
- Rose, F. (1968). *Wyre Forest (visited 28th and 29th May, 1968)*. Manuscript. pp. 21. Report to the Nature Conservancy.
- 1969
- Rose, F. (1969). *Kent lichen check-list*. Manuscript. Copy with BLS.
- Rose, F. (1969). *Burnham Beeches. Longleat Woods and Park. Cranborne Chase. Savernake Forest*. Manuscript. Report to the Nature Conservancy.
- Rose, F. (1969). *Hareshaw Linn, Bellingham. Ingleton Glens, West Riding. Hackfall, West Riding*. Manuscript. Report to the Nature Conservancy.
- Rose, F. (1969). *Report to the Nature Conservancy on a visit to Wyre Forest in April 1969 (Supplement to Report of May 1968)*. Manuscript. Report to the Nature Conservancy.
- 1970
- Rose, F. (1970). *Survey report on woodland and forest relict areas of the Wealden region: draft*. Nature Conservancy Council, South East Region. pp. 27.
- Peterken, G. F. & Rose, F. (1970). *Felbrigg Wood, Norfolk*, pp. 5.
- 1971
- Rose, F. (1971). *Report on surveys of woodland and parkland carried out in Cornwall. 1–4 October 1971*. Manuscript. Report to the Nature Conservancy.
- Rose, F. (1971). *A survey of the woodlands of the Lake District, and an assessment of their conservation value based upon structure, age of trees, and lichen and bryophyte epiphyte flora*. Manuscript. Report to the Nature Conservancy.
- Rose, F. (1971). *Report on sites visited in East Anglia, June 1970; March 1971; July 1971*. Manuscript. Report to the Nature Conservancy.
- Rose, F. (1971). *Report on the cryptogamic vegetation of woodland areas in North Wales*. Manuscript. Pp 8.
- Rose, F. (1971). *Report on Sotterley Park, East Suffolk*. Manuscript. Report to the Nature Conservancy.

1972

- Rose, F. (1972). *Brampton Bryan Park, Herefordshire*. Manuscript. pp. 3. Report to the Nature Conservancy.
- Rose, F. (1972). *Downton Castle Park & Gorge, Herefordshire*. Manuscript. Report to the Nature Conservancy.
- Rose, F. (1972). *Hull Wood, Glandford, Sheringham Park, Sturston Carr, Hilborough Park*. Manuscript. Report to the Nature Conservancy.
- Rose, F. (1972). *Kentchurch Park, Homend Park, Eastnor Park, Holme Lacy Park & Wood, Herefordshire*. Manuscript. pp. 4. Report to the Nature Conservancy.
- Rose, F. (1972). *Report on lichenological and bryological survey of the woodlands etc in Morven and the Loch Sunart – Ardnamurchan area*. Manuscript. Report to the Nature Conservancy.
- Rose, F. (1972). *Report on Wensleydale sites surveyed 5th and 6th August 1972*. Manuscript. Report to the Nature Conservancy.
- Rose, F. (1972). *Survey report on woodland sites in North Yorkshire & Co. Durham*. Manuscript. Pp 17. Report to the Nature Conservancy.
- Rose, F. (1972). *Wye Gorge – below Symonds Yat, Herefordshire*. Manuscript. pp. 3. Report to the Nature Conservancy.
- Bowen, H. J. M., Rose, F. & Mason, J. (1972). *List of species from Wychwood, Oxon, seen in April 1972*. pp. 5.

1973

- Rose, F. (1973). *Report on survey work on cryptogamic vegetation in Essex and Suffolk, 16th–19th March 1973*. Manuscript. Report to the Nature Conservancy.
- Rose, F. (1973). *Report on woodland surveys in South Wales, June & September 1972*. Manuscript. Pp 9. Report to the Nature Conservancy.
- Rose, F. (1973). *Report on surveys of woodlands in Kintyre – Knapdale and in Sunart with particular reference to their cryptogamic floras*. Manuscript. Report to the Nature Conservancy.
- Rose, F. (1973). *Interim report on surveys done in Westmorland and Cumberland August 29th – September 1st, 1973*. pp. 6. Manuscript. Report to the Nature Conservancy.

1974

- Rose, F. (1974). *Survey of woodland and parkland sites in the S.W. Midlands, April 12–18, 1973*. Manuscript. pp. 8. Report to the Nature Conservancy.
- Rose, F. (1974). *Report on work done in East Anglia in botanical survey 16th–19th July, 1974*. Manuscript. Report to the Nature Conservancy.
- Rose, F. (1974). *Report on survey of woodland and parkland sites in Cumbria, August, 1974*. Manuscript. Report to the Nature Conservancy.

1975

- Rose, F. (1975). *Report on woodland sites surveyed in Cumbria September 16th–19th, 1975*. Manuscript. Report to the Nature Conservancy.
- Rose, F. (1975). *Report on survey of Tyneham Ranges for bryophytes and lichens, 18th–20th April, 1975*. Manuscript. Report to the Nature Conservancy.
- Rose, F. (1975). *Report on survey of chalk grasslands in the military lands about Tidworth March 13th 1975*. Manuscript. Report to the Nature Conservancy.
- Rose, F. (1975). *The lichens and bryophytes of sites in Hereford, Salop, and Staffordshire, based on a survey made from April 21–24, 1975*. Manuscript. pp. 10. Report to the Nature Conservancy.
- Rose, F. (1975). *Scales Wood*. Manuscript. Report to the Nature Conservancy.
- Rose, F. (1975). *Report on the conservation of epiphytic lichens and bryophytes on the Cranborne Chase Estate, Wiltshire and Dorset. Surveyed August 28 1975*. 5 pp.
- Rose, F. (1975). *Report on sites surveyed in the (former) Merionethshire, March 27–April 2 1975*. Manuscript. Pp 6.

1976

- Rose, F. (1976). *Report on survey of Cranborne Chase 23 March 1976 and 24 March 1976*. 5 pp.
- Rose, F. & James, P. W. (1976). *A survey of the lichens of Galloway and western Dumfries-shire*. Nature Conservancy Council, Scotland, South West Region. pp. 25.
- Rose, F. (1976). *Report on survey of cryptogam flora (bryophytes & lichens) of the Longleat Estate surveyed August 1969, November 1973 & 27 November 1974*. Manuscript. pp. 4 and pp. 2. Report to the Nature Conservancy.

1977

- Rose, F. (1977). *Chequers Park*. pp 1.
- Rose, F. (1977). *Stonor Park*. pp.1.

1981

Rose, F. & James, P. W. (1981). *Report on the lichen flora and vegetation of lowland areas of the Cowal peninsula, 21–30 June 1977*. Nature Conservancy Council. Scotland, South West Region. pp. 19.

1983

Rose, F. (1983). *Report on the populations of Ophrys sphegodes in South East England in May 1983*. Nature Conservancy Council. England. South East Region. pp. 21.

1986

Hornby, R. J. & Rose, F. (1986). *The use of vascular plants in evaluation of ancient woodlands for nature conservation in southern England*. Nature Conservancy Council, Peterborough. pp. 12.

1988

Rose, F. (1988). *Report on lichen surveys of sites in West Sussex to assess the effects of the Hurricane of October 16, 1987*. Nature Conservancy Council. England. South East Region. pp. 10.

Rose, F. & Yates, E. M. (1988). *The vegetation of Ebernoe Common, Sussex: an historical and botanical survey*. King's College London. Rogate Field Centre. pp. 20.

Rose, F. (1989). *A survey of Tickfold Ghyll – West Sussex*. Nature Conservancy Council.

1989

Rose, F. (1989). *Report on lichen and bryophyte survey of Ashburnham Park SSSI, East Sussex, March–April 1989*. No place of publication given.

1991

Rose, F. (1991). *A survey of the bryophytes in Fairlight Glen, East Sussex*. English Nature, South East Region. pp. 8.

Rose, F. (1991). *A survey of lichens and bryophytes at Eridge Park SSSI*. English Nature, South East Region. pp. 10.

1992

Rose, F. (1992). *Bryophytes and pteridophytes on Wealden Sandrocks, Philpots Estate, Chiddingly Wood*. English Nature, South East Region. pp. 6.

1994

Rose, F. (1994). *Report on surveys of woodlands in Cornwall with particular attention to their epiphytic lichen floras during May and September/October, 1992 and also over period 1972–1991*. English Nature, South West Region. NCC, Peterborough.

1996

Cox, J. & Rose, F. (1996). *Species Recovery Project: summer lady's-tresses*. English Nature Species Recovery Programme & Hampshire Wildlife Trust. pp. 39.

1997

Rose, F. (1997). *Report on the present and past botanical interest of the Open Pits on Dungeness Beach, with suggestions for future management*. English Nature, Kent Team. pp. 16.

Rose, F. & Patmore, J. (1997). *Weald gill woodlands*. English Nature, Sussex and Surrey Local Team.

1998

Rose, F. & Davy, S. (1998). *A lichenological survey of Ethy Park*. National Trust. pp. 49.

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