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C. D. Preston, M. N. Sanford, D. A. Simpson

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

The Rhos Pastures of South-west Wales and their Conservation Presidential Address, 10 May 2003

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ABSTRACT

A personal view is presented of rhos pastures, the damp acid, often heathy grasslands which still occur frequently in South-west Wales. Their typical vegetation communities including examples of characteristic species and their survival, management, and social significance are described. The significance of *Carum verticillatum* (Whorled Caraway) in these grasslands, together with several other plants, are examples of species having Atlantic distributions which contribute to the particular character of rhos pastures. The history of the recording of *Carum* in South-west Wales and its distinctive character, together with its often abundant survival on the Carmarthenshire coalfield are explained but the example of the area between Cross Hands and Ammanford is given to illustrate how, in recent years, major losses have occurred due to opencast coalmining, commercial and domestic development and agricultural changes. In view of the apparent ineffectiveness of current protection measures, a plea is made to all concerned, for a concerted effort to conserve and maintain what remains.

I consider it a great honour to be addressing you today, as B.S.B.I. President. My address is on a subject very close to my heart as it was these very grasslands which fired my enthusiasm for field-botany in the early 1970s. I *should* say re-kindled as it was Barry Goater, my school biology master, who gave me my first insight into field botany, some ten years earlier. Just after that time, however, my attentions were drawn to the totally new experience of fossil-hunting, a diversion which was to shape my later life.

After leaving university having graduated in geology, it was my first step on the career ladder, that gave me my first opportunity to acquaint myself with rhos pastures. I had secured a job with the National Coal Board in South Wales and it was not long before I was sent to their outpost in the far-west of the coalfield, the Gwendraeth Fawr Valley of Carmarthenshire, where I supervised drilling-rigs, prospecting for future opencast sites. An immediate thought to strike me was the fact that all the fields in which we were drilling were full of wild flowers and included many orchids! The other concern, of course, only in the back of my mind at that time, was that wherever economic coal-reserves were proved, ultimately these flowery-fields would be destroyed when the coal was opencasted.

This address, therefore, is very much my personal view of these grasslands but I am afraid that it will be only a superficial look as the subject is so wide.

As time went by, my knowledge of the plants to be found in these fields increased, assisted, not inconsiderably, by Mrs Irene Vaughan, the then B.S.B.I. Carmarthenshire Vice-county Recorder. In fact, in 1974, one of our first outings together was to a disused colliery site at Great Mountain, near Cross Hands, which included associated unimproved pastures, where, I think, even she was impressed by the range of species I showed her (Pryce 1974).

Of course, in those far-off days, the term *rhos pasture* had not yet been coined, but looking back, that is exactly what we were examining. My good friend Stephen Evans, then the Nature Conservancy's Assistant Regional Officer in South-west Wales and a very knowledgeable all-round naturalist, tells me that it was his colleague, Chris Fuller who first used the term in order to be able to refer easily to this rather nebulous grassland habitat. It is, of course, not an invented word but is derived from the Welsh *rhos* meaning *moorland* and was intended to convey the impression, particularly amongst the Welsh farming community, of unimproved, heathy pastureland, worthy of conservation for its floral and faunal diversity.

The term was originally used to describe unimproved acid meadows or pastures which typically included an element of dwarf-shrub heath, maybe 10% or 20% *Calluna vulgaris* (Heather) which reflects the fact that they are derived from the overgrazing of heathland as has been demonstrated

at Dowrog Common in Pembrokeshire (S. B. Evans, pers. comm.). However, the term seems since to have come to be used in a wider sense, a sign of the characteristically diverse nature of these grasslands resulting from small-scale variations in such factors as hydrology, soil origin, soil chemistry and physical characters, variations which are destroyed by cultivation and intensive farming practices. The majority of sites are well on the acid side of neutral, having a pH of 4·5 to 5·5 with soils being damp and clayey and slow to warm-up in the spring. In my address I will use this wider concept as I think it important that the whole range is considered in conservation terms.

Vegetation reminiscent of rhos pasture is, of course, not confined to South-west Wales and comparable vegetation is found along the Western European seaboard from the uplands of northern Portugal and North-west Spain, through Brittany, Devon and Cornwall (where it is broadly similar and known as Culm Grassland), north to South-west Scotland and east to Belgium and Germany. But I was surprised to learn how restricted this vegetation is in most of these areas, with only the Scottish stands approaching the extent of those in South-west Wales. In all areas it remains under extreme pressure from agricultural improvement, development and neglect.

Grassland cannot be considered as climax vegetation in South Wales and depends upon man's intervention for its maintenance. Over the last 5000–6000 years the gradual removal of the native broad-leaved forest together with the introduction of domestic grazing animals have created and maintained a more open face to the landscape. The local soils are generally derived from sticky, impervious, acid, glacial boulder-clay, which blankets the bedrock and often exceeds 10m in thickness. Drainage is often further impeded by the formation of a ferruginous pan in the soil at around 20–30cm depth. Variations in topography and the inherent poor drainage also provide an opportunity for the deposition of thin peaty layers locally and may further have developed to blanket peat or even small raised-bogs where the topography is suitable. Additional diversity is provided where seepages and flushes have developed their own characteristic vegetation. Flushes, whilst generally acid, may be base-rich locally, particularly where water arises from the Carboniferous Limestone or from base-rich strata in the Old Red Sandstone or Farewell Rock. Base enriched water may also arise from pockets of glacial material derived from these rocks.

Although rhos pastures would have been considerably more extensive in the past, modern agricultural so-called 'improvement' has virtually eliminated them from all the currently intensively-farmed areas except in valley bottoms where drainage would be uneconomic. However, traditional farming practices, to some extent, even now remain a way of life in the Carmarthenshire coalfield and also still continue on parts of the northern flank of the Black Mountain (Mynydd Du). The most extensive unimproved or little-improved grasslands remaining in South Wales today are, therefore concentrated in these areas. The reason for their survival in the coalfield is because land holdings were invariably small with production only needing to provide a supplement to the main source of income from the mines or other local industries. On the flanks of the Black Mountain, however, their survival may be because the farm-holdings are linked with extensive common mountain-grazing rights which allowed less intensive use of the in-by land in summer (Bevan 1999).

The National Vegetation Classification (Rodwell 1991 *et seq*) has provided a means of characterising the range of vegetation communities typical of rhos pastures. The high rainfall of the region strongly favours the formation of damp and wet grasslands on the acid, clayey soils and it is not therefore surprising that the most extensive N.V.C. communities are Rush pastures and Purple Moor-grass mires.

The M23 *Juncus effusus/acutiflorus – Galium palustre* rush pasture community is the most extensive and is characteristically dominated by either *Juncus effusus* (Soft Rush) or *J. acutiflorus* (Sharp-flowered Rush) with other species generally at much lower cover. Poaching by livestock often leads to the creation of less diverse stands and this may be exacerbated by applications of lime or basic-slag. *Juncus conglomeratus* (Compact Rush), *Molinia caerulea* (Purple Moor-grass), *Holcus lanatus* (Yorkshire Fog) and *Agrostis canina* subsp. *canina* (Brown Bent) are often abundant or frequent components, as are various characteristic sedges including *Carex panicea* (Carnation Sedge), *C. echinata* (Star Sedge) and *C. viridula* subsp. *oedocarpa* (Common Yellow-sedge). Herbs generally include *Galium palustre* (Marsh Bedstraw), *Lotus pedunculatus* (Greater Bird's-foot Trefoil), *Angelica sylvestris* (Common Angelica), *Lychnis flos-cuculi* (Ragged Robin), *Ranunculus flammula* (Lesser Spearwort), *Cirsium palustre* (Marsh Thistle) and *Dactyloriza maculata* subsp. *ericetorum* (Heath Spotted-orchid) and less frequently *Scutellaria minor* (Lesser Skullcap), *Wahlenbergia hederacea* (Ivy-leaved Bellflower), *Anagallis tenella* (Bog Pimpernel) and *Serratula tinctoria* (Saw-wort).

The next most common community is the M25 *Molinia caerulea – Potentilla erecta* mire. It tends to be very variable and the degree of dominance of *Molinia* depends to a great extent on its management. Neglected and poorly-grazed stands quickly become tussocky to the exclusion of most other species although *Potentilla erecta* (Tormentil) is generally present even in the most impoverished examples. *Molinia* dominance is kept in check by grazing and when moderately or even heavily grazed, species-richness is preserved. The species I've mentioned as being associated with the rush-dominated grasslands are also common here. Some stands include a heathy element with the presence of *Erica tetralix* (Cross-leaved Heath) and *Calluna vulgaris* (Heather) reflecting their original conversion from dwarf-shrub heath into pasture by intense grazing and burning. Indeed, where the cover of this dwarf-shrub element increases, M25 mire can grade into M15 *Scirpus cespitosus – Erica tetralix* wet heath. The wettest M25 stands may include significant amounts of *Sphagnum* and *Polytrichum commune* mosses and support extensive populations of *Narthecium ossifragum* (Bog Asphodel). Flushed stands may commonly grade into M6 *Carex echinata – Sphagnum recurvum/auriculatum* mire or, rarely, where the seepages are more base-rich, M10 *Carex dioica – Pinguicula vulgaris* mire.

Where a degree of base-enrichment is present in the soil, the M24 *Molinia caerulea – Cirsium dissectum* fen meadow may occur. This is a less common community in the dominantly acid, boulder-clay derived soils of the region but where present, *Cirsium dissectum* (Meadow Thistle) can form dense stands with an additional suite of characteristic base-demanding sedges including *Carex flacca* (Glaucous Sedge), *C. hostiana* (Tawny Sedge), *C. pulicaris* (Flea Sedge) and *C. pallescens* (Pale Sedge). The most diverse stands may also include less frequent species such as *Serratula tinctoria, Anagallis tenella, Genista anglica* (Petty Whin), *G. tinctoria* (Dyer's Greenweed) and *Carex montana* (Soft-leaved Sedge).

In better-draining soils which, for example, may occur on the crests or slopes of drumlins or other glacial features or where the drift is less clayey, typical wet rhos vegetation may give-way to N.V.C. MG5 *Cynosurus cristatus – Centaurea* nigra grassland where, as well as *Cynosurus cristatus* (Crested Dog's-tail) and *Centaurea nigra* (Common Knapweed), *Agrostis capillaris* (Common Bent), *Anthoxanthum odoratum* (Sweet-Vernal-grass) and *Festuca rubra* (Red Fescue) may be abundant and species such as *Lotus corniculatus* (Common Bird's-foot Trefoil), *Rhinanthus minor* (Yellow Rattle), *Trifolium pratense* (Red Clover), *Sanguisorba officinalis* (Greater Burnet), *Danthonia decumbens* (Heath Grass) and *Briza media* (Quaking Grass) may also be prominent. Similar damp grasslands managed traditionally as hay fields, now very reduced in number, characteristically have often included abundant dactylorchids, *Vicia orobus* (Wood Bitter Vetch), *Ophioglossum vulgatum* (Adder's-tongue), *Platanthera chlorantha* (Greater Butterfly-orchid), *P. bifolia* (Lesser Butterfly-orchid) and *Genista tinctoria.*

Succisa pratensis (Devil's-bit Scabious) is often common in these grassland types and is present in varying amounts, generally dependant upon the management to which the fields have been subjected. It may be greatly favoured by the selective grazing of horses and ponies to which it is unpalatable. *Succisa*, of course, is the food plant of the rare and declining Marsh Fritillary Butterfly, the larvae of which, after hatching in August, spin themselves protective webs. They forage on the *Succisa* leaves and grow to a sufficient size before hibernating in the shelter of the vegetation particularly at the bases of *Molinia* tussocks or in leaf-litter close to the soil. They emerge on sunny days in February and March before feeding-up and pupating to metamorphose into adults which appear in late May or early June. Grassland management is critical for the butterfly as too little grazing results in the dominance of tussocky *Molinia* and extermination of the *Succisa,* whilst too heavy grazing, particularly horse grazing, although favouring *Succisa,* will not maintain the vegetation structure required for larval shelter during winter.

Several plant species which I have mentioned can be regarded as having purely Atlantic distributions although many dominants such as *Molinia caerulea* tend to be more widespread. It is, however, the association of the Atlantic species which contributes to the character of rhos grassland vegetation. These include, for instance, *Cirsium dissectum, Erica tetralix, Genista anglica, Scutellaria minor, Vicia orobus* and *Wahlenbergia hederacea,* as shown on Fig. 1, but, without doubt, the most characteristic species in South-west Wales is *Carum verticillatum* (Whorled Caraway) which when growing abundantly, may turn fields white with its flowers in summer (Photograph 1).

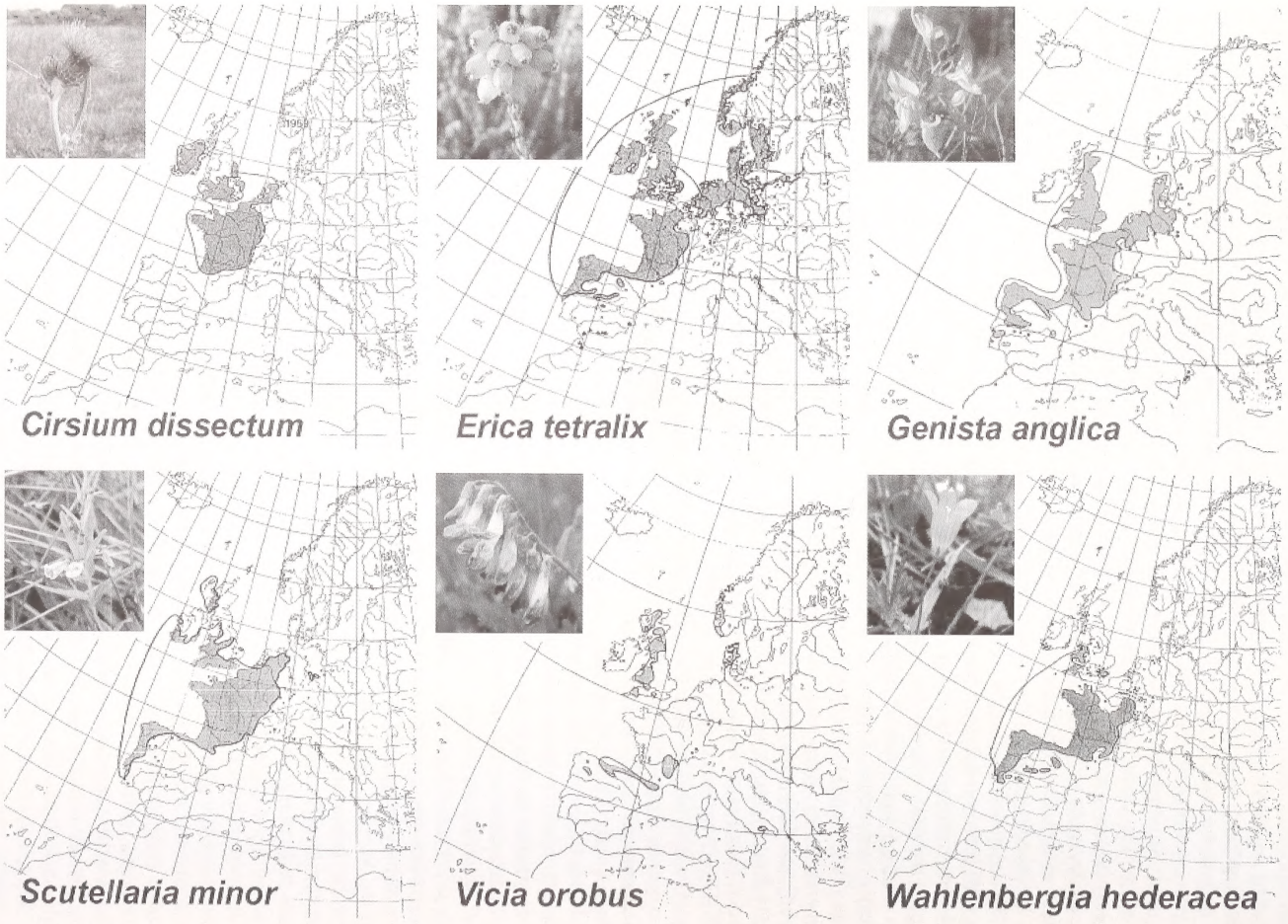


FIGURE 1. Some characteristic rhos pasture species showing their Atlantic distributions. (from Meusel *et al.* 1976, 1978, 1992).



PHOTOGRAPH 1. Hay-meadow with abundant *Carum verticillatum* (Whorled Caraway) on the Carmarthenshire coalfield.

Carum was first recorded in the region on Friday 23 July 1773 by the Rev. John Lightfoot and Sir Joseph Banks, during their botanical tour of Wales. A few years previously, Joseph Banks had undertaken important botanical and astronomical work during Capt. Cook's voyage to the southern hemisphere. But safely back on British shores, he and Lightfoot travelled westwards through South Wales, enjoying accommodation in Carmarthenshire with the Williams family at Edwinsford near Talley, before continuing on to Pembrokeshire. They noted "Sison verticillatum [*Carum verticillatum*] *in a low moist meadow on the left hand of the Road adjoining to a small bridge call'd Pelcombe Bridge 1½ miles from Haverford West in the way to St. Davids, in Abundance in Flower*". During their return on Monday 26 July, they again noted the abundance of the species at Narberth, Lanreed near St.Clears, and then "*the same afterwards for 6 miles together in almost all the low moist meadows between St.Clears and Carmarthen*". They made notes on the abundance of the plant between Llandeilo and Llandovery and also in the area around Edwinsford. They concluded that "*it is a common plant in moist and boggy meadows in the 2 Counties of Pembroke and Carmarthen*". A specimen collected by them at the time is now in the herbarium of the Natural History Museum in London (**BM**).

Lewis Weston Dillwyn of Penllergaer near Swansea, an accomplished botanist in the Victorian tradition and President of the Royal Institution of South Wales, which was founded as a result of his sponsorship, in his *Materials for a Fauna and Flora of Swansea and the Neighbourhood* of 1848 also made reference to the frequency of *Carum verticillatum* and that it was "*Abundant in moist pastures throughout the neighbourhood*".

And so recording of *Carum* and its associates continued over the succeeding years.

Carum verticillatum is an umbellifer, a member of the Apiaceae, which generally grows to about 0·5 m in height with very distinctive, simply divided, pinnate leaves which give the impression of being whorled. The plant is a biennial or short-lived perennial and can be recognised at most times

of the year, except in the dead of winter, as the leaf rosette appears early, being usually recognisable by late February. The main flowering season is from the end of June and through July but some flowers are often produced though into October.

Carum verticillatum reaches its greatest abundance in the traditionally managed fields of the Carmarthenshire coalfield, and although it is often frequent into east and north Pembrokeshire, Ceredigion, west Breconshire and west Glamorgan it seldom attains such profusion. *Carum* occurs in all the N.V.C. communities I have mentioned with the possible exception of M10 but reaches its greatest abundance in M23 rush pasture. The best shows I have seen have occurred in meadows where stock has been excluded prior to their being cut for hay in July or August. This allows the plants to flower profusely. The hay-cut is then followed a few weeks later by young cattle being turned out to enjoy the aftermath grazing. Spring, summer and autumn grazing by cattle or ponies has also been cited as a good method of maintaining the vegetation but in my experience this practice may result in the fields becoming degraded in time, due to poaching and selective grazing, particularly if ponies are used. Unless periodically rolled and mown, rushes and undesirable coarse species will increase in dominance to the detriment of species-diversity. Furthermore, if grazed throughout the season, these fields will obviously never flower as profusely as those shut-up for hay!

Fig. 2 shows that *Carum* is strongly Atlantic in its distribution and decidedly western in Britain but it only occurs in a few areas in Ireland. However, the Carmarthenshire distribution as shown by the tetrad map is misleading in as much as, although the species occurs in virtually all tetrads in the coalfield area (ie the south-east of the county), the map-dots would indicate a similar occurrence of the plant elsewhere. This is in fact not the case, as although there *are* meadows away from the coalfield where *Carum* is abundant, they are much fewer in number and the majority of populations are confined to relatively few plants in relict valley mires or field corners or to even fewer plants in flushes at stream heads and water-collects.

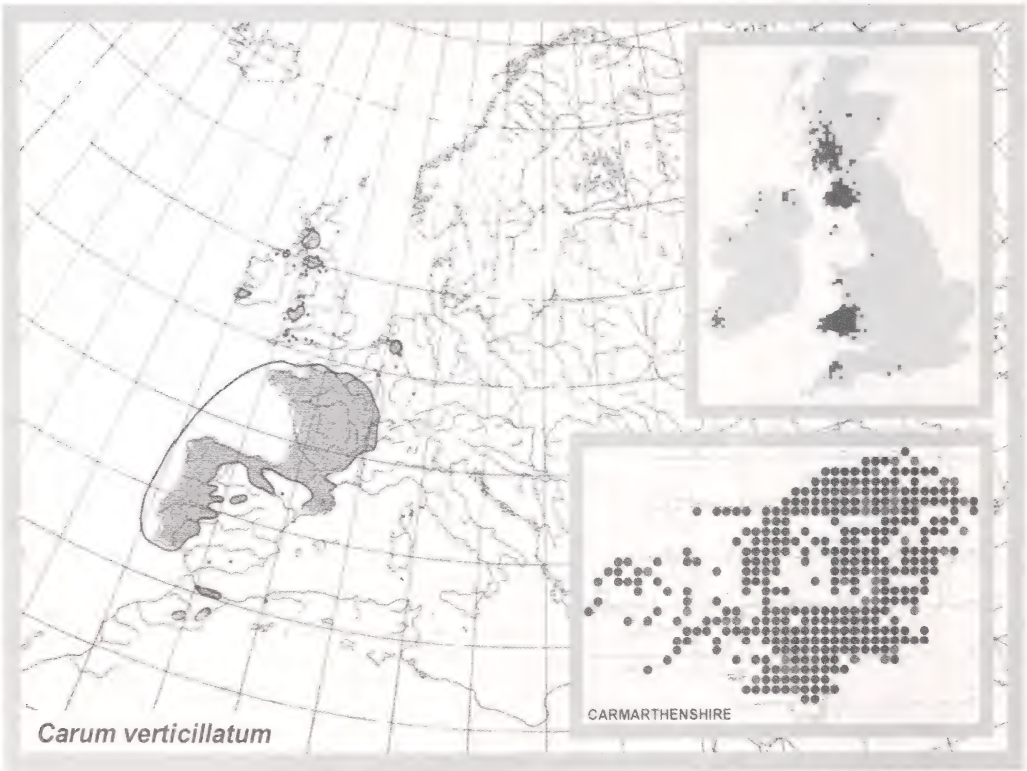


FIGURE 2. Distribution maps of Carum verticillatum (Whorled Caraway).

Carum will tolerate a degree of agricultural improvement and a field, which produced one of the most impressive displays of flower that I can remember, was one having received light doses of inorganic fertilizer over the years and which was very species-poor. It supported abundant *Juncus, Holcus lanatus* (Yorkshire-fog), *Carex ovalis* (Oval Sedge) and *Carum* but little else!

We are fortunate in South-west Wales to have retained a relatively extensive unimproved grassland resource but as I intimated earlier, it is under extreme pressure from agricultural improvement, commercial development and neglect.

As an example of the demise of rhos pastures and unimproved grasslands in general, I will concentrate on a small area of the Carmarthenshire coalfield between Cross Hands and Ammanford, which includes an area known historically as Mynydd Mawr and which, currently, has a particular abundance of rhos pastures and unimproved grassland (Fig. 3). A map of the same area dated 1813 shows Mynydd Mawr as unenclosed commonland, presumably dominated by woodland, scrub and wet-heathland (shaded on Fig. 4). Enclosure facilitated the intensification of farming practices with burning and heavy grazing converting the natural vegetation to grassland as the 6 inch Ordnance map of about 1860 shows (Fig. 5). Up until the 1950s these grasslands would have been managed traditionally without inputs of artificial fertilizers and would have retained their floristic diversity. And for many years since that date, the majority remained traditionally managed.

In response to perceived losses as agricultural intensification and other pressures gained ground, a *Survey of Wet Pastures Characterised by Whorled Caraway (*Carum verticillatum*) in the Carmarthenshire Coalfield* was commissioned in 1978 by the then Nature Conservancy Council (Jones & Hill 1978). The survey map is difficult to interpret in its raw state so, to make it more clear, I have shaded the enclosures examined (Fig. 6). Although carried out prior to the characterisation of the vegetation by the N.V.C. and using a simple classification system, this first survey provides a valuable baseline inventory of the resource at that time.

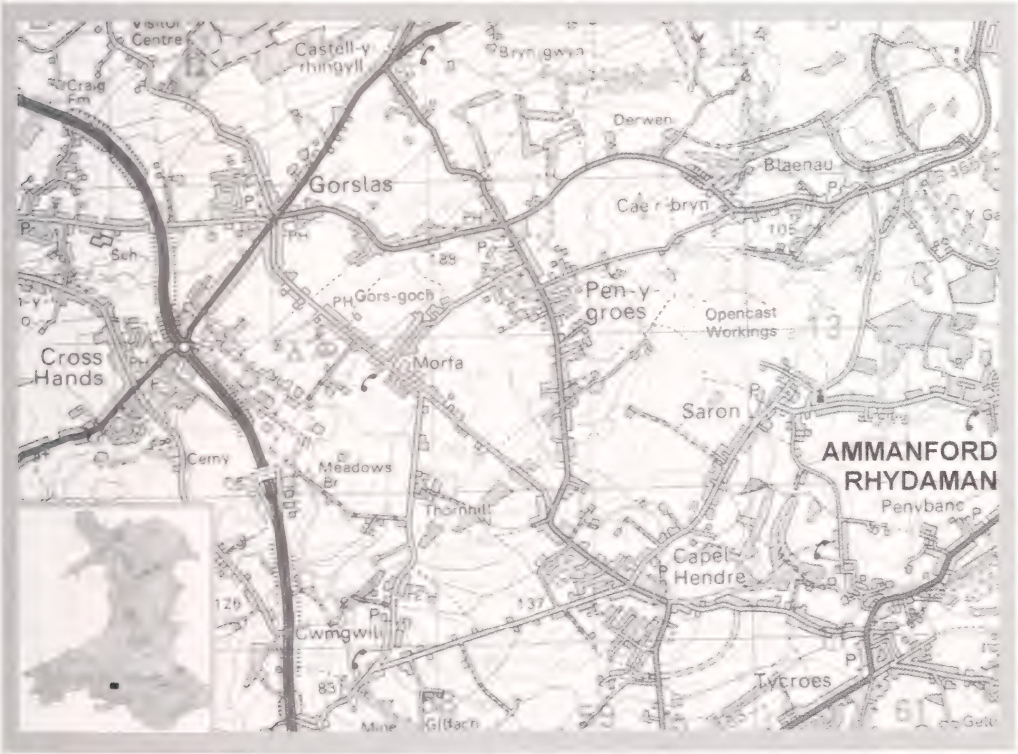


FIGURE 3. Location of Mynydd Mawr in relation to present day topographic features.

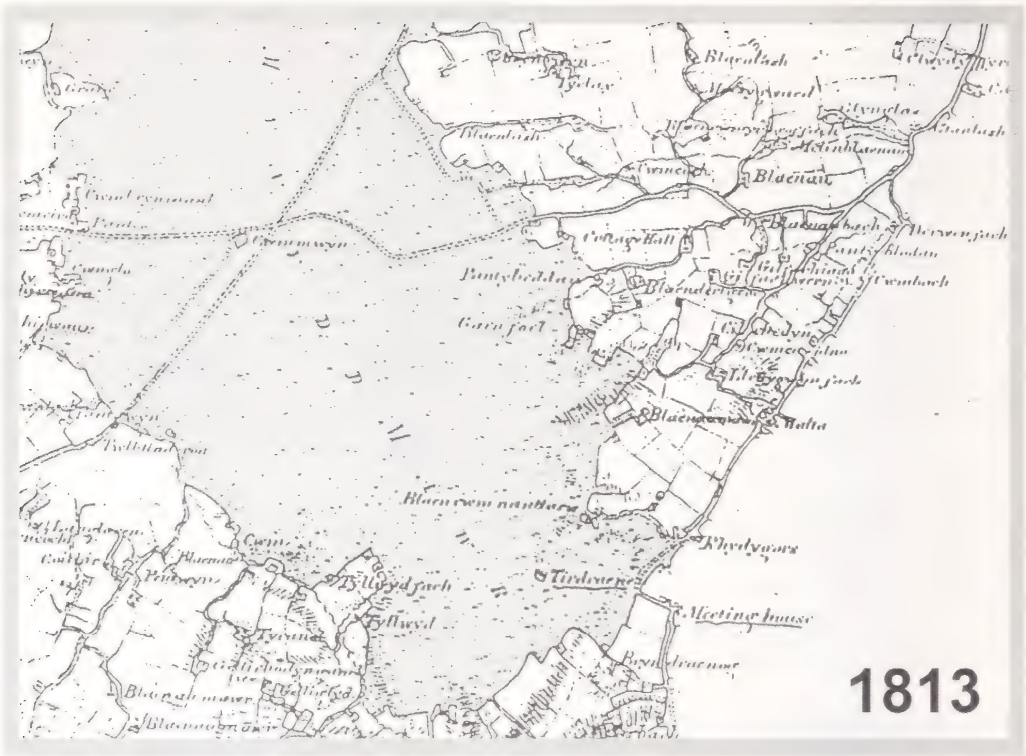


FIGURE 4. Mynydd Mawr common as depicted on a map of 1813.



FIGURE 5. Mynydd Mawr after enclosure (shaded) as shown on the Ordnance Survey map of c. 1860.



FIGURE 6. Extent of the *Carum* survey carried out by the Nature Conservancy Council in 1978.



FIGURE 7. Phase 1 survey, N.C.C., 1990.

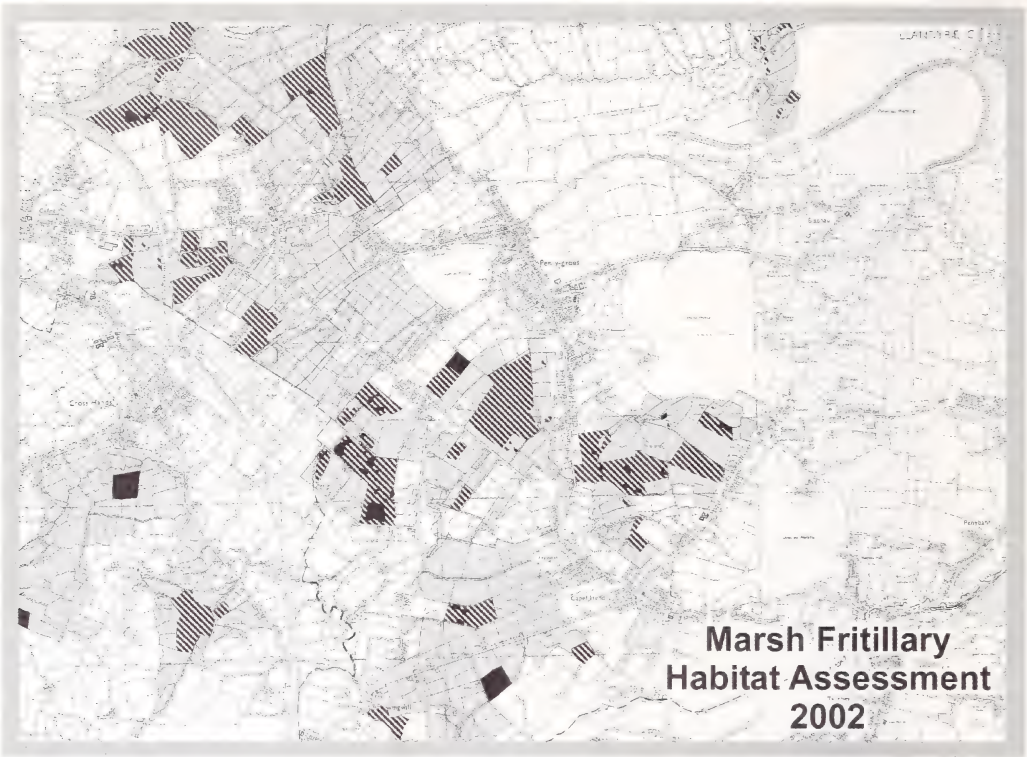


FIGURE 8. Grassland habitat assessment, winter 2001/2. Fields examined shown grey, those in favourable condition, black and those capable of relatively easy re-instatement, hatched.

The area was examined again in 1989 when the Nature Conservancy Council undertook its Phase 1 survey of the district (Fig. 7) but, with the exception of detailed N.V.C. surveys of the best sites and some site examination by field botanists recording for the Carmarthenshire Flora Project and by me as B.S.B.I. Recorder, there has been no comprehensive update since that time except that selected areas were re-surveyed in winter 2001–2 with a view to determining their suitability for designation as a candidate Special Area of Conservation for the declining Marsh Fritillary butterfly population. I must emphasise that this survey was not a botanical survey but can be taken as a measure of habitat quality in terms of species diversity and vegetation structure. It covered much the same ground as the 1978 *Carum* survey and this result confirmed that very few of the enclosures examined were in a favourable condition for the butterfly, and it may be implied, therefore, that the state of their vegetation communities was also poor. On Fig. 8 the grey areas indicate the fields surveyed but only the few black areas were found to be in good condition whilst the hatched areas were judged to have potential for straightforward restoration. The tiny extent of the black and hatched areas is alarming.

What this succession of surveys has confirmed is the extent of the losses to these unimproved grassland habitats in recent years. A few sites have been protected by their notification as Sites of Special Scientific Interest (S.S.S.I.) (Fig 9) but the system of designation of so-called second tier sites in Local and Unitary Development Plans (variously known as *Sites of Importance for Nature Conservation*, *Sites of Nature Conservation Importance* or just *Wildlife Sites*) has not so-far caught up with the Local Authorities in West Wales, although, in England, some Authorities have been using such designations for at least the past twenty years. The designation of these sites can provide a very important early warning of inappropriate development located in sensitive sites.

Opencast coal mining, a major cause of losses from the 1960s to mid 1990s has now subsided considerably, largely as a result of more strict legislation, the public objection to its impact on the environment, the demise of British Coal and, not least, because suitable shallow coal reserves are



FIGURE 9. The locations of Sites of Special Scientific Interest in the area.

largely exhausted. It was always argued that opencast mining cleared dereliction by greening the land and returned it to its former state. While that was true to an extent, another primary reason was because it was a cheap source of coal and was very profitable. Generally a far greater area than just the derelict land was taken in to provide a mine of economically workable size, which, of course, invariably meant the loss of peripheral fields of high nature conservation value. Restoration on the completion of mining invariably consisted of sowing the site with Rye-grass and clover leys of minimal ecological value. These were difficult to manage because of the lack of soil structure which resulted in waterlogging in winter and excessive drying-out in summer. With traditional low-key farm management, the result after twenty or thirty years is an N.V.C. MG10-like coarse, rush-dominated grassland comprising of Soft Rush and mosses and a few common forbs such as *Cardamine pratensis* (Lady's-smock) and Creeping Buttercup (*Ranunculus repens*). Agricultural productivity is also minimal. Experiments to restore some species diversity by the introduction of turves, containing *Carum* and other rhos pasture species to restored land, were unsuccessful. The plants did not grow well and soon died-out, and the little seed which was produced, would not easily germinate in the alien conditions (Medcalf 1989 & 1990). Where restored land is more intensively farmed, there is also little likelihood of traditional rhos pasture vegetation becoming re-established due to the changed hydrology and topography, frequent high nutrient inputs and the high sheep-grazing intensity needed to control the constant threat of rush infestation. Furthermore, the restored fields, being of a size to facilitate more efficient agricultural working, are completely alien to the traditional small field pattern of the pre-opencasted land and therefore have an adverse landscape impact.

Another major cause of rhos pasture destruction has been the large-scale development of business parks, often joint ventures between Local Authorities and the Welsh Development Agency. Again the emphasis has been given to the clearance of derelict land and, in my example area, the Cross Hands Colliery tips have been re-contoured to provide the development plateaux for the Cross Hands Business Park. However, large areas of adjacent unimproved grassland, including some former Marsh Fritillary butterfly breeding sites, have also been destroyed in

association with the scheme. Here, as elsewhere, the wildlife may have a last stand, albeit temporary, as these new open sites are colonised by protected or Biodiversity Action Plan breeding birds and mammals including Little Ringed Plover, Lapwing, Curlew, Skylark and Brown Hare.

So have we come full circle with the unenclosed common of 200 years ago now being replicated, to some degree, by the replacement of the many small fields by expanses of restored opencast land and development plateaux? Fig. 10 shows the extent of such land in my example area with the light shading representing the unenclosed land of the pre 1813 Mynydd Mawr Common, the dark shading in the eastern half of the map showing the extent of habitats lost to opencast. and the medium shading in the west, the Cross Hands Business Park and the A48 dual carriageway. This figure does not show the amount of land lost to new housing development.

Locally, house building has, in recent years, also caused considerable losses especially along road-frontages where the Local Planning Authority has been notorious for allowing ribbon-development, seemingly unchecked, which now links most of the previously discrete villages. This practice has resulted in many examples of unimproved grassland being lost or damaged, including a rhos pasture S.S.S.I. This problem continues, not least, because much of this land has been designated in the past as development land in the Local Structure Plan, and therefore might expose the local authority to compensation payments to the land owner should its designation be reversed.

The small farms were always barely viable or merely provided a supplement to the main income and now that their owners are getting older or passing-on, they are too work-demanding and not large enough or sufficiently productive to sustain a viable living. The neglect of appropriate management has now, therefore, taken over as possibly the most damaging factor causing rhos pasture losses. Absence of grazing allows scrub colonisation and *Molinia* domination. Reinstatement of this neglected land is expensive and requires many years' commitment as well as management-awareness and even then may not be entirely successful. Mechanical trashing of tussocky *Molinia* generally requires the employment of specialist equipment and scrub clearance is equally expensive, time consuming and laborious.



FIGURE 10. Areas lost to opencast (dark grey, generally in the east) and business parks and dual-carriageway (medium grey in the west) compared with the original Mynydd Mawr Common (in light grey).

Although a few fields have been designated as S.S.S.I.s and should, in consequence, be relatively safe from degradation, it might be expected that Tir Gofal, the whole-farm, Wales-wide countryside stewardship scheme, would be instrumental in conserving rhos pastures and unimproved grassland by encouraging the farming community to do just that, I have no doubt that it is of benefit. We hope that the days are gone when countryside stewardship meant excavating a pond or tree-planting on the most species-rich wet areas on your farm. Nowadays, the Tir Gofal budget is £16.8m per year for spending on such things as fencing, increasing access, woodland maintenance and planting, set-aside and less intensive grassland management but I fear that the most important targets for conservation – the areas which need the most care in their management and protection – are not being thoroughly addressed. There certainly appears to be little feedback on how such payments have actually benefited the conservation or re-instatement of our valuable grasslands.

Contrast this £16·8m per year with the mere £2·6m being spent in Wales to maintain our Sites of Special Scientific Interest, the sites which we are constantly being told are the '*Jewels in the Crown*' of our wildlife heritage. Even worse, only £15000 is being spent on S.S.S.I.s in Carmarthenshire, most of which will be accounted for by existing management agreements, ie annual payments, and many of these will not be grassland sites. This leaves very little scope for new management works which are so desperately needed to arrest the decline of sites through neglect. It also begs the question as to whether available money is being channelled towards the most urgent and effective conservation targets.

It was intended that the Countryside and Rights of Way Act, which has been in force since January 2001, would give added protection to existing S.S.S.I.s by requiring landowners to manage them appropriately and not allowing their decline by neglect. But what do we find?

Schedule 9 section 28P (6) of the Act states "*A person ..... who without reasonable excuse ..... intentionally or recklessly destroys or damages any of the flora, fauna, etc .... is guilty of an offence*". The key to the interpretation of this paragraph is the phrase "intentionally and recklessly" and this is where any competent barrister would interpret "neglect" as not constituting a positive action, rather, it is an inaction and deemed not to be intentional and reckless. Not surprisingly, S.S.S.I.s are still being lost by neglect. This loss, of course, takes no account of the far more extensive losses being allowed to occur at other important, but undesignated, sites.

I am afraid that nature conservation continues to be a very poor relation to any enterprise which might make or potentially make money or bring in jobs or votes. I acknowledge that we in South-west Wales may be better off than many areas where losses have been so severe as to have all but eliminated these habitats, but this fact alone, must only increase our duty to conserve and preserve what we have left.

At the root is the fact that the vast majority of the population is becoming increasingly divorced from the natural environment, has no idea what is necessary for its continued well-being, is now too young to remember the flower-rich countryside, is ignorant of the facts and, as a consequence, doesn't care. The education system provides little, if any, instruction in such matters and even enthusiastic teachers of the subject are stifled by the sheer lack of time allowed in the national curriculum and over-zealous safety regulations which frustrate field studies. There continues to be a massive under resourcing of "whole-organism" biology teaching, although the government has at last recognised a, so-called, "*Taxonomic Impediment*". This is resulting in, for example, many environmental assessments for developments being of very poor quality and recent conservation directives and legislation being made unworkable as a consequence of the shortage of people with the necessary field-skills essential for their implementation.

The picture that I have painted is not encouraging and I appear to have introduced more problems than solutions. In order to address this continuing decline, the Welsh Assembly must ensure that the S.S.S.I. "*Jewels in the Crown*" are comprehensively funded and effectively managed through C.C.W. Furthermore, the S.S.S.I. series must be extended to reflect the need for wide-ranging rhos pasture conservation. A comparison of Figs 6, 7 and 8 with figure 9 shows the poor degree of protection given to our rhos pastures by the present series of S.S.S.I.s. I'm forced to say, that maybe the saving grace will be the precarious state of the Marsh Fritillary butterfly. This has precipitated action to propose the best remaining rhos-pastures and unimproved grassland sites in the Cross Hands area as a Special Area of Conservation in an attempt to maintain the butterfly population.

But it is no good just to declare areas as protected sites. Constant monitoring and resurvey must also be introduced, maybe under the umbrella of the Tir Gofal whole-farm countryside stewardship scheme. This would ensure that farmers who have received payments are actually producing the required results.

Local Authorities should, as a matter of urgency, introduce the designation of second tier nature conservation sites in their Unitary Development Plans. These embody a degree of protection and development control planners could easily access them through their GIS systems. They should not, as in the case of Carmarthenshire, delete from the Draft Unitary Development Plan, the few Sites of Importance for Nature Conservation which are already identified and accepted in a current, adopted Local Plan which relates to part of the county.

Developers, local authorities and the W.D.A. should ensure that basic ecological assessment is undertaken ***prior*** to site acquisition and areas found to be of ecological importance should be left untouched.

Both central and local government should ensure that basic education at all levels includes teaching on the appreciation and fundamentals of the natural environment. Central support of the National Botanic Garden of Wales would go some way to achieving this.

But to try to conclude on a positive note,

- C.C.W. have in the past designated several rhos National Nature Reserves in Ceredigion, and S.S.S.I.s elsewhere and they are pressing ahead with proposals for the Mynydd Mawr cS.A.C.
- There are many farms within the Tir Gofal scheme that include areas of rhos grassland which presumably are being managed appropriately (although it is often the case that only the more intensive farms are entered into the scheme whilst the unimproved grasslands in the ownership of smallholders or less-commercial enterprises, do not receive payments, resulting in their continued loss).
- Plantlife International continues to grow in stature with a rapidly increasing membership and has acquired an important rhos pasture holding at Cae Blaen Dyffryn in Carmarthenshire
- Butterfly Conservation own a rhos-grassland site in the Cross Hands area which it manages for its Marsh Fritillary butterfly population and as a result ensures the well-being of the habitat
- the Wildlife Trust of South and West Wales manages several nature reserves which include rhos grassland
- practical management and restoration techniques have been tried and documented by the Shared Earth Trust at Denmark Farm near Lampeter and courses are offered for those who are interested in promoting or practicing traditional grassland management with nature conservation as a primary objective.
- There appears to be increasing awareness amongst developers and planners of biodiversity constraints and commitments, largely brought about by new legislation and the Welsh Assembly's and Local Authorities' obligations to the implementation of Biodiversity Action Plans.

So where do we stand? We have lost a major part of the resource but at least we have a reasonably good idea of the extent of what remains and are aware of the urgency of protecting it. Substantially more money is now being directed towards nature conservation and wildlife legislation is much stronger than in the past but I fear that currently we are in no better a position to conserve the remaining resource than we were thirty years ago when I first started this ramble.

I feel, therefore, and I strongly urge, that we must continue with our uphill struggle to ensure that at least a substantial proportion of those rhos pastures which remain, will be maintained in good condition into the future and we must make sure that decision makers are made aware of the situation and that the issues are satisfactorily resolved.

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John Raven's report on his visit to the Hebrides, 1948

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ABSTRACT

In the summer of 1948 John Raven visited Harris (v.c. 110) and Rum (v.c. 104) to investigate the numerous rare plant species reported from there in the preceding years by Professor J. W. Heslop Harrison. His conclusions were summarised in a report to the Council of Trinity College, Cambridge. In 1960 he presented a copy of this report to the library of King's College, Cambridge, but asked the librarian to restrict access to it until after his death, and that of Professor Heslop Harrison. The text of this report is published in full for the first time, with an annotated list of the documents attached to the report and notes on some of the species, people and places mentioned in it.

KEYWORDS: Heslop Harrison, Rum, Harris, *Carex*, fraud.

INTRODUCTION

In the 1930s and 1940s Professor J. W. Heslop Harrison reported a number of remarkable discoveries made in the Inner and Outer Hebrides of Scotland by the natural history expeditions he led from King's College, Newcastle-upon-Tyne. Records of vascular plants, bryophytes and invertebrates which were new to Britain, or represented major range extensions within the British Isles, were published by Heslop Harrison or, in some cases, by other members of his expeditions. As the number of remarkable plant records grew, many botanists began to suspect their veracity. It fell to John Earle Raven of Trinity College, Cambridge, classicist and amateur botanist, to investigate them. Raven obtained a grant from the Fellows' Research Fund of Trinity College which enabled him to visit Scotland in July and August 1948 to carry out his inquiry. He searched for three rare *Carex* species reported by Heslop Harrison from Harris, Outer Hebrides (v.c. 110) and joined the professor's party on Rum, North Ebudes (v.c. 104) to inspect some of his discoveries on that island. His conclusions about two of the notable species were published, briefly, in *Nature* (Raven 1949). He suggested that both *Carex bicolor* and *Polycarpon tetraphyllum* were introductions to Rum, but did not comment on the possible means of introduction. Since then the records of these two species, and those of a number of other very rare plant species reported by Heslop Harrison from the Hebrides, have been regarded as doubtful or completely rejected by British botanists.

In addition to the paper in *Nature*, Raven submitted a more detailed report to the Council of Trinity College. Although this report was not published, Raven subsequently lent copies to interested friends and colleagues, and knowledge of its contents therefore spread by word of mouth. In 1960 he presented a copy of this report to the library of King's College, Cambridge (he was elected to a Fellowship at King's in October 1948), saying in the accompanying letter to the Librarian that he would "like it kept under lock and key until both its hero [Heslop Harrison] and I are safely in our graves". In the absence of any published details, however, there was inevitably much speculation in botanical circles about how the dubious records came to be made.

J. W. Heslop Harrison died in 1967 and John Raven in 1980. The report was withheld by King's for the lifetime of Professor Heslop Harrison's son, J. Heslop-Harrison, but his death in 1998 removed any remaining reason for secrecy. The full story of Raven's investigation was told by Karl Sabbagh (1999) in his book *A Rum Affair*, which draws extensively on Raven's unpublished report. Now that the story is in the public domain, it seems appropriate that the full report should be published. The report is printed here by kind permission of Mrs Faith Raven. In an accompanying paper, Pearman & Walker (2004) provide a detailed consideration of all the plants which were recorded by Heslop Harrison's expeditions to Rum but have not been refound.

NOTE ON THE TEXT

The text of the report which follows is taken from the copy of Raven's handwritten report in King's College library (catalogued as MISC 18/1–2). In his letter presenting it to the library, Raven explains that "The original, of which this is a photograph, was a report to the Council of Trinity....". The original has not been traced (Sabbagh 1999, pp. 3, 119; A. C. Green, *in litt.*, 2003).

The text is reproduced with the same capitals and underlining as in Raven's report. However, his frequent small ampersands are spelled out as 'and', a change which perhaps makes the prose read slightly more ponderously than does the handwritten original. Repetitions indicated by ditto marks are printed in full. The effect of these changes can be seen by comparing the first page of the handwritten report, reproduced by Sabbagh (1999), with the text below. The photograph at King's is rather dark towards the edges of some sheets, and one or two words are difficult to read or apparently missing. I have mentioned all but the most trivial of these uncertainties in the notes.

Some paragraphs of the report are enclosed in square brackets. These brackets do not appear to have been written in the same dark ink as the rest of the text, and both this and their close spacing in relation to neighbouring words suggests that they may have been added later. They do not appear to be a considered series of deletions, as no adjustment has been made to the first, linking, sentence of the subsequent paragraphs. To include these sections in square brackets in a printed report gives a misleading impression; I have therefore marked their presence by a ‖ symbol. There are also paragraphs towards the end of the report marked with a vertical line in the left-hand margin, and the entry under September 8th is marked with a double line in the margin and 'Summarise' added at the top; the double line has been crossed through (later?) and the date ticked. These annotations suggest that Raven intended revising the report. If it was not for Raven's statement in 1960 that the photograph was a copy of the original, I would have concluded that the document at King's represents a copy of the penultimate manuscript, which was rewritten with minor changes for presentation to the Council of Trinity.

There are 22 letters and other documents cited in Raven's report, as A–T, and appended to it. These are too long to reproduce here in full, but I have summarised them after the report. I have also listed additional documents which are not cited, but which were deposited by Raven with the report. I have tried to limit my notes on the text to the minimum necessary to explain references made by Raven or point to subsequent discussion of the points he raises. I have added notes on the more significant species discussed by Raven and listed all plants which are cited in the report under outdated names, adding their current names. I have also provided brief biographical notes on some of the *dramatis personae* and listed the Hebridean place names mentioned by Raven with their grid references and the current spelling if this differs from that in Raven's report.

To simplify the citation of the numerous papers by Heslop Harrison and his colleagues, publications with three authors are cited with all the authors' names and only those with four authors are cited as the first author followed by '*et al.*'

The text of the report follows.

REPORT by J. E. RAVEN on his BOTANICAL RESEARCHES in the HEBRIDES

This report will inevitably be of considerable length, and much of it will, I am afraid, be rather dull. But I want it to be as complete as possible, and I hope that as it progresses it will become more interesting. The greater part of it was written in the train on my way back, on August 9th & 10th, from Arisaig to Cambridge. I thought it best to record my observations while the memory of them was still fresh; and I have left that part of my report to stand almost exactly as it was first drafted. I have added, in the form of a postscript, an account of all important developments since that date. But what follows now is what was written in the train only two or three days after my return from the Isle of Rhum.

In case members of the Council have forgotten the content of my application for a grant from the Fellows' Research Fund, I had perhaps better begin this report by reminding them of the object of my expedition to the Hebrides. For the past 13 years a party of botanists and students, under the leadership of Professor J. W. Heslop Harrison, D.Sc., F.R.S., has gone out each summer from King's College, Newcastle-upon-Tyne, to investigate the flora of the Hebrides. During this long period they have published, at regular intervals and in a variety of periodicals, a series of very remarkable botanical discoveries, in both the Inner and the Outer Hebrides. These discoveries have consisted, in the main, of two separate elements: first Arctic-alpine species, at least 5 of which were new to Britain, while many others were known only from single localities on the Scottish mainland; and second, Southern species, known in the British Isles, if at all, only in the South-Western corner of England and in the Channel Isles.

The former of these two elements contains, for instance:-
EPILOBIUM LACTIFLORUM)
ERIGERON UNIFLORUS) All new to Britain, and all recorded from
CAREX CAPITATA) Barkeval, Isle of Rhum
CAREX BICOLOR)
CAREX GLACIALIS)
LYCHNIS ALPINA – known only in 2 or 3 very small areas on the mainland,
CAREX MICROGLOCHIN – known only in Coire Buidheag, Ben Lawers,
CAREX LACHENALII – known only on the highest Scottish mountains,
CAREX CHORDORRHIZA – known only at Altnaharra, in Sutherland,
and every other species of scarce Scottish sedge excepting only C. BUXBAUMII, which, being known both from Arisaig and from the shores of Lough Neagh, might perhaps have been thought the most likely of all to occur in the Hebrides.

The latter element contains only 3 plants that are relevant to this report, namely:-
JUNCUS CAPITATUS – known only in the Channel Isles, West Cornwall and Anglesey,
POLYCARPON TETRAPHYLLUM – known only in the Channel Isles, Cornwall, Devon and Dorset,
CICENDIA PUSILLA – known only in the Channel Isles.

The finding of all these plants in the Hebrides[1], where none of them had ever been seen before, represents a very remarkable achievement, and has naturally added very greatly to Prof. Heslop Harrison's reputation. But unfortunately a number of the best qualified of British botanists (several of whom, incidentally, knew some at least of the Hebrides pretty intimately) came to view this ever lengthening list of Hebridean rarities with growing suspicion. Since the Professor was reluctant to allow outsiders to examine some of his most notable specimens, the belief became widespread that some at least of his records rested on faulty identification; other records again were alleged to be due to confusion of specimens in the laboratory; and even the apparently fantastic rumour gained currency that the Professor must himself have planted the specimens that he subsequently discovered. There was, so far as I know, no decisive evidence one way or the other; suspicion and controversy were growing apace; and the time seemed to have come when, in the interests of scientific truth as well as peace, a determined effort should be made to settle the dispute.

It was for these reasons that, towards the end of 1947, it was decided that a party consisting of Miss M. S. Campbell (Secretary of the Botanical Society of the British Isles), Professors A. R. Clapham and T. G. Tutin (Professor of Botany at Sheffield and Leicester respectively), Dr. E. F. Warburg and myself should visit the two islands from which the most remarkable discoveries had been reported, namely Harris and Rhum. Unfortunately the original plans had to be considerably modified. First Tutin and then Warburg were compelled to drop out of the party – the former because he had to take some of his students to Switzerland and the latter because he chose to get married. And finally the cabin-cruiser in which (there being no accommodation on the island) we had intended to live while exploring Rhum proved after all unobtainable and no substitute was forthcoming. I even contemplated, at this stage, returning the grant of £50 that the Council had so generously voted me. But in spite of these hitches the remaining 3 of us decided to carry out what we could of the original plans; and the final timetable evolved was as follows:-

July 12–19: M.S.C., A.R.C. and J.E.R. to Kilchoan, Ardnamurchan – a district which, being geologically akin to Rhum but botanically unknown, was considered likely to prove interesting.

July 19–30: The same 3, with 3 botanical students, to Tarbert, Isle of Harris – an island from which 3 very unexpected sedges had been recorded by the Professor.

August 2 onwards: J.E.R. alone, at the suggestion of Professor Heslop Harrison himself who was due there at the same time, to the Isle of Rhum.

‖This last stage represents so complete a change of plan that some explanation is perhaps called for. It happened that, when I first heard that the cabin-cruiser was not after all available, my father was carrying on a botanical correspondence with the Professor. He had even, at my suggestion, mentioned to the Professor that some time during the summer I hoped to visit Rhum; and the Professor had replied, cordially enough, with the letter that I append labelled A. At this stage, therefore, I myself took up the correspondence, and wrote and asked the Professor the dates of his projected visit to Rhum. His reply is also appended, labelled B. It will be seen that this letter contains a definite offer, which I promptly and gratefully wrote and accepted, asking at the same time to whom I should apply for permission to land, and adding, perhaps rather provocatively, that I understood from my friend Professor Butler that, once on the island, I might be able to persuade one of the crofters on the island to supply me with my meals. The Professor's answer, labelled C, contrived to give me, perhaps wrongly, the impression that he was not altogether eager for my presence, and therefore merely strengthened my determination to go. I wrote and asked Lady Bullough for her permission to land on Rhum – obeying, incidentally, the Professor's injunction not to refer to him – and duly received the very civil answer labelled D. Letter E to my father and F to myself, which closes the correspondence, are appended only because they prove that, during June of this year, the Professor not only spent some days on Rhum but actually visited the colony of CAREX BICOLOR in the Coire Dubh below Barkeval. ‖

My plans for this last stage of my expedition were in the end – as the latter part of this report will show – modified yet again; but for the rest the expedition went according to plan. It will be best if I record my activities in the form of a diary, sticking so far as possible to facts, and making it perfectly clear when I am reduced either to second-hand accounts or to my own opinion. But before I do that I must just say a few words about the attitude with which I approached the problem.

I was, I must admit, one of those who viewed the Professor's activities with considerable suspicion. This suspicion was based on three grounds, the first simply a matter of opinion, the other two matters of fact.

1) It seemed to me highly improbable that so small an area as the Isle of Rhum, for all its geological peculiarities, should contain so large a selection of exceedingly rare plants as the Professor claimed to have discovered there; and in particular I was not predisposed to believe that the hill called Barkeval – which, being under 2,000′, is by no means the highest of the Rhum hills – should support no less than 5 species unknown elsewhere in Britain.

2) In 1946 I had spent several hours searching a small stony patch on the Isle of Raasay on which the Professor had claimed, in print accompanied by photographs, to have found a fair quantity of

both JUNCUS CAPITATUS (a plant that plays a large part in this report) and CICENDIA PUSILLA (a plant, as I said above, known hitherto in the British Isles only from the Channel Isles). Not only did I fail to find a trace of either plant, but I left the spot convinced that they were not there. It is true that in his published account the Professor had himself reported that "almost immediately" after the discovery of the plants "the bulk was badly damaged by cattle"; but since both are annuals I did not believe that they would be so easily and suddenly exterminated.

3) In 1947 Prof. J. R. M. Butler had visited the Isle of Rhum and had there ‖– as the appended letters will already have shown –‖ met Prof. Heslop Harrison. It appears that, on the mention of my father's and my names, Harrison had taken Butler a short distance up the Kinloch River and shown him a small plot of land in which he was cultivating, evidently for purposes of study, some at least of the island's rarest plants. Butler, thinking that I would be interested but naturally unaware of the significance of his kindness, had written down, on the back of an envelope which he later gave me in Cambridge, the names of two of these plants. They were JUNCUS CAPITATUS (a plant the name of which should by now be becoming familiar) and CAREX CAPITATA (a plant which had not as yet been publicly recorded from Rhum, but only a single specimen from a very unlikely station on South Uist). I may well have put an entirely wrong interpretation on these facts, but in view of the slight suspicion that I already entertained I could not help regarding them with considerable interest.

It will be seen, therefore, that I had not, at the beginning of the expedition, a completely open mind. But in spite of that I did my best to remain impartial; and I believe that the facts which I shall now record speak for themselves.

July 12–19:

Ardnamurchan proved, as we had hoped, an area of considerable botanical interest, but it could hardly be said to have thrown much light on the problem with which I am concerned. Only 3 surprising plants were found, namely GERANIUM SANGUINEUM, RHYNCHOSPORA FUSCA and ASPLENIUM SEPTENTRIONALE, none of which figure in Prof. Harrison's Flora of Rhum[2]. No trace was seen of any of the more surprising species that he had recorded in that publication. But that, in view of the peculiarly discontinuous distribution of the rarer Scottish plants, is admittedly evidence of very little, if any, weight.

July 20–30:

The Isle of Harris was naturally more illuminating, since it was from there that the Professor and his party had reported 3 of the rarest of Scottish sedges, namely CAREX MICROGLOCHIN, C. LACHENALII and C. CHORDORRHIZA. I made it my personal responsibility – being the only one of the party who was familiar with all 3 sedges in their widely separated and very restricted habitats on the mainland – to undertake a thorough search of the areas on the island from which each had been recorded. As the result of these searches I have little hesitation in saying that 2 at least of the 3 sedges are not where they are alleged to be. I cannot, of course, claim that I examined every inch of the areas in question; and even if I had I would never feel confident that I had not overlooked a plant so small and inconspicuous as CAREX MICROGLOCHIN. But both areas are entirely unsuited to the plants. ‖CAREX MICROGLOCHIN grows on the Ben Lawers range in base-rich, micaceous bogs, accompanied by varying quantities of such other Arctic-alpine species as JUNCUS TRIGLUMIS and J. BIGLUMIS, CAREX SAXATILIS and C. USTULATA, and KOBRIESIA. Uisgnaval Mhor, the mountain in Harris from which it was recorded, is a dry and intensely acid mountain. Its alpine flora consists only of SAXIFRAGA STELLARIS and EPILOBIUM ALPINUM, POLYGONUM VIVIPARUM and OXYRIA DIGYNA, SALIX HERBACEA, LUZULA SPICATA and CAREX RIGIDA, and a very small quantity of ARABIS PETRAEA. This is a wholly different plant community from that which accompanies CAREX MICROGLOCHIN. JUNCUS TRIGLUMIS and CAREX SAXATILIS would, I am quite sure, be found always to accompany C. MICROGLOCHIN wherever else it were to be discovered in Britain. Neither of the two has ever been recorded from Harris, not even by Professor Heslop Harrison himself. Conversely ARABIS PETRAEA has never been found on the Ben Lawers range. Yet it is found, as Prof. Harrison admits, on Uisgnaval Mhor.

For these reasons I conclude with confidence that CAREX MICROGLOCHIN never in recent years grew by nature on Uisgnaval Mhor. But in this connection there is one surprising fact that must be mentioned. This particular plant was apparently found, and certainly recorded, not by the Professor himself but by his son-in-law, Dr. W. A. Clarke, a botanist whose honesty has never been doubted, and who seems, indeed, to have been so disturbed by the suspicions surrounding the Professor's activities that for some years past he has dissociated himself from the Hebridean excursions. The only surmise that I can make to explain this fact is so unfounded that I do not think it is worth putting on paper.

The considerations that convinced me that the record for CAREX LACHENALII was also erroneous are of a similar nature. This sedge, though again very rare, is at least more widely distributed in Scotland than is C. MICROGLOCHIN. It grows on a few of the Cairngorms, on Lochnagar, and in one corrie on the North side of the Ben Nevis range. In all these stations it is at an elevation of at least 3,000′; and it grows always in Britain within a short distance of snow-patches which, if not actually perpetual, lie on the North-facing slopes for at least three-quarters of the year. Its alleged station in Harris, "between the stream in the Coire Serien and the crags of Sgaoth Ard"[3], is at a maximum altitude of 1400′, and can hardly – though this is surmise – lie under or near the snow for more than 3 or 4 months in the year. ‖

The case of CAREX CHORDORRHIZA is of a different nature. Its one station on the mainland, in the great bog at the head of Loch Naver in Sutherland, is in no visible way remarkable, and there is no obvious reason why the plant should not be more widespread than in fact it is. I would not be at all prepared to say that it could not be in the locality from which it was recorded in Harris, "a patch of extremely boggy ground near Loch Stioclett, South Harris."[4] It is true I did not see it there; but that, again, is no valid argument. There are very many patches of extremely boggy ground in the area, and I did not look at by any means all of them. But in one such patch which I did examine – a patch that was so boggy that, when we were there, it was covered to an average depth of some 2 inches with stagnant water – there was a considerable quantity of a sedge which I myself, though I had seen C. CHORDORRHIZA at Altnaharra only a year before, thought at first sight to be indeed that species. It had the same far-creeping stem, with the same tufts of narrow leaves arising at irregular intervals from it. The fact that it bore not a single flowering or fruiting spike made it at first sight hard to determine. But a brief inspection of the drier ground around the pool revealed a large quantity of perfectly normal CAREX LIMOSA complete with numerous fruiting spikes; and a careful comparison of the leaves of this plant with those of the other growing in the pool proved that they were unquestionably identical. The plant that so effectively imitated genuine CAREX CHORDORRHIZA was nothing but a submerged form, which we subsequently found to be not uncommon in Harris, of C. LIMOSA. A voucher specimen was sent, fresh, to the British Museum (Natural History)[5]. It is again a mere surmise, though at least a plausible one, that it was this plant that was erroneously recorded, from the same locality, as CAREX CHORDORRHIZA.

But in spite of these conclusions I returned from Harris with no evidence that I could reasonably expect anyone else to regard as conclusive. There still remained, of course, the Isle of Rhum, and it was there, if anywhere, that I had always felt that the solution of the problem was to be found. That feeling was largely justified by events. And as, from now onwards, those events became almost daily more and more significant, I shall chronicle the main incidents of the last week of my expedition day by day.

July 31st:

Early in the morning we reached Arisaig, where I was due to spend the week-end with Mr. Walter Hamilton. With Miss Campbell and one of the students I examined some sand-dunes near Morar, where we found, as well as an abundance of CORYNEPHORUS CANESCENS, a quantity of a variable form of TEESDALIA NUDICAULIS – a plant new to this district of Scotland. As the Professor had recorded another species of TEESDALIA (T. LEPIDIUM, new to Britain) from the sandy shores of Eigg opposite, it is hard to resist the suspicion that this may be another instance of mistaken identification.

August 2nd:

In the morning I attempted to ring up Lady Bullough, owner of Rhum, to get permission for Hamilton and Mr. T. R. M. Creighton (who was due to reach Arisaig from the South later in the morning) to land and camp with me on the island. Visitors to the island are ferried from Macbrayne's steamer (which is too large to come alongside) to the quay at Kinloch by a private motor-boat piloted by the factor. The factor is instructed to bring ashore nobody who has not Lady Bullough's permission to land. Permission was therefore essential if we were to enter Rhum by Kinloch. But I found to my surprise that Kinloch Castle, Lady Bullough's monstrous residence on the island, had no telephone; and it was already much too late to hope that an answer to a telegram could arrive before the weekly steamer left Mallaig. And so we decided to go instead to the Isle of Canna, to the West of Rhum, and to enter Rhum without permission from that side. Unfortunately ‖– as will be clear from his letters cited above –‖ the Professor was expecting me alone to join his party that day; and so, once aboard the steamer, which serves both Rhum and Canna, I had to identify the Professor, whom I had never met but knew to be on board, and break to him the news that I should not after all be arriving till the 5th. I located him just in time, and was instructed, somewhat peremptorily, as soon as I reached Canna, to despatch a reply-paid telegram to Lady Bullough seeking her permission to bring Creighton with me on the 5th. Hamilton, from the distance, was not impressed by the Professor's appearance.

August 3rd:

We despatched the telegram to Lady Bullough, adding, as he had further instructed me, that the Professor raised no objection.

August 4th:

We hired A. McIsaac, crofter, to ferry the 3 of us, accompanied by Mr. J. L. Campbell (owner of Canna and an amateur entomologist of some note) over to Harris Bay on the West shore of Rhum. From Harris I climbed Ruinsival, a hill of some 1,800', in search of ARENARIA NORVEGICA, which the Professor had reported to be abundant there, but which is elsewhere in the British Isles known only from Inchnadamph in Sutherland and Unst in Shetland. This record proved, as I had expected it would, to be perfectly accurate: when a plant is reported as abundant there is good ground for supposing that it is there. The plant is indeed plentiful over a wide area, even spreading down streamsides, as the Professor had again reported, to the shores of Loch Fiachanis some 900' below its main station. While I was on Ruinsival, Campbell searched the neighbourhood of Harris Bay unsuccessfully for the Large Blue butterfly (M. ARION), which the Professor had very surprisingly recorded from there. Campbell's search may, of course, have been rendered less thorough by the fact that he himself is firmly convinced ‖– as he had written to me in the letter appended, labelled G –‖ "that the specimens were confused in the laboratory"[6]. None of our party met or saw anybody else all day, although there is a shepherd and his family living in a croft at Harris; but we did leave an abundant supply of very evident footmarks, especially Creighton, who walked in his heavily nailed climbing boots all round the sandy margin of Loch Fiachanis.

On our return to Canna in the evening we found awaiting us an obviously grudging affirmative from Lady Bullough. It ran: "No accommodation available. Must bring tents, food, and all equipment."

August 5th:

We rose at 4.30 a.m. to catch the boat, Creighton and myself for Kinloch, Hamilton for Mallaig. Creighton and I landed, not without incident, at Kinloch, where we were obviously – at first – far from welcome. This may have been in part due to the fact that in our hasty transference of all our impedimenta from the steamer to the motor-boat we had somehow contrived, as we were forced to confess to the factor, to leave all our cooking and eating utensils behind. But the surprising fact remains that as soon as we made it clear that we were not after all, as our telegram had mistakenly suggested, friends of the Professor, the attitude of the inhabitants towards us underwent a sudden and total change. As our short stay on the island advanced it became increasingly evident that the Professor was regarded by all the locals, including Lady Bullough herself, with considerable hostility and some suspicion.

By 10 a.m. I reported to the Professor's base-camp and was instructed, again somewhat peremptorily, to set out at once on foot and await the arrival of a car, bearing the Professor and his party, at an appointed meeting-place. The car eventually arrived about 11.45 – a late hour for a serious botanical expedition to begin its day's work. The party proved to consist of:

The Professor,
his wife,
his niece,
a certain Smith, whose botanical knowledge appeared to be confined to grasses,
a girl of about 20, whose name was apparently Iolande and who was evidently there to gather instruction,
and Dr. W. A. Sledge, of the Department of Botany at Leeds University, a field botanist of note and evidently the honoured guest of the year[7].

With this party, excepting Mrs. Heslop Harrison who is now too infirm to walk any distance, I set out to explore a hill called Fionchra. It proved, as the Professor had indicated, to be botanically rich. On its Southern cliffs there are, among other interesting alpines, a vast quantity of very variable Mossy Saxifrages and a considerable colony of one of the two alpine THLASPIS. The THLASPI was unfortunately too withered to be identified with absolute certainty; but, though T. CALAMINARE is at present known only from Derbyshire, it seems most likely that the Professor is right in saying that it is that species – if the two are indeed distinct – rather than the more widespread T. ALPESTRE. In any case he raised no objection to my removing a seedling for cultivation and determination.

The North cliffs of Fionchra, though they looked even more promising and carried an abundance of such interesting alpines as SAXIFRAGA NIVALIS and POA GLAUCA, produced nothing as notable as the THLASPI. A colony of a SALIX, which the Professor had found on an earlier visit and determined to be S. ARBUSCULA, mysteriously eluded our attempts to refind it and was eventually decided to have probably perished in a landslide.

Finally we were led across a series of barren shoulders to a small, steep outcrop of Mugearite, at the foot of which, on a very steep little slope of loose gravelly soil, we were shown some 10 or 12 small and weak rosettes of LYCHNIS ALPINA. Sledge and I were slightly surprised that the plant did not grow also on the solid rock immediately above. It appears from the Professor's account that it had in fact originally grown also on the North cliffs of Fionchra that we had just inspected, but it, like the SALIX, had apparently disappeared from that locality in a landslide. In its present locality it was causing the Professor grave anxiety lest it should be trampled into destruction by passing deer – an eventuality which the extreme steepness of the slope, topped as it was by a small cliff, seemed to me to make very improbable. It was, however, true that the LYCHNIS looked far from securely established.

That evening Creighton and I called on Lady Bullough. While we were awaiting her arrival from her distant boudoir, her companion, Miss Rhodes, showed us a large raised map of the island and very kindly told us not only how best to climb Ruinsival, but also where we might hope to find ARENARIA NORVEGICA. I was glad – though I did not say so – to learn that my instinct had led me, the previous day, by the recognised route to the approved station. When Lady Bullough eventually appeared, not even the presence of a vast ivory eagle brooding over Creighton's head could detract from the friendliness and charm with which she received us. We found it hard to believe that she resented the presence of strangers on her island so strongly as the Professor had led us to suppose.

August 6th:

Our doings on the 5th had once again, despite one or two suspicious features, produced no evidence that could be regarded as conclusive. The 6th was to prove very different. Indeed it produced so much evidence that it may well be – though I hope and think not – that it has to some extent coloured my account of all that preceded it. That evidence is largely, I am afraid, of a technical nature, and its full weight will hardly, perhaps, be apparent to any but field-botanists. But any experienced field-botanist will, I feel certain, agree with me that it admits of only one interpretation.

The day's activities began, as had those of the day before, with my[8] reporting at 10 a.m. to the Professor's base-camp. I found, as I had been led to expect, that the whole party was intending to motor to Harris in order to climb Ruinsival and see ARENARIA NORVEGICA. I told the Professor that much as I should have liked to see the ARENARIA, I felt that I should devote my last day on the island to a search for some at least of the 5 new species that he had discovered on Barkeval. To my great surprise he not only raised no objection but even produced a pencil and paper and gave me more or less detailed directions for finding CAREX BICOLOR and EPILOBIUM LACTIFLORUM, CAREX GLACIALIS and ERIGERON UNIFLORUS. He told me, moreover, that I might collect a fruiting spike from a particular plant of CAREX BICOLOR, and that, though I should find the EPILOBIUM was past flowering, it was a perfectly simple plant to raise from seed. Nothing in the whole affair surprises me more than the readiness with which he allowed me to go without escort to examine his most precious discoveries. It might indeed be regarded as a powerful argument in support of his good faith. I am more inclined to think, however, that he simply dismissed me from serious consideration as an ignorant and incompetent fool – an attitude, I may say, which, even if it had been in my power to dispel it, I was at some pains to foster.

Just as I was about to leave, Sledge, who had been standing by in silence, asked me whether I had seen JUNCUS CAPITATUS. I replied, truthfully, that I had only seen it in Cornwall. Thereupon the Professor, with a curt order to Iolande to come too, led Sledge and myself up the track beside the Kinloch River. After some 300 yards we approached a small rocky outcrop between the track and the river. Here, the Professor said, they had known for a number of years a very interesting and unexpected plant; with evident pride he pointed out, on bare patches at the edge of the outcrop, a colony consisting of 2 unusually large and 2 small plants of POLYCARPON TETRAPHYLLUM. Now it happened that I had already heard something of this remarkable discovery from Mr. A. J. Wilmott, of the British Museum (Natural History). Wilmott had seen a small specimen of the Rhum plant collected on an earlier expedition by Dr. W. A. Clarke, the Professor's son-in-law; and he had reached the rather surprising conclusion that it was a very unusual form of the plant, quite unlike the form found elsewhere in the British Isles. I was therefore on the alert for anything suspicious; and though I was not at this stage allowed leisure for a detailed examination, I did have time to notice, and point out to the Professor, the striking coincidence that out of the very middle of the largest plant of POLYCARPON was growing a vigorous specimen of JUNCUS CAPITATUS. The Professor contented himself for the moment with the startled expletive "Well, I'll be shot!" and he then hustled us on another 200 yards or so to see JUNCUS CAPITATUS in its approved station. As we walked I asked as guilelessly as possible whether the POLYCARPON was identical with the plant that I already knew in Devon and Cornwall. "Well," said the Professor, "according to Wilmott – if you can trust his determinations – it isn't. The plant has puzzled us a good deal; but we have eventually concluded that it must have been introduced with deer-food."

We were then shown a colony of some 30 specimens of JUNCUS CAPITATUS scattered about some small, bare, stony patches between the heather beside the track. The plant, though again somewhat larger than I had expected, looked very natural, and its habitat appeared, superficially at least, strikingly similar to the bare, stony patches that it frequents, for instance, on Kynance Downs. In view of the great interest of this remarkable extension of the plant's range, I asked the Professor, with a certain hesitation, whether I might be allowed to remove a specimen. He suggested at first that I should take the plant that was growing out of the middle of POLYCARPON lower down; but on second thoughts he selected another specimen for me, which I duly collected and later pressed, and instead despatched Iolande down the track to collect the other for his own herbarium. In the end, however, even that solution failed to satisfy him. He called Iolande back, and he himself, followed by the rest of us, returned to the POLYCARPON and carefully uprooted the JUNCUS from its midst. I was considerably surprised that, instead of being naturally delighted that one of his most notable discoveries was extending its hold on the island, he seemed more concerned to exterminate it from its new foothold. And, since he then pointed out to Sledge and myself how well his specimen showed the rooting system of the plant, there is no possible doubt that that particular specimen will never reappear.

I returned to my tent feeling that at last I had lighted on some positive evidence; and Creighton and I then set out at once for Barkeval. The stations for CAREX BICOLOR and EPILOBIUM LACTIFLORUM (both plants, it should be remembered, new to Britain) lie very close together within 1½ miles of Kinloch. The CAREX grows, at an altitude of about 940′, on bare banks of gravel at the junction of two burns in the middle of the Coire Dubh. With the Professor's directions we found it at once. There were 7 mature plants, and also 2 young plants which, though too small to be identified with complete certainty, were most probably of the same species. ‖ These 9 plants were disposed roughly as in the accompanying sketch-map, which is drawn from memory only:-



‖
space[9] of about one foot separated each of the chain of plants on the North bank, except in the case of the two young plants, which were barely 6 inches from their presumed parents. The two large plants on the South bank were perhaps 4 or 5 feet apart.

At the very first sight of this small colony the same thought immediately occurred to both Creighton and myself: that if we had been looking for a suitable place in which to plant a remarkable botanical rarity, this was exactly the sort of locality – impossible to forget, and so bare that any plant on it was as conspicuous as its nature allowed – that we should ourselves have selected. And it was not long before we noticed also that one plant at least – the middle one of the larger specimens on that North bank – looked precisely as if it had been fairly recently and very carelessly dibbled in and, being more than half dead, had not taken root as it should. And these impressions, of little value in themselves, were [illegible word[10]] strikingly corroborated by a closer examination. The first fact that struck us was that one tuft of the CAREX contained, sprouting from its very midst as JUNCUS CAPITATUS had sprouted from POLYCARPON, a vigorous plant of POA ANNUA. Now POA ANNUA, though it does sometimes occur on mountains (as, for instance, around the summit cairn of Ben Lawers or near the Scottish Mountaineering Club's hut on Ben Nevis) is not a plant that I should normally expect to find in a Scottish corrie. It is primarily, though not exclusively, a weed of gardens, paths and roadsides. Moreover I noticed, on looking still closer, that it was accompanied in the middle of this particular tuft of sedge by another plant of precisely the same predilections, namely SAGINA APETALA. I drew Creighton's attention to this extraordinary fact and asked him to witness my examination of the remaining 8 plants. As might have been expected the two very young plants were free from contamination; but of the mature plants two others besides that already examined proved to contain POA ANNUA, while yet two more contained SAGINA APETALA. Of the 7 mature plants, in other words, 5 were accompanied by weeds associated primarily with gardens. The only two that were uncontaminated were, first, the plant that I have already mentioned as being more than half dead, and, second, the largest and healthiest tuft – the most Northerly of the colony – which may well, in my opinion (since it was with this plant that the Professor had, in my preliminary conversation with him, shown himself most delighted) have received more careful grooming than the rest.

It remained only to make sure that neither POA nor SAGINA was elsewhere in the neighbourhood. Of the SAGINA I cannot speak with absolute certainty, since there was a large quantity of the closely related S. PROCUMBENS dotted about which may conceivably have camouflaged other small plants of S. APETALA. But of the POA I am quite certain that there were no other specimens in the vicinity excepting only the plants that emerged from the middle of the tufts of CAREX BICOLOR. I searched the gravel banks with great care; examining, I believe, every single plant that had found a foothold on them. It is only as the result of this detailed search that I write so emphatically. And moreover, in the course of the search I made a last discovery which – though I am still unable to see its precise significance – constitutes yet another undeniably suspicious feature in the case. Just 7 feet from the Easternmost clump of the CAREX ‖ in approximately the position marked by the cross on my sketch-map above, ‖ I found, to my astonishment, a small plant of the by now only too-familiar JUNCUS CAPITATUS. It bore only 3 fruiting spikes, of which, having once again drawn Creighton's attention to the plant, I removed and later pressed one. Finally I took two specimens of SAGINA APETALA from the tufts of CAREX, one of which was accompanied by two bryophytes and a small pellet of soil. I hope that the bryophytes and the soil, once they are identified and analysed respectively, may prove yet other pieces of evidence to the same effect as all the rest. But even if – as is most likely – that hope is disappointed, there is, I think, no shadow of doubt remaining that CAREX BICOLOR, in its only known British station, was deliberately planted there by human hand. As for JUNCUS CAPITATUS, it is, I think, indisputable that it would not have grown by nature at an altitude of 940 feet in a North-facing mountain corrie on the Isle of Rhum. The only question concerning its presence there is whether it was deliberately or accidentally introduced. On that question, as I say, I have no definite views; but it is fortunately of no vital concern.

Before I leave the case of CAREX BICOLOR there are two other points that deserve mention. It appears, in the first place, that the station in which we saw it was not the identical station from which it was first reported. The original station was on "steep terraces" on the other side of the corrie, from which, according to the Professor's latest account, it has been recently exterminated either by landslides or by deer[11]. (It is, incidentally, interesting to note that in its present station too – and this is perhaps another reason that led to the selection of that station – the entire colony could be very easily washed away in a spate. There is no doubt at all that the gravelly banks on which it grows are periodically submerged beneath the swollen waters of the burn. There is thus, if the new colony, like the old, fails to maintain its hold, a convenient excuse always ready to hand to account for its disappearance.) And in the second place, I have recently heard, at only second hand, a very strange story relating to the first discovery of CAREX BICOLOR in its original station. This story was told me by Prof. A. R. Clapham, who had himself just heard it from Mr. R. B. Cooke. Cooke used, in the early days before his suspicions were aroused, to accompany Professor Heslop Harrison's party on its Hebridean excursions, and he had in fact witnessed the first finding of CAREX BICOLOR. The Professor had apparently set out on that particular day's walk armed with a trowel – an instrument that he had seldom carried before but for which he accounted on this occasion by the statement that he intended to "dig beetles". When Cooke, with Dr. W. A. Clarke, was some 200 feet higher up the slopes of Barkeval than the Professor himself, there was suddenly a loud shout from below and the Professor came running up the hill, with a plant in his hand, saying "I've got a new sedge." Cooke had to content himself with the sight of the specimen that the Professor had already dug up. The Professor was not, as might have been expected, at all eager to show the rest of the party the colony from which his own specimen had come. Incidentally the Professor's own account of this episode, which differs from this, of course, in a number of details, was published in the Journal of Botany, July 1941, pp. 111–3[12].

After our detailed examination of CAREX BICOLOR Creighton and I moved some 100 yards up another tributary burn to look at EPILOBIUM LACTIFLORUM. It grew – some dozen plants of it – on the smaller of two mossy springs which rise side by side on the steep West-facing slope. It looked natural and healthy enough, though I was a little surprised to note that it grew only in the smaller spring, while the larger, which was apparently even more suitable, bore no trace of it. The only other curious feature – and this, which applies equally to CAREX BICOLOR, is to my mind a very powerful argument against its genuineness – was that it was not accompanied by any other species

of Arctic-alpine plant whatever – not even, what I should certainly have expected in such a locality, its common alpine congener, E. ALPINUM.

I learnt later in the day from Sledge that when we were looking at this EPILOBIUM we were actually within a very few yards of CAREX CAPITATA. The Professor's party had evidently spent the day after their arrival in an exploration of Barkeval, and Sledge had been shown all 5 of the mountain's unique plants. CAREX CAPITATA had apparently caused the Professor grave concern. When he had first found it in this station – and I[13] tried, but failed, to find out how long ago that was – there had, by his own account, been 6 or 7 plants of it. This year there was one only. He was unable to decide whether the alleged disappearance of the other 5 or 6 was due to the avidity of some unknown and unauthorised botanist – a conjecture which, since he himself had assured me that without minute directions I should never find the plant, did not impress me as very plausible – or to a lack of botanical discrimination on the part of some sheep that had been recently introduced onto the island. I myself would surmise – though this is nothing but a guess – that there had never been more than the one plant; and it even seems to me not impossible that the plant was the very one that Prof. Butler had been shown in 1947 in the plot of ground by the Kinloch River, having been transplanted into its present station during the Professor's preparatory visit to the island in June of this year.

Unfortunately my directions for CAREX GLACIALIS and ERIGERON UNIFLORUS soon proved hopelessly inadequate. I had been told simply that they grew together on the shoulder of Barkeval just below a large boulder that "looked like a squashed tank." The whole shoulder proved to be covered with innumerable boulders, any one of which, to a lively imagination, might have resembled a squashed tank. As I had been warned also that there were only 3 plants of the CAREX and hardly more of the ERIGERON – facts, incidentally, of the utmost significance in themselves, since no genuinely British alpine is quite as scarce as that – I determined not to waste more than two hours on an obviously hopeless search, and instead dropped down again to Kinloch to pay another, and – since at this stage Creighton went off for a walk by himself – this time a solitary visit to the POLYCARPON.

The station for the POLYCARPON is, as a matter of fact, within sight of the Professor's base-camp. But I had reason to hope – rightly, as it turned out – that the party would not yet have returned from Harris; in any case I came to the conclusion that I should at this stage run the risk of my peculiar activities being observed by the Professor. This second and solitary visit paid a rich dividend. There were, as I have already explained, 2 large and 2 small plants of the POLYCARPON. One large and one small plant grew close together, and they were separated by some 10 or 12 feet from the other large and the other small plant. It was from the largest of the 4 that the Professor had, earlier in the day, removed the flourishing specimen of JUNCUS CAPITATUS; but I observed on closer inspection that there still remained, concealed among the stems of the POLYCARPON, a small seedling of a rush which is almost certainly of the same species, and which will, I hope, later in the season, grow up to take the place of the plant so carefully uprooted. Moreover – and this is the last important fact that I have to record, but perhaps the most significant of them all – I soon found, growing once again out of the very middle of the other large plant of POLYCARPON, a single specimen of a diminutive flowering plant which, although I am acquainted in the field with every known species of Scottish plant, was entirely unknown to me. I thought at first that it could only be that other of the Professor's most remarkable Hebridean discoveries, CICENDIA PUSILLA; for CICENDIA – being, apart from the Professor's records, confined in Britain to the Channel Isles – is one of the very few British plants that I have never seen growing. Anyhow I collected and later pressed the plant, together with a branch of the plant of POLYCARPON from which it was sprouting. And at this point I shall have to anticipate. Soon after my return to Cambridge I spent a large part of a morning, with Dr. Catcheside and Dr. Richards, in an attempt to identify the plant. Though it did indeed resemble CICENDIA more closely than any other British plant, the only conclusion that we reached was that it was not in fact a member of the British flora at all. And this conclusion was confirmed very soon afterwards by Mr. H. Gilbert Carter, who recognised it at once. It proved to be WAHLENBERGIA NUTABUNDA, an abundant weed of the Canaries, which is sometimes cultivated in Botanic Gardens in Britain, where it tends to survive by seeding itself, but elsewhere in Britain is entirely unknown.

Now both POLYCARPON TETRAPHYLLUM and JUNCUS CAPITATUS were, when the Professor first reported them from the Hebrides, entirely new to Scotland; and they were also very unexpected. The POLYCARPON itself is, as I have already explained, open to grave suspicion of having been introduced. When I first noticed the JUNCUS growing out of the middle of the POLYCARPON the coincidence already struck me as too great to be credible. And when I later found that out of the other of the two large plants of POLYCARPON grew the WAHLENBERGIA – a plant unknown in Britain outside a few Botanic Gardens – the conclusion became, so far as I can see, quite irresistible. The POLYCARPON had been, like CAREX BICOLOR, deliberately planted; and whoever it was who had planted it had been so careless as to leave in the soil surrounding its roots the seeds of two other plants that were to betray its origin.

Two other minor episodes remain to be chronicled, and then at last I can pass to my conclusions.

That same evening we were invited by Lady Bullough's factor, Mr. D. McNaughton, to drop in and drink a glass of whiskey. The party consisted simply of Mr. and Mrs. McNaughton, Lady Bullough's butler named Bryce, and our two selves. In the course of a most friendly and interesting conversation I succeeded in eliciting the following two facts:-

1) Up till 1939 deer-food had indeed been imported into the island every winter in the form of maize from the River Plate.
   It is perhaps worth mentioning that POLYCARPON is certainly not native in that part of the world.
2) In the opinion of Bryce, which was pretty clearly shared by the more cautious McNaughton, "the Professor kept something up his sleeve – either a butterfly or a plant – to discover every year".

On our way back to our tents we met two of the Professor's party, who invited us back to his base-camp for a cup of tea. There too a friendly and interesting conversation ensued, in the course of which, while I was engaged in botanical technicalities with the Professor and Sledge, Smith and Iolande reported to Creighton their startling discovery, on the shores of Loch Fiachanis under Ruinsival, of the recent marks of a large pair of heavily nailed climbing-boots. Creighton, having accurately described the course of his walks on the past two days, neither of which, of course, took him anywhere near Loch Fiachanis, closed the conversation by remarking, again perfectly truthfully: "No doubt it was somebody who landed without permission on the far side of the island. I understand it's a common enough practice." I do not think that even then they had the slightest suspicion of our actual motives. At all events, when we left the island next morning, the farewells of the entire party, and particularly of the Professor himself, were as cordial as could have been desired.

It will be best, I think, to group the conclusions that I have extracted from these remarkable facts under two headings, the first psychological, the second botanical.

A. PSYCHOLOGICAL:

There seem to me to be 3 possible explanations that might account for the facts – namely:-

1) that the Professor is himself the victim of a practical joke.
   This explanation, though it has the merit of being the most charitable, has the outweighing defect that it not only fails to account for, but actually conflicts with, a number of the facts recorded.
2) that as Dr. Jekyll he plants the specimens which as Mr. Hyde he later discovers.
   This, though I find it an attractive explanation, is certainly somewhat romantic – which is no doubt why it appeals to me. And since there is, I think, no doubt that Mr. Hyde remembers – rather than independently discovering – what Dr. Jekyll has done, it may well be also psychologically absurd[14].
3.) that the Professor is deliberately indulging in the most culpable dishonesty in order to secure for himself an immediate reputation and an immortal place in the annals of British botany[15].

This is, I fear, the only explanation that really fits the facts. I am only too well aware that I, who have no scientific training whatever, am bringing a very grave charge indeed against one who, besides being a Professor of Botany, is also a Doctor of Science and a Fellow of the Royal Society. I need hardly say that unless I[16] were sure of the ground upon which my charge is based I should do no such thing. The Professor is clearly a man of very humble origin: he is in fact, I have been told credibly enough, the son of a miner[17]. He is obviously able, and almost equally obviously ambitious. He is indeed – as Sledge, Creighton and I all independently felt – the type of which dictators are made. Most unfortunately he is, I believe, so constituted that he can never rest content with the honest fruits of his genuine ability. There are, in the history of Scottish field botany, several names that might well fire the imagination of any modern British botanist. (There is also, incidentally, at least one name – that of George Don – to which will always attach the suspicion of activities remarkably similar to those which I am imputing to the Professor.) The form that the Professor's ambition has eventually taken is, I believe, the determination to add his own name to this notable list. Rhum, of course, provided the ideal scene for the fulfilment of this aspiration. Exceptionally mountainous, geologically diversified and rich, it had the two supreme advantages that it was hitherto almost unknown and that ingress to it was notoriously difficult. By the simple expedient of exaggerating this already notorious difficulty ‖ – an expedient of which not only the letters cited above but also Prof. Butler's oral account of his visit to the island bear ample witness – ‖ the Professor has contrived, for some 10 consecutive seasons, to keep the field entirely to himself and his few invited guests. I am firmly persuaded that the combination of his own peculiar psychology with the opportunities offered him in the Hebrides in general and in particular in Rhum has led him into the astonishing aberrations that I have described. ‖ Whether on that account he should be exposed and disgraced I find it difficult to decide. I cannot help hoping not, since, for all his eccentricity, he treated me throughout with a rather touching, if usually gruff and peremptory, generosity. But one thing seems indisputable – that in the interests not only of truth but also of the reputation of British science it is essential somehow to discover what plants and what insects he has either completely fabricated or else deliberately introduced into the Hebrides. My own researches leave a very great deal still to be done; but for what they are worth, I will end this report by tabulating my own botanical conclusions. ‖

B. BOTANICAL:

1.) One plant at least can be confidently struck off the British list, into which, since 1941, it has been officially admitted, namely

CAREX BICOLOR.

And one other plant can be similarly struck off the Hebridean, and so also the Scottish, list, namely

POLYCARPON TETRAPHYLLUM.

2.) So strong a case can be brought against the authenticity of the records of the following plants:-

EPILOBIUM LACTIFLORUM	CICENDIA PUSILLA	CAREX CHORDORRHIZA
LYCHNIS ALPINA	JUNCUS CAPITATUS	CAREX LACHENALII
ERIGERON UNIFLORUM	CAREX CAPITATA	CAREX GLACIALIS
	CAREX MICROGLOCHIN	

that unless or until they are ever found again in different circumstances in the Hebrides, they too should be struck off the respective lists into which they have been recently admitted. There are undoubtedly many other plants also that should fall into this category, but these are all of which my own field studies entitle me to give a first-hand opinion.

3) There are also a number of the Professor's Hebridean records that are either certainly or most probably accurate; and for these he should get the credit he deserves. Of these the two most important that I was myself able to confirm were

ARENARIA NORVEGICA,

which I should regard as unquestionably authentic, and

THLASPI CALAMINARE

which seems to me to be most probably so. And here again, in this category, there are doubtless other plants that should be included, but of which I am not myself in a position to give first-hand evidence.

POSTSCRIPT

To bring this report up to date, and at the same time to tie up the few loose threads, it will again be best, I think, if I chronicle in the form of a diary the main events since my return from Scotland. I will make this part of the report as brief as possible.

August 11th

As soon as I could I visited the Botany School and handed over to Catcheside, for identification, the moss and the liverwort which, with SAGINA APETALA, I had extracted from the middle of one of the tufts of CAREX BICOLOR. He promised to consult Richards and get into touch with me again later.

August 13th

It will be seen from the above report that I had deliberately put myself in a somewhat delicate position. Having decided in advance that without the Professor's assistance I was unlikely to find any of his more notable botanical discoveries on Rhum, I had used the information that he had unsuspectingly given me to discredit him. Feeling that I was under some sort of an obligation to him, I therefore decided, after careful consideration, to offer him a possible way of escape from the troubles in which he had involved himself. Having consulted Prof. P. W. Duff on the laws of libel, I registered and posted the letter of which a copy is appended labelled H.

August 14th

I again visited the Botany School to hear the verdict of Catcheside and Richards on my liverwort and moss. Both had proved too immature to identify with certainty, but they were thought to be, respectively, PELLIA EPIPHYLLA or P. FABBRONIANA and BRYUM ?INCLINATUM? – species that are apparently so widely distributed that they would be worthless as evidence one way or the other. Thereafter we began the attempts, already recorded on p. 14 above, to identify the small, flowering plant that I[18] had removed from the second of the large plants of POLYCARPON.

‖ The day's post produced a letter from Sledge, to whom (as he was travelling from Rhum to the mainland on the same boat as ourselves, and as I suspected that I might ultimately need to cite him as a witness) I had imparted some of my more remarkable observations. This letter is appended, labelled I. ‖

August 15th

Mr. H. G. Carter showed me WAHLENBERGIA NUTABUNDA growing in the Botanical Gardens. Having been originally planted, it now maintains itself as a self-sown weed in the bed devoted to CAMPANULACEAE and in other neighbouring beds. ‖ Though I suspect that the Professor cultivates such species as he proposes to introduce into the Hebrides in a private rather than in a public garden, it seemed worth while to make sure whether the WAHLENBERGIA was established as a weed in the Botanical Gardens at Newcastle as well as at Cambridge. I therefore asked my father to write to Dr. D. H. Valentine, Reader in Botany at King's College, Durham, with whom he is slightly acquainted. A copy of this letter is attached, labelled J. ‖

I also interviewed Prof. Tilley, of the Department of Mineralogy and Petrology, who very kindly undertook to have the pellet of soil from under CAREX BICOLOR analysed for any element extraneous to the Barkeval area of Rhum. Though this again is highly improbable, the discovery in the sample of any fragments of, say, carboniferous limestone would be yet another piece of vital evidence.

August 16th

On my way through London I took the opportunity of visiting the British Museum (Natural History), and there, as the obvious repository for such material, I left all the specimens the collection of which is recorded above[19]. Mr. A. J. Wilmott confirmed all those of my determinations which might conceivably have been questioned. With him I also compared my specimen of POLYCARPON with every single specimen in the Museum's world herbarium. It was not precisely matched by any, its combination of much-branched inflorescence and narrow, acuminate sepals being apparently most unusual. But it resembled most closely the specimens of POLYCARPON TETRAPHYLLUM from Malta and Greece.

August 18th

On my return from Rhum I had despatched to Prof. T. G. Tutin, for illustration in the new Flora that he is editing, specimens of both ARENARIA NORVEGICA and THLASPI CALAMINARE. In his letter acknowledging their safe arrival Tutin happens to add: "I collected CAREX BICOLOR in Switzerland and am interested to see that it appears to be very easy to cultivate. My plant has made a lot of growth in the past month."

August 23rd

Letter K arrived from Valentine and confirmed my fear that, if indeed the Professor cultivates specimens for transplantation to Rhum, he does so in the seclusion of his own private garden.

September 1st

Letter L arrived from the Professor. I felt at first reading that some – though not all – of his arguments carried a certain weight. But on more mature consideration I felt justified, by

September 5th,

in posting the open declaration of war labelled M. It is, I think, true that none of the arguments he adduces are really relevant; and in particular I cannot see any purpose in the addition of his §6[20] unless it is by way of preparation of a last line of defence.

September 8th

produced the letter from the Professor labelled N, together with two articles, one of which, since it records the presence of the gnat Pseudohormomyia granifex on CAREX BICOLOR, is appended and labelled N1, the other of which – an entomological review – is of no conceivable relevance to the discussion. I immediately wrote to Pryor asking him to let me know the British and European distribution of the gnat in question, and then gave some careful thought to the rest of the Professor's letter. The vigorous attack on p. 2 is unfortunately – as my entry under August 13th has already admitted – fully justified. But its efficacy is, to my mind, severely impaired by the rest of the letter. It seems not unreasonable to wonder why, if he regarded the observations I had already listed as "trifles capable of a simple explanation by any ordinary person", he had yet seen fit, in the mere week since he received my first letter, to write and send to the printer an article that was evidently designed to counter those observations. In any case I have, by inducing him to write such an article, achieved the first of my objectives. What my right course will be after its publication must depend, obviously, on its contents. But for the moment at least the letter labelled O, which I posted on

September 9th

may, I hope, have closed the correspondence.

September 17th

That hope proved vain. The day's post produced the letter labelled P, which calls for little comment, but is appended for the sake of completeness. My brief acknowledgement, labelled Q, is also appended.

The letter labelled R, which arrived by the same post, is more significant. The Professor's article – a mere 2 pages of typescript – was of course enclosed with it. The relevant sentences which I copied out verbatim, are labelled R1. The whole is, as Sledge had immediately recognized, a somewhat unskilful attempt to deprive my observations in advance of their potential sting. I replied at once to Professor Wynne-Edwards with a brief account of the circumstances that had given rise to the article, and added that, though I could not therefore honestly advise him to publish it, I none the less hoped that he would see fit to do so, because I might then feel justified in publishing a reply.

The day's correspondence, in fact, very nicely presents the whole crux of the matter. Professor Heslop Harrison is perfectly justified in his denunciation of my breach of professional etiquette (v. p. 6 of letter P)[21]. Though I am pretty certain that without the Professor's help no conclusive evidence would ever have been forthcoming to determine the status of the plants in question, it would still be with a very uneasy conscience that I actually published observations that were only

made possible by accepting that help. At the same time the letter from Professor Wynne-Edwards seems to show how important it is that the problem should be publicly aired and settled. By suppressing my observations I become an accomplice to what I firmly believe to be deliberate fraud. If the Council, either as a body or as individuals, would consent to advise me in this dilemma, I should be sincerely grateful; and if, either as a body or as individuals, they feel that I should overcome my scruples and publish a bald statement of the botanical evidence that I have recorded in this report, then I should be genuinely and profoundly relieved to have their moral support.

September 22nd

A letter from Pryor reported the results of his investigations into the distribution of "the rare British gall-gnat Pseudohormomyia granifex K." It appears that, though there are old records of its occurrence in England in E. W. Swanton's "British Plant Galls" (1912) and C. Honard's "Les Zoocecidies des Plantes d'Europe" (1908–13), the only localised records are two in "A preliminary catalogue of British Cecidomyidae" (in Trans. Roy. Ent. Soc. Lond. 1917) by R. S. Bagnall and J. W. H. Harrison (the Professor himself.) One of these two records, by Bagnall, is from Bidston Hill, Cheshire, the other, by Harrison, is, as I had hoped but hardly expected, from Birtley, Co. Durham! I am warned by Pryor against attaching too much significance to this apparently striking coincidence[22] "If the creatures exist in Cheshire, they probably exist all over the country, if anyone takes the trouble to look for them." But, as he adds, "I suppose that if there is a secret Caricetum at Birtley and it is infected with Cecidomyids, one would expect the Rum plantations to be infected too." A visit to the Professor's garden would, of course, settle the matter once and for all. If, as I strongly suspect, it proved that

1) WAHLENBERGIA NUTABUNDA was established as a weed,
2) the gnat in question was galling the sedges, there could hardly be any further argument. But apart from the practical difficulty of gaining admittance, I am not disposed to press my investigations quite so far.

September 28th

On my return to Cambridge I found two letters from Wynne-Edwards (S & T) awaiting me. It seems that, if anything is to be published concerning the subject of this report, I myself shall have to take the first steps; but I hardly think the Scottish Naturalist the appropriate periodical in which to publish any article I may eventually write.

September 30th

Reference to the Professor's Flora of Rhum[2] (in Proc. Univ. Durham Phil. Soc., May 1939) confirmed my suspicion that in the only published record of POLYCARPON in Scotland there is not the faintest suggestion that the plant is only an alien introduction. It actually runs as follows:

"POLYCARPON TETRAPHYLLUM L.

A single plant found growing in a rock crevice along the Kinloch Burn, Rhum; a new county record."

Two experienced botanists to whom I showed this notice said without hesitation that they would regard it as recording a native species. This disposes of the Professor's claim at the bottom of p. 1 of letter P[23].

October 2nd

I visited the Department of Mineralogy and Petrology and sought out Mr. McLoughlin, to whom Prof. Tilley had entrusted the sample of soil from under CAREX BICOLOR on Barkeval. He proved to have just completed his analysis. The sample had contained, besides the olivine of which that part of Rhum consists, a proportion of extraneous granitic elements, including quartz. Now olivine and quartz cannot exist together in the same igneous rock. The obvious explanation to account for their presence together in one small sample would be that the quartz had drifted or been washed down from higher levels. But as the entire hill above consists of olivine, that too is impossible. McLoughlin himself had concluded – though it is only fair to add that Prof. Tilley refused to commit himself – that the quartz had been artificially introduced. Quartz is, of course, a ubiquitous mineral, and this argument by itself could carry little weight. But added to all the rest it seems to make the case against CAREX BICOLOR as conclusive as could be.

I end this report, as I began it, with a further apology for its excessive length.

NOTES

[1] This list of Heslop Harrison's remarkable discoveries is not comprehensive. Raven might have added records of *Sisyrinchium bermudiana* and *Trifolium bocconei* from Coll (see Pearman & Preston 2002), *Juncus pygmaeus* from Raasay, *Carex atrata*, *C. atrofusca*, *C. capillaris*, *C. norvegica* and *Filago gallica* from Rum (see Pearman & Walker 2004) and *Alopecurus alpinus*, *Carex norvegica*, *C. rariflora*, *C. rupestris*, *C. vaginata*, *Crassula tillaea*, *Herniaria ciliolata* and *Illecebrum verticillatum* from the Outer Hebrides (see Pankhurst & Mullin 1991).

[2] Heslop Harrison (1939a).

[3] The quotation is from Heslop Harrison, Heslop Harrison & Clark (1941b).

[4] The quotation is from Heslop Harrison (1945).

[5] There is a large vegetative specimen of *Carex limosa* at BM collected from Loch Stioclett, Harris, by A. R. Clapham, D. [E.] Coombe and J. [E.] Raven on 20 July 1948, and sent fresh to the Museum by Miss Campbell.

[6] See Campbell (1975) for a detailed discussion of the Large Blue records from the Hebrides.

[7] Sledge's herbarium specimens from Rum (now in CMM) were collected on 4–6 August 1948 (K. J. Walker, pers. comm.).

[8] This word is at the edge of the page and its correct reading as 'my' is uncertain.

[9] There is no sign in the manuscript of a word preceding 'space', where 'A' might have been expected, but this falls at the bottom corner of the sheet and may not have been photographed.

[10] An illegible word at the edge of the page might be 'most', 'more' or even 'now'.

[11] The terraces on which *C. bicolor* grows are described by Heslop Harrison (1941a), although I have not traced the exact phrase "steep terraces". The Professor's "latest account" perhaps refers to information given to Raven on Rum, as it does not appear to refer to a published description or to material in his letters to Raven.

[12] Heslop Harrison (1941a).

[13] No word is visible at the edge of the photographed sheet but I assume that 'I' was present on the original.

[14] In R. L. Stevenson's story *Strange case of Dr Jekyll and Mr Hyde*, the apparently respectable Jekyll finds a way of turning himself into Hyde, a man of pure evil. In the original story Jekyll remembers what he does as Hyde, although the story "now lives an independent life from Stevenson's creation" (Mighall 2002) and the Jekyll figure is now often presented as one who has no recollection of the actions of Hyde. Raven appears to swap Jekyll and Hyde's roles, but it seems likely that this possible explanation for Heslop Harrison's conduct was not intended to be taken seriously.

[15] Although Raven discusses Heslop Harrison's motives in purely personal terms, Sabbagh (1999) and Pearman & Walker (2004) point out that the supposed discoveries also bolstered his theories on the origin of the Hebridean biota.

[16] At this point Raven started a new page and ceased to inset this paragraph.

[17] Heslop Harrison's father, George Heslop Harrison, was actually a foreman patternmaker in the Birtley Ironworks (Peacock 1968).

[18] No word is visible at the edge of the photographed sheet but I assume that 'I' was present on the original.

[19] Specimens collected by Raven on Rum and currently (October 2003) incorporated into the collection at BM include *Epilobium lactiflorum* from Coire Dubh, *Juncus capitatus* from Coire Dubh and Kinloch, *Polycarpon tetraphyllum* from Kinloch, *Sagina apetala* subsp. *erecta* from Barkeval, *Thlaspi caerulescens* from Fionchra and *Wahlenbergia lobelioides sens. lat.* from Kinloch. I have failed to find a specimen of *Carex bicolor* collected by Raven but suspect that I may have overlooked it in the extensive *Carex* collection.

[20] Heslop Harrison's point 6 in letter L reads "The original colonies of *Carex bicolor* were higher up the corrie on the broken ground to the left as you ascend."

[21] Heslop Harrison's letter P p. 6 includes his points 8–11, questioning Raven's behaviour on Rum (see Sabbagh 1999, pp. 209–212).

[22] Any punctuation after 'coincidence' is invisible at the edge of the document.

[23] "No one ever suggested that the former plant [*Polycarpon*] was a true native except yourself."

DOCUMENTS CITED IN THE REPORT

The letters and other documents cited in Raven's report are listed below, with a brief summary of the more relevant contents. JER indicates J. E. Raven and JWHH J. W. Heslop Harrison. All are represented by copies in the King's College library.

A Letter from JWHH, King's College, Newcastle upon Tyne, to C. E. Raven, 28 April 1948. JWHH offers to take JER to stations for all the rarities on Rhum except *Arenaria norvegica*, which would involve too long a walk. Quoted by Sabbagh (1999, pp. 67–68) although sentences about *A. norvegica* omitted.

B Letter from JWHH, King's College, Newcastle upon Tyne, to JER, 8 May 1948. JWHH says he will be very pleased indeed to assist JER in every possible way, but points out the limitations of accommodation and food on Rhum. Quoted in part by Sabbagh (1999, p. 68).

C Letter from JWHH, King's College, Newcastle upon Tyne, to JER, 24 May 1948. JWHH discusses the practical arrangements for JER's visit to Rhum. Quoted in part by Sabbagh (1999, p. 68).

D Letter from Monica Bullough, Warren Hill, Newmarket, to JER, 5 June 1948. Lady Bullough gives JER permission to visit Rhum.

E Letter from JWHH, Isle of Rhum, to C. E. Raven, 8 June 1948. JWHH sends *Carex bicolor* which he collected the previous day. "In all I saw nine plants but some of these were magnificent specimens. One large tuft had no fewer than eight flowering spikes. I contented myself with collecting young plants and took no more than these two."

F Letter from JWHH, Isle of Rhum, to JER, 8 June 1948. Further discussion of the practical details of JER's visit. Quoted in part by Sabbagh (1999, p. 69), although 'August 3rd' should read 'August 2nd'.

G Letter from J. L. Campbell, Isle of Canna, to JER, 21 May 1948. Campbell outlines legitimate and illegitimate ways of visiting Rhum. He expresses his scepticism about reports of the Large Blue butterfly there but confirms the presence of the Transparent Burnet moth near Harris. Quoted in part by Sabbagh (1999, p. 75).

H Letter from JER, Trinity College, Cambridge, to JWHH, 13 August 1948 (JER's copy). JER discusses the difficulties his observations raise and suggests that there may have been "some unauthorised and irresponsible botanist at work on the island". Quoted in part by Sabbagh (1999, p. 105).

I Letter from W. A. Sledge, The University, Leeds, to JER, 13 August 1948. Sledge says that with the most charitable feelings it is still impossible to escape the conclusion that *Carex bicolor* had been deliberately planted on Rhum. Quoted in part by Sabbagh (1999, p. 105).

J Letter from C. E. Raven, Christ's College, Cambridge, to D. H. Valentine, 15 August 1948 (JER's copy). C. E. Raven outlines JER's "rather disturbing observations" and asks whether *Wahlenbergia nutabunda* or *W. lobelioides* is established as a weed in the botanical garden at Newcastle, and whether *Juncus capitatus* and *Polycarpon* grow there. Quoted in part by Sabbagh (1999, p. 107).

K Letter from D. H. Valentine, Department of Botany, University of Durham, to C. E. Raven, 20 August 1948. Valentine says that the plants about which Raven was asking are certainly not grown in the experimental greenhouse at Newcastle and very probably not in the botanical garden, but that JWHH has a large garden at his house at Birtley. Adds that he knows JWHH quite well and that, although he accepts that the situation should be looked into, he himself prefers to abstain from any action. Quoted in part by Sabbagh (1999, p. 108).

L Letter from JWHH, Birtley, to JER, 30 August 1948. JWHH comments on JER's letter of 13 August 1948 (H), saying that the presence of *Poa annua* with *Carex bicolor* is not surprising, that *Juncus capitatus* could have been blown into the Barkeval area as a casual seed and that *Polycarpon* is an introduction with imported deer-food. Quoted in part by Sabbagh (1999, pp. 109–110).

M Letter from JER, Selsey, Gloucs., to JWHH, 5 September 1948 (JER's copy). JER reports that the plant he earlier thought was *Cicendia pusilla* has now been identified as an annual *Wahlenbergia*, probably *W. nutabunda*. He suggests this record should be published, and at the same time the alien status of *Polycarpon* clarified. The second page of the letter is missing from the documents in King's College library. Quoted in part by Sabbagh (1999, pp. 110–111).

N Letter from JWHH, Birtley, to JER, 6 September 1948. JWHH replies to JER's letter of 5 September 1948 (M), reporting that "there is already in the printer's hands a short article dealing with all the points you raise". He transcribes his field notes for 29 May 1943 on *Carex bicolor*, noting that he has seen *Poa annua*, *Sagina* spp. and *Stellaria media* with it in subsequent years and that the *C. bicolor* plants are galled at the roots by the gnat *Pseudohormomyia granifex*. He also reports the presence on the same slopes of a small oak, a seedling holly and several *Cotoneaster simonsii*. He "cannot conceive that any human being would be vile enough to sabotage our work" and criticises Raven for failing to communicate his concerns to JWHH on Rhum, for removing a plant he believed to be *Cicendia pusilla* and for planning to publish material about plants shown to him under a pledge of secrecy. Quoted in part by Sabbagh (1999, pp. 112–113).

N1 Copy of Heslop Harrison (1948b) with the published record of *Pseudohormomyia granifex* in huge masses galling the sedge *Carex bicolor* on Barkeval, Rhum.

O Letter from JER, Selsey, Gloucs., to JWHH, 17 September 1948 (JER's copy). JER thanks JWHH for his prompt reply and expresses his relief that there is already in the printer's hands a short article dealing with all the points he raised. "I very much hope that it will dispose once and for all of the unwelcome misgivings I have already communicated to you." Summarised by Sabbagh (1999, pp. 113–114).

P Letter from JWHH, Birtley, to JER, undated but received by JER on 17 September 1948 (see Report). JWHH reiterates his view that *Carex bicolor* is native on Rhum and *Polycarpon tetraphyllum* is alien, and reproaches JER for lack of candour in his dealings with him. Quoted by Sabbagh (1999) in full (pp. 209–212) and in part (pp. 114–115).

Q Letter from JER, Selsey, Gloucs., to JWHH, 17 September 1948 (JER's copy). JER acknowledges the safe arrival of JWHH's letter (P) and says that a detailed reply would serve no useful purpose. Quoted in full by Sabbagh (1999, p. 115).

R Letter from V. C. Wynne-Edwards, Marischal College, University of Aberdeen, to JER, 4 September 1948. Wynne-Edwards encloses an article submitted by JWHH for publication in the *Scottish Naturalist* and invites JER's comments. Quoted in part by Sabbagh (1999, p. 115).

R1 JER's manuscript copy of a section of JWHH's article submitted to the *Scottish Naturalist* (see R). In this, JWHH reports the plants and a gall-gnat seen associated with *Carex bicolor* since 1943 (see N). Quoted in full by Sabbagh (1999, pp. 115–116); the dots in Sabbagh's extract are present in Raven's original.

S Typed letter from V. C. Wynne-Edwards, Marischal College, University of Aberdeen, to JER, 22 September 1948. Wynne-Edwards thanks JER for replying so fully to his letter (R), and says he has just written to JWHH and politely rejected his manuscript. Wynne-Edwards says he does not feel he is the right person to take the responsibility for making a public exposure. He suggests that JER should state in print that *Carex bicolor* is an introduction without mentioning JWHH by name, and says he would gladly publish such a note in the *Scottish Naturalist*. He asks whether JER can revisit Rhum next year to see if the plants have survived the winter. Quoted in part by Sabbagh (1999, p. 120).

T Handwritten letter from V. C. Wynne-Edwards, Editor, the *Scottish Naturalist*, to JER, 23 September 1948. Wynne-Edwards says he has thought more about the subject since writing to JER the previous evening. He does not now see how JWHH's name could be kept out of any publication suggesting that *Carex bicolor* was planted with the intention to "defraud the world". As this would be a great personal disaster for him, "which could end in his resignation from the University, if not worse", a public exposure should be avoided if possible (the phrase "at all costs" was originally written but deleted in favour of "if possible"). Wynne-Edwards suggests that JWHH might be approached personally and privately. Quoted in full by Sabbagh (1999, pp. 120–121).

ADDITIONAL DOCUMENTS FILED WITH THE REPORT

The following letters are not referred to by Raven in his report but are also included in the file in King's College library. In his letter depositing the report in the library (letter 11), Raven described letters 1–10 as "a few later appendices, which I've never had the energy to fit into their context, but which again, I hope, are largely self-explanatory".

1 Letter from W. A. Sledge, The University, Leeds, to JER, 16 September 1948. Sledge wonders what kind of reply JER had received to his letter to JWHH but "I think I can guess its contents now in view of the article which Wynne-Edwards consulted me about and which I suggested he forwarded to you". He also asks about the bryophytes associated with *Sagina apetala*.

2 Letter from the editors of *Nature*, London, to JER, 9 February 1951. The editors enclose a communication from JWHH, "Alien and relict plants in the Hebrides", and ask whether JER wishes to make any comment on it "for publication or otherwise". Quoted in full by Sabbagh (1999, pp. 123–124).

3 Typescript of JWHH's letter to *Nature* (see 2). First paragraph is quoted by Sabbagh (1999, pp. 124–125). Heslop Harrison (1951a) is a published paper along similar lines.

4 Typescript reply by JER to JWHH's letter to *Nature* (3).

5 Letter from the editors of *Nature*, London, to JER, 20 February 1951. The editors thank JER for the return of JWHH's submission and for his comments on it.

6 Letter from the editors of *Nature*, London, to JER, 28 February 1951. The editors report that they have now had a reply from JWHH, who is unable to accept their suggestion for omitting part of the first paragraph of his letter and asks for the return of the manuscript; they return Raven's response.

7 Letter from G. Taylor, British Museum (Natural History), London, to JER, 22 November 1951. "I am sending you an extract from a letter I had from R. B. Cooke a few days ago ... Cooke, I know, will want to be in at the kill but he wishes to prepare his brief in collaboration with Clark." Quoted in part by Sabbagh (1999, p. 126).

8 Typed extract of a letter from R. B. Cooke to G. Taylor, 17 November 1951. Cooke reports the circumstances of the discovery of *Carex bicolor* in May 1941 by JWHH, and his failure to find the species on his last visit to Rhum in 1946. "Although I did not see them being planted I feel as sure they were planted as if I had seen it." Quoted in full by Sabbagh (1999, p. 126).

9 Letter from V. C. Wynne-Edwards, Marischal College, University of Aberdeen, to JER, 21 December 1951. Wynne-Edwards says he has already seen *Occasional Notes* no. 6 (Heslop Harrison 1951a), a copy of which was sent to him by JWHH. "My own carefully considered opinion is that you should not make any reply .... To do so would merely provoke a further evasive reply, and the whole unpleasant affair would be prolonged ...".

10 Letter from JWHH, Birtley, to JER, 7 May 1952. JWHH reports the death of his wife after a long and painful illness, and informs JER "of the pain and unnecessary suffering your lust for notoriety caused her". Quoted in full by Sabbagh (1999, pp. 177–178); the word 'only', qualified by Sabbagh with 'sic' as it makes little sense in the context, should actually be 'early'.

11 Letter from JER, Shepreth, to Tim [Dr A. N. L. Munby, King's College Librarian], 5 May 1960. JER encloses the report and associated appendices, and outlines the conditions he would like the library to apply to it. Quoted in part by Sabbagh (1999, p. 4).

GAZETTEER OF HEBRIDEAN PLACE-NAMES MENTIONED IN THE TEXT

The names of the places mentioned by Raven are listed, with the current form of the name in brackets (if it differs from that used by Raven) and the Ordnance Survey grid reference.

Barkeval, Rhum NM39
Canna NG20
Coire Dubh, Rhum NM39
Coire Serien, Harris (Coire Scrien) NB10
Eigg NM48, 49
Fionchra, Rhum NG30
Harris, Outer Hebrides NF, NG, NA, NB
Harris Bay, Rhum NM39
Kinloch & Kinloch Castle, Rhum NM40.99.
Kinloch River, Rhum NG30, NM39-49
Loch Fiachanis, Rhum NM35.94.
Loch Stioclett, Harris NB12.00.
Raasay NG
Rhum (Rum) NM, NG
Ruinsival, Rhum NM39
Sgaoth Ard, Harris (Sgaoth Aird) NB10
South Uist NF
Tarbert, Harris NG19, NB10
Uisgnaval Mhor, Harris (Uisgnaval Mór) NB10

NOTES ON SPECIES MENTIONED IN THE REPORT

The following notes provide comments on the British or wider distribution of the rarer species mentioned in the report or its appendices, and also give current names (after Stace 1997 or Blockeel & Long 1998) for British taxa which appear in the report under an earlier synonym.

Arenaria norvegica = *Arenaria norvegica* subsp. *norvegica*. A European Arctic-montane species, known from a few sites in mainland western Scotland and from Rum and Eigg. First reported from Rum by Clark (1939) and Heslop Harrison (1939a, b) and now known to be locally abundant on open, magnesium-rich soils overlying peridotite on mountains in the south-east of the island and on the sandy shores of Loch Fiachanis.

Bryum inclinatum = *B. imbricatum*.

Carex bicolor A Circumpolar Arctic-montane species, never confirmed from the British Isles; for a map of its world distribution, see Hultén & Fries (1986). Reported from Rum by Heslop Harrison (1941a, 1945) and Heslop Harrison *et al.* (1941, 1942) and supplied as living material to Kew (Heslop Harrison 1944a); see also Polunin (1941) and Pugsley (1941) for their congratulatory comments on its discovery. For Heslop Harrison's response to Raven's (1949) view that the species was planted, see the pre-emptive comments in Heslop Harrison (1949) and Heslop Harrison's subsequent remarks (1951a, b). Heslop Harrison (1951c) and Heslop Harrison & Morton (1951) reported that most of the plants at the best site on Rum had been collected, leaving only "a few miserable fragments". See Pearman & Walker (2004) for a detailed discussion of the Rum records.

Carex capitata A Circumpolar Arctic-montane species, never confirmed from the British Isles; for a map of its world distribution, which includes the published Hebridean locality, see Hultén & Fries (1986). By 1944 Heslop Harrison (1944a) had sent living material from South Uist to Kew, and the species was formally reported from South Uist by Heslop Harrison (1945). Heslop Harrison never published anything about the presence of this species on Rum, despite the record discussed in Raven's report.

Carex chordorrhiza When Raven was writing this was known from a single mainland locality in Scotland, Altnaharra (v.c. 108); in 1978 it was discovered in the Insh Marshes (v.c. 96) but it has

never been confirmed from the Hebrides. *C. chordorrhiza* from South Harris was exhibited at a meeting of the Northern Naturalists' Union in 1942 (Anonymous 1942) and living material sent to Kew Gardens by 1944 (Heslop Harrison 1944a); it was formally reported from there by Heslop Harrison (1945).

Carex glacialis A Circumpolar Arctic-montane species, never confirmed from the British Isles; for a map of its world distribution, see Hultén & Fries (1986). Reported from central Rum by Heslop Harrison (1944b) and from "the upper slopes of the southern turning of the Barkeval ridge" by Heslop Harrison (1945); living material was sent to Kew (Heslop Harrison 1944a, as *C. pedata*). The significance of this record is discussed by Heslop Harrison (1948a). Melderis's (1953) view that the status of *C. glacialis* as an indigenous plant on Rum was doubtful was rejected by Heslop Harrison (1954).

Carex lachenalii A Circumpolar Arctic-montane species, reported as *C. bipartita* from Harris by Heslop Harrison, Heslop Harrison & Clark (1941b) and Heslop Harrison (1945). Known from high altitudes (950–1150 m) on the mountains of mainland Scotland, but never confirmed from the Hebrides.

Carex microglochin A European Arctic-montane species, known in Britain from base-rich flushes at high altitudes (610–975 m) on Ben Lawers, where it was discovered in 1923. Reported by Clark (1941), Heslop Harrison, Heslop Harrison & Clark (1941a, b) and Heslop Harrison (1944a, 1945) from Harris, and sent as living material to Kew, but never confirmed from the Hebrides.

Carex rigida = *C. bigelowii*.

Carex ustulata = *C. atrofusca*.

Cicendia pusilla = *Exaculum pusillum*. A Suboceanic Southern-temperate species, known with certainty from the British Isles only from Guernsey, where it was discovered in 1850. It was, however, reported from Raasay by Heslop Harrison (1936, 1937, 1939b), Anonymous (1937) and The Staff of the Department of Botany, Armstrong College (University of Durham), Newcastle upon Tyne (1937), from Barra by Heslop Harrison (1939c, as *Microcala pusilla*) and from South Uist and Fuday by Heslop Harrison (1941b, c). Pankhurst & Mullin (1991) erroneously report the records from the Outer Hebrides as *Cicendia filiformis*.

Epilobium alpinum = *E. anagallidifolium*.

Epilobium lactiflorum A Circumpolar Boreo-arctic Montane species, extending south to Iceland, the Faeroes and Scandinavia but never confirmed from the British Isles; for a map of its world distribution, see Hultén & Fries (1986). Although this species figures in Raven's report, neither Heslop Harrison nor any other members of his team appear to have published any record of its occurrence on Rum.

Erigeron uniflorus/um *E. uniflorus* is a Circumpolar Arctic-montane species, never confirmed from the British Isles; for a map of its world distribution, see Hultén & Fries (1986). It was reported from Barkeval, Rum, by Heslop Harrison *et al.* (1942) and cited by Heslop Harrison (1948a) in a paper which includes a photograph of a plant "from its only British station, Isle of Rhum"; living material was sent to Kew (Heslop Harrison 1944a).

Juncus capitatus A European Southern-temperate species, known as a certain native in the British Isles only from the Channel Islands, W. Cornwall and Anglesey. It was reported from Raasay by Anonymous (1937), Heslop Harrison (1936, 1937) and The Staff of the Department of Botany, Armstrong College (University of Durham), Newcastle upon Tyne (1937), from Rum by Heslop Harrison (1939a) and from Barra by Heslop Harrison (1939c, 1941c). Its presence in the Hebrides is often mentioned in Heslop Harrison's phytogeographical papers (e.g. Heslop Harrison 1939b, 1941b) and in other papers from the Newcastle group.

Kobriesia = *Kobresia simpliciuscula*.

Lychnis alpina A European Arctic-montane species, known as a certain native in Britain only

from Cumberland and Angus. It was reported from Fionchra, Rum, by Heslop Harrison *et al.* (1942) and living material was supplied to Kew (Heslop Harrison 1944a).

Pellia fabbroniana = *P. endiviifolia*.

Polycarpon tetraphyllum A Mediterranean-Atlantic species, known in the British Isles as a possible native in the Channel Islands and S.W. England and as an introduction at scattered sites elsewhere. A single plant was initially reported from Rum by Heslop Harrison (1939a); he subsequently stated that it was alien on the island (Heslop Harrison 1948c, d, 1951a, b).

Polygonum viviparum = *Persicaria vivipara*.

Sagina apetala = *S. apetala* subsp. *erecta*.

Salix arbuscula A Circumpolar Arctic-montane species, found on base-rich rocks above 620 m in the Scottish Highlands. It was reported as a thicket in a ravine on Fionchra by Heslop Harrison *et al.* (1941) but the record was withdrawn by Heslop Harrison (1958), who said that the plant was an unusual form of *S. phylicifolia*.

Teesdalia lepidium = *T. coronopifolia*. A southern European species, allied to the British *T. nudicaulis*; for a map of its European distribution see Jalas, Suominen & Lampinen (1996). It was reported as a small group of plants on sandy ground near Laig Bay, Eigg, by Heslop Harrison (1939a), new to Britain, but later included amongst a list of introduced vascular plants (Heslop Harrison 1948c) with the comment "only one plant seen".

Thlaspi alpestre = *T. caerulescens*. This European Boreal-montane species was first reported from Rum by Clark (1939) and by Heslop Harrison (1939a, b, as *T. calaminare*). It was still present on the basalt cliffs of Fionchra in 2003.

Thlaspi calaminare = *T. caerulescens*. *T. calaminare* was formerly regarded as a distinct species, but is now treated as a synonym of the variable *T. caerulescens*.

Wahlenbergia lobelioides As narrowly interpreted, this is a species of Madeira, the Canaries and the Cape Verde islands. However, *W. nutabunda* (q.v.) and the tropical African *W. riparia* are now regarded as subspecies of *W. lobelioides* (Thulin 1975).

Wahlenbergia nutabunda An annual of the western Mediterranean region, Sudan, Ethiopia and the Arabian peninsula, now treated as *W. lobelioides* subsp. *nutabunda* (Sales & Hedge 2001, Thulin 1975).

NOTES ON PEOPLE MENTIONED IN THE REPORT

The following notes cover the main figures, and some of the minor characters, mentioned in the report and the ancillary documents. The format is:

Name, date of birth and death (college and university attended for first degree), position in 1948.

In some cases a brief biographical note is added.

Bullough, Lady Monica, née Monique Lilly de la Pasture, 1869–1967. Eldest daughter of the 4th Marquis de la Pasture, and a great beauty, she married her second husband, Sir George Bullogh Bt. (1870–1939) in 1903.

Butler, James Ramsey Montagu, 1889–1975. (Trinity College, Cambridge). Regius Professor of Modern History and Fellow of Trinity College, Cambridge.

Campbell, John Lorne, 1906–1996. (St John's College, Cambridge.) Owner of Canna (which he presented to the National Trust for Scotland in 1981), farmer, author and amateur entomologist.

Campbell, Miss May Sherwood ('Maybud'), 1903–1982. Secretary of the Botanical Society of the British Isles, amateur botanist of independent means and close associate of Wilmott (and rival of

Heslop Harrison's) in an attempt to prepare a Flora of the Outer Hebrides.

Catcheside, David Guthrie, 1907–1994. (King's College, London). University lecturer in Botany and Fellow of Trinity College, Cambridge. Professional geneticist and keen bryologist.

Clapham, Arthur Roy, 1904–1990. (Downing College, Cambridge). Professor of Botany, University of Sheffield.

Clarke, William Andrew, 1911–1983. (University College, Dundee). Lecturer in Botany, King's College, Newcastle-upon-Tyne. Clarke married Heslop Harrison's daughter Helena ('Dolly'), herself a Lecturer at Newcastle.

Cooke, Randle Blair, 1880–1973. A timber-broker who was able to retire early to pursue his horticultural interests, including his garden at Kilbryde near Newcastle upon Tyne; a friend of George Taylor.

Creighton, Thomas Richmond Mandell, 1915–1987. (Trinity College, Cambridge). Creighton worked at Blectchley Park during the War and afterwards on the reconstruction of German education; he subsequently held academic appointments in Britain and Africa but I have not established which of these posts he held in 1948. For an excellent account of his friendship with Raven, see Creighton (1981).

Don, George, 1764–1814. Pioneer botanist in the Scottish mountains. He made many significant discoveries, but a few of the species he reported have never been confirmed as British (e.g. *Potentilla tridentata*, *Ranunculus alpestris*). His "reputed discoveries" are listed and discussed by Druce (1904); see also Britten (1906) and Ingram & Noltie (1981). Raven (in Raven & Walters 1956, pp. 15–18) discusses his genuine discoveries and the accusations of malpractice made against him.

Gilbert Carter, Humphrey, 1884–1969. (University of Edinburgh). University Lecturer in Botany and Director of the University Botanic Garden, Cambridge.

Hamilton, Walter, 1908–1988. (Trinity College, Cambridge). University Lecturer in Classics and Fellow of Trinity College, Cambridge.

Heslop Harrison, John William, 1881–1967. (Durham College of Science). Professor of Botany, King's College, Newcastle-upon-Tyne (formerly Durham College of Science).

Iolande, presumably Yolande (not Iolande) Massey, b. 1919, who married J. Heslop Harrison (1922–1998), J. W. Heslop Harrison's son, in 1950 and became a distinguished botanist in her own right.

Pryor, Mark Gillachrist Marlborough, 1915–1987. (Trinity College, Cambridge). University Demonstrator in Zoology and Fellow of Trinity College, Cambridge.

Raven, Charles Earle, 1885–1964. (Gonville & Caius College, Cambridge). Regius Professor of Divinity, Vice-Chancellor of the University and Master of Christ's College, Cambridge; also a noted historian of science and a keen amateur naturalist. "It seems natural to apply to him," his biographer Dillistone (1975) comments, "the very word imperious".

Raven, John Earle, 1914–1980. (Trinity College, Cambridge). Fellow of Trinity College (1946–48) and King's College (1948–1980), Cambridge.

Rhodes, Miss Georgia Margaret, 1891–1978. Niece of Cecil Rhodes of Rhodesia. Her father, Cecil's brother, died in 1901 and her mother leased Hildersham Hall, Cambs., in 1939. The Hall was held by Miss Rhodes and her sister until their deaths in 1978.

Richards, Paul Westmacott, 1908–1995. University Lecturer in Botany and Fellow of Trinity College, Cambridge. Ecologist and bryologist.

Sledge, William Arthur, 1904–1991. (University of Leeds). Lecturer, University of Leeds. Strong interests in the British flora and in fern systematics.

Taylor, George, 1904–1993. (University of Edinburgh). Deputy Keeper of Botany, British Museum (Natural History), with particular interests in aquatic, Himalayan and cultivated plants.

Tilley, Cecil Edgar, 1894–1973. (University of Adelaide). Professor of Mineralogy and Petrology and Fellow of Emmanuel College, Cambridge. "A man dedicated to his work and without hobbies", Tilley had by 1948 published several papers on the metamorphic rocks of the Hebrides (Deer & Nockolds 1974).

Tutin, Thomas Gaskell, 1908–1987. (Downing College, Cambridge). Lecturer in Botany, University College, Leicester.

Valentine, David Henriques, 1912–1987. (St John's College, Cambridge). Reader in Botany, University of Durham.

Warburg, Edmund Frederic, 1908–1966. (Trinity College, Cambridge). University Demonstrator in Botany and Curator of the Druce Herbarium, Oxford (from 1948).

Wilmott, Alfred James, 1888–1950. (St John's College, Cambridge). Department of Botany, British Museum (Natural History). A leading authority on the British flora, "ruling like one of the less predictable Roman emperors over the European section of the herbarium" (Meikle 1995).

Wynne-Edwards, Vero Copner, 1906–1997. (New College, Oxford). Regius Professor of Natural History, University of Aberdeen.

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An examination of J. W. Heslop Harrison's unconfirmed plant records from Rum

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ABSTRACT

Between 1939 and 1958 Professor J. W. Heslop Harrison published a series of papers on the flora of the Hebridean island of Rum (v.c. 104). These provided records for over 600 species, including a number of remarkable discoveries which have long been the subject of considerable debate. Using a variety of information we critically examine the status of all the 113 of Heslop Harrison's taxa (excluding microspecies of *Taraxacum, Hieracium* and *Rubus*) which have not been recorded since 1957. The majority of these "losses" (46 taxa) were casual introductions, particularly weeds associated with cultivation, which declined due to land use changes. Taxonomic advances and the decline in the recording of critical taxa accounted for a further 30 taxa, whereas mis-identifications and genuine losses from semi-natural habitats were relatively minor (24 taxa). In contrast, Heslop Harrison appears to have deliberately introduced or mis-represented the native occurrence of 13 species, five of which were new to the British Isles. Eight of these were verified by independent botanists (*Carex bicolor*, *C. capitata*, *C. glacialis*, *Epilobium lactiflorum*, *Erigeron uniflorus*, *Juncus capitatus*, *Lychnis alpina* and *Polycarpon tetraphyllum*) and were most likely introduced to provide evidence for Heslop Harrison's theory of glacial survival. In contrast, the records for *Carex atrata*, *C. atrofusca*, *C. capillaris* and *C. norvegica* were never verified and are therefore rejected on distributional grounds. The presence of *Filago gallica* is rather more enigmatic although we suspect that it was unintentionally introduced and then spread into semi-natural habitats.

KEYWORDS: Arctic species, glacial survival, plant distribution, Hebrides.

INTRODUCTION

Between 1939 and 1958 Professor J. W. Heslop Harrison (hereafter referred to as Heslop Harrison) and colleagues from King's College, Newcastle-upon-Tyne, published a series of papers on the flowering plants and ferns of the island of Rum as part of a larger investigation into the flora of the Hebrides (Heslop Harrison 1939b, 1951a, 1958; Heslop Harrison & Morton 1951; Heslop Harrison *et al.* 1941, 1942). Prior to these works very little botanical recording had been carried out on the island, with only two published accounts based on brief visits (Lightfoot 1778; Grieve 1886). By contrast, Heslop Harrison covered the island in much greater detail and as a result discovered over 250 new species, including many critical taxa, hybrids and aliens. This total included five Arctic species which were new to Britain and a further eight which represented notable, and in some cases very surprising, extensions in range in the British Isles. Although some of these species were shown to respected British botanists during the 1940s the authenticity of the records, particularly those species new to Britain, has long been the subject of considerable debate (Raven 1948, 1949; Young 1950; Sabbagh 1999a, 1999b). As a consequence, most of Heslop Harrison's most controversial species were not mapped in national atlases (Perring & Walters 1962; Preston *et al.* 2002) and have been questioned or ignored in major taxonomic works (e.g. Clapham *et al.* 1962; Jermy *et al.* 1982; Clapham *et al.* 1987; Stace 1997).

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Rum was designated a National Nature Reserve in 1957, just as Heslop Harrison was completing his researches on the island, but despite subsequent recording 113 taxa (excluding microspecies of *Taraxacum, Hieracium* and *Rubus*) that he claimed to have discovered, or were attributed to him, have not been refound. Subsequent checklists for the island (Eggeling 1965; Ball 1987) have not provided sources and therefore failed to clarify what species Heslop Harrison actually recorded and to sort out those records that are believable from those that are not. Sabbagh (1999a) has covered much of the background but dealt with very few species. In order to assess the scale of any alleged misrepresentation, and in preparation for a new flora of the island, we examine the likely status of these "lost" species. These are discussed in relation to advances in taxonomy, subsequent recording, land use history and the findings of John Raven's (1948) confidential report on some of the rarer species, an edited version of which is published in this volume (Preston 2004).

Nomenclature follows Stace (1997) or Tutin *et al.* (1964–1980) where species are not covered by the former work.

THE ISLAND OF RUM

The island of Rum, or Rhum[1], part of Watsonian vice-county 104, is the largest of the Small Isles of the Inner Hebrides (10650 ha) and lies approximately 8 km to the south of the Isle of Skye. The climate is highly oceanic, being wet and windy with low insolation, and rainfall varying from 1800 mm a year in the coastal zone to 3000 mm in the hills (Clutton-Brock & Ball 1987).

The geology of the island is extremely complex and dominated by an extinct Tertiary volcano (Emeleus 1987). The mountains in the south-east of the island mark its eroded root and are made up of ultramafic peridotites which weather rapidly to form magnesium-rich soils (Ragg & Ball 1964; Emeleus 1987; Looney & Proctor 1989). Nutrient deficiency limits the development of closed vegetation on these soils (Ferreira & Wormell 1971) and as result they support open communities with affinities to serpentine assemblages elsewhere in Scotland (Birse 1982; Looney & Proctor 1989; Proctor 1997). The granitic mountains to the west are botanically less interesting although basalt outcrops on Fionchra and Bloodstone Hill support populations of a number of Arctic-montane species. In contrast, much of the north of the island is made up of older Torridonian sandstones which give rise to extensive areas of species-poor blanket bog, wet heath and moorland dominated by *Molinia caerulea* (Ball 1987). Botanically this is rather monotonous terrain although there are isolated outcrops of limestone in the north west which support *Dryas octopetala* heath (Emeleus 1987).

Away from basic outcrops, species-rich grasslands and heaths are confined to coastal slopes and heavily grazed machair grasslands at the head of Harris and Kilmory Glens, whereas dunes and saltmarsh occur locally in some sheltered bays (e.g. Kinloch, Harris, Samhnan Insir and Kilmory). The remainder of the coastline is rocky, with numerous sea-cliffs and coastal gorges (geos). In comparison to other Hebridean islands the aquatic flora is of "restricted diversity" and comparable to poorer oligotrophic lochs in Scotland (Farmer 1984).

By 1957 the island was virtually treeless, with only very small populations of trees and shrubs surviving in rock clefts and inaccessible gorges near sea-level (Ball 1983). However, since the 1960s extensive tree-planting has led to the development of substantial blocks of native broadleaves and alien conifers where fencing has been erected to exclude deer grazing and commercial forestry techniques applied (Wormell 1968; Wood 2000).

One of the main factors affecting the vegetation of Rum is grazing by sheep and red deer *Cervus elaphus*, the latter re-introduced[2] for sport in 1845 (Magnusson 1997). By the time Rum was purchased by the Nature Conservancy (NC) in 1957 the island was severely overgrazed (Eggeling 1964; P. Wormell, in litt. 2002) and this led to the decision to remove the sheep and cull one-sixth of the deer population each year. This regime led to a general improvement in the condition of the

[1]Sir George Bullough changed the name to Rhum but the true Gaelic spelling is Rum or Rùm (Magnusson 1997).

[2]Native red deer disappeared from the island in the second half of the 18th Century as the human population increased to over 300 (Clutton-Brock & Guinness 1987).

vegetation (P. Wormell, in litt. 2002), although the loss of sheep grazing led to a decline in the diversity of the machair grassland in Harris Glen (Ball 1974). As a consequence a herd of Highland cattle were introduced in 1970. In contrast, recent research has shown that deer grazing sustained the diversity of the productive grasslands over the same period (e.g. *Agrostis-Festuca* grasslands, machair, sand dunes, etc.) whereas increased culling policies had a negligible effect on the species composition of unproductive swards and heaths (Virtanen *et al.* 2002). Current plans, however, are to reduce deer numbers by 50% over the next decade (Magnusson 1997; Loder 2000; Scottish Natural Heritage 2000).

The well preserved "lazy-bed" systems which are still visible in the major glens indicate the previous history of extensive cultivation on the island. These persisted into the 1820s although arable cultivation for fodder continued up till the mid 1970s when the island's dairy herd was removed (Love 1987; P. Wormell, in litt. 2002). These areas provided a habitat for a number of arable weeds which probably originated from imported seed. In addition, an extensive alien flora persists at Kinloch, where many species were introduced following the planting of policy woodlands and gardens following the construction of the castle around 1900.

BOTANICAL INVESTIGATIONS ON RUM

The earliest plant records for Rum were provided by the Reverend John Lightfoot who visited the island with Thomas Pennant in July 1772 (Lightfoot 1778). On the second day of their brief stay they visited Barkeval where they recorded *Arabis petraea*, *Minuartia sedoides* (the first British record), *Thalictrum alpinum*, *Tofieldia pusilla*, *Salix herbacea* and *Vicia orobus*, the latter "on the bank of a rivulet running down a mountain called Baikevall [Allt Slugan a' Choilich]" (Lightfoot 1778) where it still grows today. Other species recorded during their stay included *Eleogiton fluitans*, *Oxyria digyna*, *Populus tremula* (a dwarfed form), *Saxifraga oppositifolia*, *Sedum rosea* and *Silene acaulis*.

Over a hundred years later Symington Grieve (1886) published a much longer list of species recorded during a nine day visit in July 1884. This included 279 species (and 11 infraspecific taxa) most notably *Potamogeton praelongus*, the first record for western Scotland, *Carex bigelowii*, *Cystopteris fragilis*, *Eleocharis uniglumis*, *Equisetum variegatum*, *Draba incana*, *Dryopteris aemula*, *Myrica gale* and *Salix myrsinifolia*. Sixteen of Grieve's species have never been refound although many occur on neighbouring islands (e.g. *Gnaphalium supinum*, *Galium boreale*, *Potentilla crantzii*, *Scilla verna*; Table 5) (Currie & Murray 1983).

Professor J. W. Heslop Harrison (1881–1967) and colleagues from King's College, Newcastle-upon-Tyne began their Flora of the Inner and Outer Hebrides in 1934 (Heslop Harrison 1939a, 1941a). Their first expeditions to Rum were in 1937 and 1938, and their findings are summarised in Heslop Harrison (1939b). Although no mention is made of earlier works, this was the first "thorough examination" of the flora of the island and included around 450 taxa, of which just over 213 were new for the island. These included a small number of alien species as well as many critical taxa (e.g. of *Euphrasia*, *Hieracium*, *Rubus*, *Rosa*, *Salix*) which were covered to an extent that has not been repeated since. Notable discoveries from these trips which are still known to occur include *Arenaria norvegica* subsp. *norvegica* on Ruinsival and *Poa glauca*, *Saxifraga nivalis* and *Thlaspi caerulescens* on the basalt cliffs of Fionchra (Clark 1939).

This Flora was supplemented by further reports over the next 20 years based on irregular visits between 1941–1951 and a final expedition in 1957 (Heslop Harrison 1951a, 1958; Heslop Harrison & Morton 1951; Heslop Harrison *et al.* 1941, 1942). These provided many new records and also updated those of the rarer species, including a few of those which were subsequently viewed with suspicion. In addition, detailed papers were published on alien introductions (Heslop Harrison 1948a, 1951b), noteworthy sedges (Heslop Harrison 1945), pondweeds (Heslop Harrison 1948b), eyebrights (Pugsley 1945, 1946), roses (Heslop Harrison & Bolton 1938) and orchids (Heslop Harrison 1949).

In the summer of 1948 John E. Raven made a brief visit to Rum in order to investigate "the ever lengthening list of Hebridean rarities" which were being viewed by many of the "best qualified British botanists" with "growing suspicion" (Raven 1948). His trip coincided with a visit by W. A. Sledge and as a result his report to the Council of Trinity College, Cambridge provides

independent verification for the presence of *Carex bicolor*, *Epilobium lactiflorum*, *Juncus capitatus*, *Lychnis alpina* and *Polycarpon tetraphyllum* as well as speculation as to their status and origin. In the following year a selection of Raven's (1949) findings were also published in a very brief letter to *Nature* in which he rejected *Carex bicolor* and *Polycarpon tetraphyllum* as native species on the island as well as casting doubt over the origin of *Lychnis alpina*.

After the Nature Conservancy Council (NCC) purchased the island in 1957 a comprehensive checklist of the flora was completed by W. J. Eggeling (1965). This was based on Heslop Harrison's earlier papers plus additional records collated by NCC staff during the intervening period and includes 44 species new to the island, most notably *Hymenophyllum tunbrigense*, *Polygonum oxyspermum* subsp. *raii* and *Rhynchospora fusca*. However, the list is rather uninformative because details on localities and frequency appear to have been copied directly from Heslop Harrison's earlier papers leading to doubt as to whether Eggeling or his colleagues were merely citing Heslop Harrison's records or whether they had seen the plants for themselves between 1957 and 1965. Also confusing are records for six species not recorded by Heslop Harrison or any subsequent workers. We list these in Table 5 because these too have sometimes been attributed to Heslop Harrison but actually originate from the Eggeling checklist without supporting information. Similarly, a more recent checklist (Ball 1987), apparently based on Eggeling (1965), provides no indication of whether a species had been recorded in the intervening period (1965–1987) or, for new species, no indication of the locality, recorder, date or source.

Since the 1960s the vast bulk of botanical recording on Rum has been undertaken by visiting botanists and research workers. Most of the largest lochs were surveyed during the 1980s by Farmer (1984) and the NCC (and latterly Scottish Natural Heritage (SNH)) Loch Survey team and, in recent years, these have been extended to include all major water-bodies (Preston *et al.* 2000). In 1983 C.N. Page (1986) studied the pteridophyte flora and recorded 52 taxa, seven of which were new to the island (*Dryopteris expansa*, *Equisetum* × *dycei*, *E.* × *littorale*, *E.* × *rothmaleri*, *E.* × *trachyodon*, *Polypodium interjectum*, *P.* × *montaniae*). In addition, visiting botanical recorders have provided many modern records for rarer and critical species, as have vegetation surveyors funded by the NCC (Ferreirra 1970) and SNH (Bates *et al.* 2002). A useful list of rarer Hebridean species on Rum is given by Currie and Murray (1983).

In recent years SNH have produced various provisional checklists which attempt to differentiate between species for which there are modern records and those that have not been seen for 20 years or more. However, these lists are rather uninformative because they include unconfirmed records for species not covered by earlier works. Furthermore, many common species lack modern records due to the lack of systematic recording on the island in recent decades. As a result, records published in the *New Atlas* (Preston *et al.* 2002) require updating. The current work is an attempt to update these lists as well as examine in detail those records attributed to Heslop Harrison in preparation for a modern Flora of the island.

HESLOP HARRISON'S RECORDS FOR RUM

In this paper we deal with species (excluding microspecies of *Hieracium*, *Rubus* and *Taraxacum*) recorded by Heslop Harrison between 1937 and 1958 but which have not been refound. These are divided into four groups: a) dubious species, b) critical or difficult taxa, c) introductions and d) extinct native species (Tables 1–4).

DUBIOUS SPECIES

Heslop Harrison recorded 10 Arctic and three southern species which have been doubted since they were first reported in the 1940s.(Table 1). The controversy surrounding J. E. Raven's (1948) report on some of these species is well, if rather luridly, told in a recent book and the reader is referred to Sabbagh (1999a, 1999b) for the full story, where similar doubts over "discoveries" in other groups are also discussed.

1. Arctic and Boreo-Arctic species

Carex atrata

This Circumpolar Boreo-arctic Montane species was reportedly discovered in 1942 by the Allt Slugan a' Choilich on the slopes of Barkeval (Heslop Harrison *et al.* 1942), where it was

TABLE 1. SPECIES RECORDED FROM RUM BY J. W. HESLOP HARRISON WHICH ARE NOW CONSIDERED TO BE DOUBTFUL OR DELIBERATE INTRODUCTIONS (SEE TEXT FOR FURTHER DETAILS)

	HH (1939b)	HH *et al.* (1941)	HH *et al.* (1942)	HH (1945)	HH (1948a)	HH & Morton (1951)	Details of records and specimens in major herbaria
1. Arctic and Boreo-Arctic species							
Carex atrata			+	+			No specimens or independent evidence for its occurrence.
Carex atrofusca	+			+			No specimens or independent evidence for its occurrence.
Carex bicolor		+	+	+		+	The only British record. Known to have occurred but probably introduced; **E**.
Carex capillaris	+			+			No specimens or independent evidence for its occurrence.
Carex capitata							The only published British record is from S. Uist but seen on Rum in 1947 and 1948.
Carex glacialis				+			The only British record. Known to have occurred but probably introduced; **E**, **BM**.
Carex norvegica			+	+			No independent evidence for its occurrence; **E**.
Epilobium lactiflorum							The only British record. Never published but seen on Rum by Raven in 1948; **BM**.
Erigeron uniflorus			+				The only British record. Known to have occurred but probably introduced; **E**.
Lychnis alpina			+				Known to have occurred but probably introduced.
2. Southern species							
Filago gallica	+				+		Probably introduced in imported seed or hay.
Juncus capitatus	+					+	Probably an intentional introduction; **CMM**, **BM**.
Polycarpon tetraphyllum	+				+		Probably an intentional introduction; **BM**.

"scattered irregularly, and very sparingly, in tumbled grassy places along the burn…occurring at quite low altitudes" (Heslop Harrison 1945). It is not known whether it was shown to other botanists at this locality, although the original specimens were determined by E. Nelmes who thought them referable to forma *gelida* Sch. (Heslop Harrison 1944b). In Scotland *C. atrata* is a rare plant of ungrazed ledges above 550 m where there is some calcareous influence (Jermy *et al.* 1982; Preston *et al.* 2002). In contrast, the Rum site is below 250 m on acid Torridonian sandstone, although there is likely to have been some flushing of base-rich water from the corrie above (Coire Dubh).

Carex atrofusca

This Circumpolar Arctic-montane species was reportedly discovered "on boggy ground" on the southern turning of the Orval-Ard Nev ridge where it was recorded as "exceedingly rare" (Heslop Harrison 1939b, 1945). It is not known whether it was shown to other botanists in this locality and we have been unable to trace specimens. In Scotland *C. atrofusca* is a very rare plant of stony, usually micaceous flushes and more rarely of wet mountain ledges between 680–1000 m (formerly down to 540 m) in Perth, Westerness and Argyll (Jermy *et al.* 1982; Preston *et al.* 2002). The Rum site is below 450 m on microgranite and is therefore unlikely to have been suitable.

Carex bicolor

This Circumpolar Arctic-montane sedge was reportedly discovered in 1941 by Heslop Harrison on "sparsely clad" terraces between 380–450 m above the easternmost tributary of the Allt Slugan a' Choilich on the eastern side of Coire Dubh (Heslop Harrison 1941b; Pugsley 1941; Heslop Harrison *et al.* 1942). Two separate colonies were recorded in this locality in 1942, 1943 and 1945 (Heslop Harrison 1945), and living material sent to Kew (Heslop Harrison 1944a), although by 1948 they had apparently been lost to landslides or deer (Raven 1948). A few years later a third colony was discovered at 285 m "on bare banks of gravel at the junction of two burns in the middle [floor] of Coire Dubh" where Raven (1948, 1949) located nine small plants in 1948. Although this habitat was similar to localities in the Canadian Arctic (Polunin 1941) and Iceland (Heslop Harrison 1951b), its habitat and associated species (which included *Juncus capitatus*, *Poa annua* and *Sagina apetala*) left Raven (1948, 1949) in no doubt that "*Carex bicolor*, in its only known British station, was deliberately planted there by human hand". This accusation Heslop Harrison (1951b, 1951c) strenuously denied claiming that on Rum "*Carex bicolor* is a relict glacial form, and a genuine native". The infection of some plants by a native gall-gnat *Pseudohormomyia granifex* was given as "unequivocal evidence" for its native status (Heslop Harrison 1951b). Whatever the truth, it apparently persisted for a number of years. In 1951 there were 28 plants and its range extended further along the Allt Slugan a' Choilich (Heslop Harrison 1951b, 1951d), although overall numbers had declined due to "collecting" (Heslop Harrison & Morton 1951). It was recorded again in 1958 (Heslop Harrison 1958) and finally in 1961 when Heslop Harrison collected a number of specimens on his last visit to Rum (Sabbagh 1999a). It has not been recorded since. Polunin (1953b) included *C. bicolor* in a list of Arctic species present in the British Isles, although he noted it was considered to be an introduction by some botanists. It is a circumpolar species which occurs in Fennoscandia, Iceland, Greenland, North America, Siberia and the Alps (Hultén & Fries 1986).

Carex capillaris

This Circumpolar Boreo-arctic Montane sedge was reportedly discovered on the same slope as *Carex atrofusca* (Ard Nev-Orval ridge) but nearer to the Sròn an t-Saighdeir (Heslop Harrison 1939b, 1945). It was not reported again and it is not known whether any other botanists were shown specimens. In the British Isles this is a local plant of species-rich upland grasslands, overlying base-rich soils or areas flushed by base-rich waters (Jermy *et al.* 1982; Preston *et al.* 2002). The slopes of the Ard Nev-Orval ridge are almost entirely composed of volcanic microgranites and therefore are unlikely to have been suitable.

Carex capitata

This Arctic-montane sedge was reportedly discovered by Heslop Harrison at Loch Boisdale, South Uist (Heslop Harrison 1945) and subsequent works have continued to report this as the only British record (e.g. Jermy *et al.* 1982; Clapham *et al.* 1987). However, it is now known that a single specimen of *C. capitata* was shown to W. A. Sledge in 1948 on the eastern side of Coire

Dubh, Barkeval, growing close to the station for *Epilobium lactiforum* (Raven 1948). In addition, the specis was shown to J. R. M. Butler growing in cultivation with *Juncus capitatus* near Kinloch in 1947, and this led Raven (1948) to suspect that a single specimen had been "transplanted into its present station during the Professor's preparatory visit to the island" in June 1948. Heslop Harrison never published this remarkable record although he reported to Raven that the original colony consisted of six or seven plants (Raven 1948). We have been unable to trace specimens and it has never been recorded since. An Amphi-Atlantic species occurring in Fennoscandia, Iceland, North America, Siberia and the Alps (Hultén & Fries 1986).

Carex glacialis
This Arctic-montane sedge was reportedly discovered on dry stony ground on "the upper slopes of the southern turning of the Barkeval ridge" (Heslop Harrison 1945) where it was reported as very rare (Heslop Harrison 1944b). Living material was sent to Kew where it was confirmed by E. Nelmes (Heslop Harrison 1944a as *C. pedata*). Raven (1948) failed to find *C. glacialis* on his visit in 1948 although W. A. Sledge had been shown it a few days before. Heslop Harrison provides no further information on this remarkable find although it is mentioned in a number of phytogeographical papers (e.g. Heslop Harrison 1948c). Polunin (1953b) included *C. glacialis* in a list of Arctic species present in the British Isles although he noted that it was considered doubtful by some botanists. A circumpolar species which occurs in Fennoscandia, Iceland, Greenland, North America and Siberia (Hultén & Fries 1986).

Carex norvegica
This Circumpolar Arctic-montane sedge was reportedly discovered by Heslop Harrison on damp ground by a stream leading from the Cnapan Breaca to the east of Coire Dubh (Heslop Harrison *et al.* 1942; Heslop Harrison 1945). Despite the significance of this record it is not known whether independent botanists were shown the locality or sent material for determination, although there is a Heslop Harrison specimen in **E** labelled "Hallival, slopes towards corrie, Rhum, August 1944". In Scotland this is a very rare sedge of north-facing corries where it occurs above 700 m in association with snow-beds and on wet ledges, rocky slopes and turf overlying basic rock (Jermy *et al.* 1982; Preston *et al.* 2002). Although north-facing, the Rum locality is below 500 m on exposed volcanic breccias.

Epilobium lactiflorum
A Boreo-arctic species reportedly discovered by Heslop Harrison in Coire Dubh, Barkeval. As with *Carex capitata*, this record was never published although it was seen by W. A. Sledge and Raven (1948) in 1948 growing "on the smaller of two mossy springs which rise side by side on the steep west-facing slope". This habitat is similar to its localities in Iceland (Löve 1983) but, as with *Carex bicolor*, Raven (1948) noted the lack of other Arctic-alpine species growing in the immediate vicinity of the colony. Polunin (1953a) lists this species as an Arctic plant which could conceivably occur in the British Isles. A classic Amphi-Atlantic species occurring in Fennoscandia, Faeroes, Iceland, Greenland and North America (Hultén & Fries 1986).

Erigeron uniflorus
This Arctic-montane species was reportedly discovered by Heslop Harrison growing with *Carex glacialis* "in very small quantity on two low, somewhat bare ledges on Barkeval" (Heslop Harrison *et al.* 1942). Living material was subsequently sent to the Royal Botanic Gardens at Kew (Heslop Harrison 1944a) and Edinburgh and it was also shown to W. A. Sledge in 1948 (Raven 1948). No further details were published on this remarkable find although Heslop Harrison (1948c) included a photograph of it "from its only British station; Isle of Rhum" in one of his phytogeographical papers. In Iceland, *E. uniflorus* (subsp. *eriocephalus*) occurs on gravelly flats at high elevation (Löve 1983). It is also known to occur at over 2200 m on nunataks in Greenland (Halliday 2002). A circumpolar species which also occurs in Fennoscandia, North America and Siberia, and with outlying populations (subsp. *uniflorus*) in the mountain ranges of Europe and Asia (Hultén & Fries 1986).

Lychnis alpina
A small population of this rare Boreo-arctic Montane species was reported from basalt cliffs on the north side of Fionchra (Heslop Harrison *et al.* 1942) and living material sent to Kew (Heslop Harrison 1944a). In 1948 a small colony of 10 to 12 weak rosettes was shown to W. A. Sledge and Raven growing "on a very steep little slope of loose gravely soil" where it had apparently

colonised from the crags above (Raven 1948). Raven (1949) noted how weak these specimens looked in comparison to the more robust plants in Glen Clova. In Britain *L. alpina* has only been confirmed from two sites in Cumberland and Angus where it is confined to metalliferous soils between 600–700 m (Preston *et al.* 2002).

2. Southern species

Filago gallica

This Mediterranean species was reportedly discovered growing "along the sandy path-side south of Kilmory" (Heslop Harrison 1939b). Although it was originally reported as "a remarkable discovery: new to Scotland" Heslop Harrison subsequently listed it as an introduction to the island (Heslop Harrison 1948a). In Britain *F. gallica* is a very rare archaeophyte of well-drained, sandy and gravelly soils in southeast England (Preston *et al.* 2002). The origin of the Rum plants are not known although it may have been an unintentional introduction in imported seed or hay which subsequently spread into semi-natural habitats.

Juncus capitatus

This Southern-temperate rush was reportedly discovered growing on bare peaty ground by the track along the Kinloch Burn (Heslop Harrison 1939b). In 1948 Raven and W. A. Sledge were shown a small colony of around 30 plants "scattered about some small, bare, stony patches between the heather beside the track" in Kinloch Glen (Raven 1948). In addition, Raven discovered a few plants growing with *Polycarpon tetraphyllum* on the same track and, more remarkably, a few plants growing a few feet away from *Carex bicolor* at c.400 m in Coire Dubh. In addition, it was also shown to J. R. M. Butler growing in cultivation with *Carex capitata* near Kinloch in 1947 (Raven 1948). As with *Polycarpon tetraphyllum,* Heslop Harrison (1954) later denied that it was native on Rum despite having suggested that it colonised Coire Dubh from wind-dispersed seed (Heslop Harrison 1951b). We suspect that it was intentionally introduced to Rum, given its earlier "discovery" by Heslop Harrison on Raasay and Barra. Only known as a certain native from the Channel Islands, West Cornwall and Anglesey where it is confined to shallow soils around rock-outcrops, serpentine "pans" and dune-slacks which dry out in the summer months (Wigginton 1999).

Polycarpon tetraphyllum

This Mediterranean species was reportedly discovered in 1938 as "a single plant growing in a rock crevice along the Kinloch Burn, Rhum; a new county record" (Heslop Harrison 1939b). In 1948 Raven and W. A. Sledge were shown a few small colonies scattered along the Kinloch track, where it was growing in association with *Juncus capitatus* and *Wahlenbergia lobelioides* (Raven 1948; see Preston 2004). These had originally been determined by A. J. Wilmott as a Mediterranean variety known from Malta and Greece and this led Raven to conclude that *P. tetraphyllum* was undoubtedly an introduction to Rum (Raven 1949). The suggestion that it was originally treated as a native was vehemently denied by Heslop Harrison (1951b) and in the same year as Raven's visit he included it in a list of introductions, stating that it was "clearly an escape from the grounds, or brought in with deer food" (Heslop Harrison 1948a). This species has only been confirmed as a probable native from coastal sites in the Channel Islands, Dorset, South Devon and Cornwall where it occurs in a variety of habitats including sunny banks, shingle, stone walls, bulb fields and gardens (Wigginton 1999).

CRITICAL AND DIFFICULT TAXA

Heslop-Harrison was the last botanist to deal with critical taxa on Rum in any detail and as a result there are 30 taxa which have not been recorded since his day (Table 2). Some of these belong to genera which have been the subject of significant taxonomic revisions since the 1940s. For example, the plasticity of *Cochlearia* species has long presented taxonomic difficulties for British botanists, particularly *C. pyrenaica* which is thought to merge into *C. officinalis* s.s. in coastal localities in the U.K. (Rich 1992). In the absence of herbarium material, older records for this

TABLE 2. CRITICAL AND DIFFICULT TAXA RECORDED ON RUM BY J.W. HESLOP HARRISON BUT NOT RELIABLY RECORDED SINCE 1957[1]

Taxon	HH (1939b)	HH *et al.* (1941)	HH *et al.* (1942)	HH (1948b)	HH (1951a)	HH & Morton (1951)	HH (1958)	Details
Arctium lappa[2]	+							Probably an error for *A. minus*.
Arctium nemorosum	+							Taxon unlikely to have been recorded reliably at the time.
Callitriche obtusangula						+		Probably an error for *C. stagnalis*.
Cochlearia danica					+			Overlooked?
Cochlearia micacea[3]		+						Rejected on distributional grounds.
Cochlearia pyrenaica[4]	+							Perhaps an error for *C. officinalis* s.l. which still occurs.
Crepis mollis	+							Rejected on distributional grounds.
Dactylorhiza incarnata × *purpurella*[5]					+			A sporadic hybrid and therefore likely to have been overlooked?
Dactylorhiza maculata subsp. *rhoumensis*[6]					+	+	+	Now thought to be of dubious status.
Dactylorhiza majalis subsp. *occidentalis*[7]						+		Overlooked?
Dryopteris carthusiana[8]	+							Doubted by Page (1986) although not rejected outright.
Empetrum nigrum subsp. *hermaphroditum*		+	+		+			Only one unconfirmed record since 1957; possibly overlooked?
Epilobium montanum x *obscurum*					+			A sporadic hybrid and therefore likely to have been overlooked?
Euphrasia arctica subsp. *arctica*[9]	+							Overlooked?
Euphrasia foulaensis	+							Overlooked?
Euphrasia tetraquetra[10]	+							Rare and taxonomically difficult in Scotland.
Galium sterneri					+			Rejected on distributional grounds.
Myosotis scorpioides[11]	+							Possibly overlooked? Recent SNH unconfirmed record.
Nymphaea alba subsp. *occidentalis*	+							Overlooked?
Potamogeton pusillus				+				Probably an error for *P. berchtoldii*.
Rhinanthus minor subsp. *lintonii*[12]	+							Overlooked?
Rhinanthus minor subsp. *monticola*	+							Overlooked?
Rosa pimpinellifolia × *sherardii*	+							A sporadic hybrid and therefore likely to have been overlooked?
Sagina × *normaniana*[13]						+		Rejected on distributional grounds.
Salix cinerea × *repens*	+							A sporadic hybrid and therefore likely to have been overlooked?
Salix myrsinifolia			+					Rejected on distributional grounds. Probably *S. phylicifolia*.
Thalictrum minus subsp. *arenarium*	+							Overlooked? Not recognised by Stace (1997)
Thalictrum minus subsp. *majus*	+							Overlooked? Not recognised by Stace (1997)
Thymus pulegioides[14]	+							Rejected on distributional grounds..
Viola reichenbachiana[15]	+							Rejected on distributional grounds. Probable error for *V. riviniana*.

1. *Festuca prolifera* and *Rosa glaucophylla* were recorded by Heslop Harrison (1939b) but are excluded from these lists because they cannot be satisfactorily assigned to modern species (C. A. Stace, in litt. 2002). *Salix arbuscula* (Heslop Harrison et al. 1941) is also excluded as it was subsequently thought to be an "unusual form" of *S. phylicifolia* (Heslop Harrison 1958). 2. As *Arctium major*. 3. As *Cochlearia arctica* (= *C. micacea* E.S. Marshall). 4. As *Cochlearia alpina*. 5. As *Orchis latifolia* × *purpurella*. 6. As *Orchis ericetorum* subsp. *rhumensis*. 7. As *Orchis majalis*. 8. As *Lathraea spinulosa*. 9. As *Euphrasia borealis*. *Euphrasia brevipila* has been interpreted as *E. arctica* subsp. *borealis* and *E. borealis* as *E. arctica* subsp. *arctica* (C. A. Stace, in litt. 2002). Both were reported as separate taxa for Rum in 1939 (Heslop Harrison 1939b). 10. As *Euphrasia occidentalis*. 11. As *Myosotis palustris*. 12. As *Rhinanthus drummond-hayi*. 13. As *Sagina scotica*. 14. As *Thymus ovatus*. 15. As *Viola sylvestris*.

species are best interpreted as either *C. officinalis* subsp. *officinalis* or subsp. *scotica*, both of which have been recently been confirmed for Rum. Older records for *Cochlearia arctica* on the other hand (e.g. Heslop Harrison *et al.* 1941; Eggeling 1965) are more difficult to interpret, having been variously assigned by different authors (C. A. Stace, in litt. 2002). Heslop Harrison, however, gives the synonym "= *C. micacea* E. S. Marshall" and therefore we suspect he is referring to *C. micacea* s.s., which, in the absence of herbarium material, should be rejected on distributional grounds. Similarly, older records for *Arctium lappa* (scarcely known from Scotland) and *Euphrasia arctica* subsp. *arctica* (confined to Orkney and Shetland) are unlikely to be reliable.

There is no doubt that some species in Table 2 represent mis-identifications. For example, the presence of *Dryopteris carthusiana* on the island, which was considered to be "fairly common" by Eggeling (1965), has recently been doubted by Page (1986), though he was reluctant to dismiss the record entirely. In addition, a recent survey of the major lochs of Rum failed to find *Potamogeton pusillus* which may have been originally confused with *Potamogeton berchtoldii* (Preston *et al.* 2000). Other taxa which might be included in this category include *Crepis mollis*, *Galium sterneri*, *Sagina* × *normaniana* and *Thymus pulegioides*.

A number of species are likely to have been overlooked because they have not been subjected to detailed study for many years. Obvious examples in Table 2 include uncommon hybrids, such as *Epilobium montanum* × *obscurum*, as well as *Euphrasia* and *Dactylorhiza* taxa, which were both the subject of detailed investigations during the 1940s (Pugsley 1945, 1946; Heslop Harrison 1949). Given their wider Hebridean distributions, *Euphrasia foulaensis*, *Dactylorhiza majalis* subsp. *occidentalis* and *D. maculata* subsp. *rhoumensis* presumably still occur although the last is now considered to be of dubious subspecific rank (Stace 1997). Other species which might be included in this category are the subspecies of *Rhinanthus minor* and *Empetrum nigrum* subsp. *hermaphroditicum*, for which there is a single unconfirmed record.

Finally, there are a number of taxa which are no longer recognised by British botanists (e.g. subspecies of *Thalictrum minus*) and several critical taxa (not included in Table 2) that cannot be assigned to any modern species (*Euphrasia curta, E. eurycarpa, Festuca prolifera*, *Rosa glaucophylla*) (C. A. Stace, in litt. 2002).

ACCEPTED INTRODUCTIONS

Accepted introductions to Rum are listed in Table 3. These can be divided into two main groups: species planted for ornamental, herbal or medicinal purposes (22 taxa) and those associated with arable cultivation and livestock production (24 species).

With the exception of *Crataegus laevigata,* all the planted introductions were recorded from Kinloch where they were planted for ornament (e.g. *Astilbe thunbergii*, *Picea abies*, *Salix fragilis*, *Sorbus aria*, *Viola cornuta*) and domestic use (e.g. *Prunus* spp.) or introduced with imported trees (e.g. *Fallopia japonica*, *Moehringia trinervia*; *Wahlenbergia gracilis*). This list also includes a number of herbal and medicinal relics which would have been traditionally planted around crofts (e.g. *Artemisia absinthium*, *Inula helenium*).

By far the largest group of introduced species, however, are crop and livestock weeds. Although some of these are likely to have been casuals brought in with imported grain (e.g. *Conringia orientalis*, *Mentha arvensis*, *Phalaris canariensis*) or hay (e.g. *Festuca pratensis*, *Gnaphalium luteoalbum*, *Linum perenne*, *Medicago lupulina*), the loss of many presumably resulted from the decline of arable cultivation since the 1930s (Magnusson 1997). This process is likely to have eliminated opportunities for regeneration of once common crop weeds such as *Chenopodium album*, *Chrysanthemum segetum*, *Fallopia convolvulus*, *Galeopsis* spp., *Geranium* spp., *Urtica urens* and *Veronica agrestis*.

EXTINCT NATIVE SPECIES

Some of the species listed in Table 4 may reflect genuine losses from semi-natural habitats due to changes in management. For example, *Pilularia globulifera* (now re-introduced to pools at Harris) probably disappeared when cattle and sheep were removed in 1957 (Magnusson 1997). This may

also account for the loss of *Oenanthe lachenalii* and *Lemna minor* which occurred with *P. globulifera* in a pool behind the beach at Harris.

In contrast, some species may have been ephemeral colonists which persisted for a few years. For example, *Platanthera chlorantha* was recorded as abundant in 1947 and 1948 (Heslop Harrison 1951a) but had gone by 1951 (Heslop Harrison & Morton 1951)[3]. In comparison to these genuine losses, other species may have been overlooked due to their extreme rarity (e.g. *Circaea lutetiana*, *Hypericum perforatum*, *Gnaphalium sylvaticum*, *Pyrola minor*, *Sanicula europaea*) or confinement to inaccessible habitats. For example, *Orobanche alba* has only been recorded from the treacherous west-facing slopes of Bloodstone Hill which are very difficult to survey (Heslop Harrison 1939b). In addition, the only records for *Zostera marina* are "cast up" material on the beaches around the north of the island (Heslop Harrison 1958; Eggeling 1965).

Several of the species listed in Table 4 are likely to be errors for more common species. The record of *Draba norvegica* from Fionchra (found by H. R. Fletcher) has long been considered an error for *D. incana* which occurs on the same cliff (Eggeling 1965), although the former species has recently been discovered on Skye (Currie & Murray 1983). Other species which might be included in this category include *Potamogeton coloratus* (*P. polygonifolius*?), *P. pectinatus* (aquatic form of *Juncus bulbosus*?), *Elytrigia atherica* (*E. juncea*?) and *Leontodon hispidus* (*L. saxatilis*?).

DISCUSSION

The majority of the species listed in Tables 2–4 were undoubtedly present on Rum but have been "lost" since the 1950s due to a variety of reasons: taxonomic changes and a decline in the recording of critical taxa are likely to account for 30 species, whereas 46 were most probably casual escapes from gardens or weeds associated with management practices (e.g. arable cultivation) which no longer take place on the island. In contrast, mis-identifications and genuine losses of native species from semi-natural habitats appear to have been have been relatively minor (24 species; Table 6).

In contrast, 13 of Heslop Harrison's most remarkable discoveries appear to have been mis-representations. Although we cannot rule out the involvement of a third party, we suspect that some, if not all, were deliberately introduced to the island by Heslop Harrison, and later "discovered" by him or his co-workers. We have no idea where he obtained this material or indeed whether the plants were cultivated away from the island, although Sabbagh (1999a) has some thoughts on the matter. We doubt that other members of his expeditions (including members of his family) were party to this deception, although it has been suggested that his son, J. Heslop Harrison, knew of his father's activities and warned him against further fraudulent actions. Indeed his 1953 paper to the Botanical Society of the British Isles conference (Heslop Harrison Jnr 1953) was seen as a direct attack on his father's earlier work (S. M. Walters, pers comm. 2003), whereas in an earlier paper on Hebridean phytogeography he conspicuously ignores the remarkable Rum discoveries listed in Table 1 (Heslop Harrison Jnr 1948). Similarly, Heslop Harrison's son-in-law, W. A. Clarke, who accompanied him on many Hebridean expeditions, later withdrew his support from earlier "survival" theories (Clarke 1956).

Species that were likely to have been intentionally planted in semi-natural habitats include *Carex bicolor*, *C. capitata*, *C. glacialis*, *Epilobium lactiflorum*, *Erigeron uniflorus* and *Lychnis alpina*. We are less certain about the origin and status of *Juncus capitatus* and *Polycarpon tetraphyllum* but suspect that they were also intentionally introduced (or unintentionally with one or more of the above named species) and perhaps subsequently spread into semi-natural habitats (e.g. *Juncus capitatus* at 450 m in Coire Dubh). The presence of *Carex atrata*, *C. atrofusca*, *C. capillaris* and *C. norvegica* were never verified by independent botanists and were all recorded from atypical habitats. We have no direct proof of their introduction but in the absence of supporting evidence or herbarium specimens we consider their native presence on Rum to be extremely unlikely. In contrast, we suspect that *Filago gallica* was an unintentional introduction

[3]Similarly *Platanthera chlorantha* was recorded by Heslop Harrison (1951a) on Coll in 1947 and South Uist in 1949 but has never been recorded since on either island.

TABLE 3. INTRODUCED SPECIES RECORDED ON RUM BY J. W. HESLOP HARRISON BUT NOT RELIABLY RECORDED SINCE

	HH (1939b)	HH *et al.* (1941)	HH (1945)	HH (1948a)	HH (1951a)	HH & Morton (1951)	HH (1958)	Details
1. Species associated with gardens, the policy woodlands and imported timber								
Alchemilla xanthochlora	+					+		Only in the Kinloch Woods (as *Alchemilla pratensis*).
Astilbe thunbergii				+				An escape from the castle grounds (as *Astilbe japonica*).
Carex brunnea			+	+				Introduced with bamboos at Kinloch.
Crataegus laevigata	+							Planted at Papadil on the south coast.
Equisetum telmateia	+							Only recorded at Kinloch; probably introduced with imported top-soil.
Fallopia japonica				+				Only recorded at Kinloch; probably introduced with imported top-soil.
Inula glandulosa				+				Planted at Kinloch.
Moehringia trinervia	+							Only recorded at Kinloch; probably introduced with imported timber.
Picea abies				+				Planted.
Prunus domestica subsp. *domestica*						+		Planted at Kinloch.
Prunus domestica subsp. *insititia*						+		Planted at Kinloch.
Rosa caesia subsp. *caesia*		+		+		+		As an escape from the castle grounds where it was used for hedging.
Salix fragilis	+							Planted at Kinloch.
Salix pentandra					+			Planted at Kinloch.
Sorbus aria	+			+				Planted at Kinloch.
Staphylea pinnata								Presumably an escape from the castle grounds (Heslop Harrison 1954).
Viola cornuta				+				An escape from the castle grounds.
Wahlenbergia gracilis[1]				+				An escape from derelict greenhouses (Heslop Harrison 1951b).
2. Herbal and medicinal relics associated with dwellings								
Artemisia absinthium				+				Recorded as a relic of croft gardens.
Carum carvi				+	+			On the site of an old house at Kinloch.
Inula helenium	+			+				Only recorded from near old crofts.
Mentha arvensis x *spicata*	+			+				Only recorded as a garden outcast (as *Mentha gentilis*).

TABLE 3. (CONTINUED)

Taxon	HH (1939b)	HH *et al.* (1941)	HH (1945)	HH (1948a)	HH (1951a)	HH & Morton (1951)	HH (1958)	Details
3. Weeds associated with crops, livestock fodder (including food for red deer) and waste places								
Anchusa arvensis					+			Only recorded from fields near the sea (as *Lycopsis arvensis*).
Aphanes arvensis	+							Scattered in waste places.
Calystegia sepium	+							Rare at Kinloch; possibly confused with *C. silvatica*.
Chenopodium album	+							Recorded as "not common" in waste areas.
Chrysanthemum segetum					+			Recorded from a field of oats near Kinloch.
Conringia orientalis	+							Recorded once at Kinloch (as *Erysimum orientale*).
Fallopia convolvulus					+			Amongst corn at Kilmory.
Festuca pratensis	+							Meadow at Kinloch; probably introduced with imported hay.
Galeopsis speciosa					+			Frequent on arable land at Kinloch and Kilmory.
Galeopsis tetrahit	+							Common weed at Kinloch, possibly found in 2003 (leaves only).
Geranium dissectum	+							A weed of cultivated areas.
Geranium pratense	+			+				Only at Kinloch; probably introduced with imported seed or hay.
Gnaphalium luteoalbum				+				Only at Kinloch; probably introduced with imported seed or hay.
Lamium amplexicaule	+							Only at Kinloch.
Lamium purpureum	+							Scattered over the island, presumably in waste places.
Lapsana communis	+			+			+	Scattered over the island, presumably in waste places.
Linum perenne				+				Probably introduced with imported seed or hay.
Malva neglecta							+	Recorded as rare weed at Kinloch.
Medicago lupulina		+			+			By paths near Kinloch and Kilmory; possibly an adventive.
Mentha arvensis					+			A weed in fields at Kinloch and Kilmory.
Phalaris canariensis	+			+				Recorded as a casual on waste heaps.
Sherardia arvensis		+			+			Only at Kilmory; probably introduced with seed or hay.
Urtica urens							+	Only on waste ground at Kinloch.
Veronica agrestis	+							Scattered on cultivated ground.

[1] Probably best referable to *W. lobelioides* (see Preston 2004).

TABLE 4. NATIVE SPECIES RECORDED ON RUM BY J.W. HESLOP HARRISON WHICH HAVE NOT BEEN RELIABLY RECORDED SINCE 1957. ALL ARE CONCEIVABLE ON DISTRIBUTIONAL GROUNDS ALTHOUGH SOME (E.G. *HYPERICUM PERFORATUM*) ARE AT THE EXTREME EDGE OF THEIR RANGE IN THE HEBRIDES

Taxon	HH (1939b)	HH *et al.* (1941)	HH *et al.* (1942)	HH (1948a)	HH (1948b)	HH (1951a)	HH & Morton (1951)	HH (1958)	Details
Circaea lutetiana									Only recorded from the Rudha na Roinne.
Crepis capillaris	+								Posibly overlooked as a native but recorded as a garden weed in 2003.
Draba norvegica						+			Probable error for *D. incana*.
Elytrigia atherica	+								Probable error for *E. juncea* or *E. repens* (var. *aristatum*).
Festuca filiformis	+								Recorded (as *Festuca capillata*) as rare and may still occur.
Gnaphalium sylvaticum	+								Only recorded from Glen Shellesder. An SNH record requires confirmation.
Hypericum perforatum	+								Only recorded near Kinloch. Possibly introduced.
Lemna minor		+							Only known from pools near Harris. Disappeared after cattle were removed.
Leontodon hispidus	+								Rejected on distributional grounds. Suspected error for *L. saxatilis*.
Oenanthe lachenalii	+								Only recorded from pools near Harris. Disappeared after cattle were removed.
Orobanche alba	+								Only recorded from the slopes of Bloodstone Hill. Probably overlooked.
Pilularia globulifera[1]									Only recorded from pools near Harris. Disappeared after cattle were removed.
Platanthera chlorantha						+	+		A brief colonist recorded in 1947 and 1948.
Potamogeton alpinus	+				+				Collected by K. B. Blackburn in the North Block but never seen again.
Potamogeton coloratus			+		+				Glen Shellesder: habitat unsuitable and suspected error for *P. polygonifolius*.
Potamogeton filiformis					+				Conceivable on distributional grounds but never refound.
Potamogeton pectinatus									Probable error for the aquatic form of *Juncus bulbosus*.
Pyrola minor	+								A single record from Hallival. Probably overlooked.
Ruppia maritima	+							+	Only recorded at Harris. Probably overlooked.
Sanicula europaea	+								Only one record. Probably overlooked.
Scrophularia nodosa						+			Only one record. Probably overlooked.
Spergularia media	+								A recent SNH record requires confirmation; could conceivably still occur.
Stachys × ambigua			+	+					Recorded in a few places. Possibly declining due to loss of crofting.
Zostera marina								+	Only recorded as cast-up specimens on the north coast.

[1] Re-introduced in the 1990s to pools near Harris (Magnusson 1997).

TABLE 5. NATIVE PLANTS RECORDED BY GRIEVE (1886) AND EGGELING (1965), NOT FOUND BY HESLOP HARRISON, AND NOT RECORDED RELIABLY SINCE 1965

	Grieve (1886)	Eggeling (1965)	Details
Atriplex patula	+		
Cirsium heterophyllum	+		Present on Eigg.
Epilobium anagallidifolium	+		Present on Skye.
Epilobium obscurum x *palustre*		+	
Festuca ovina	+		
Galium boreale	+		Present on Skye, Eigg and Canna.
Galium uliginosum	+		Present on Coll and Tiree.
Gnaphalium supinum	+		Present on Skye.
Hymenophyllum tunbrigense		+	No recent records despite Page (1983).
Lamium confertum		+	
Luzula spicata	+		Rejected on distributional grounds.
Myosotis sylvatica	+		
Papaver dubium subsp. *dubium*		+	Possibly former crop weed.
Poa compressa		+	
Populus alba	+		
Potentilla crantzii	+		Present on Skye.
Ranunculus sardous	+		
Rumex maritimus	+		Rejected on distributional grounds.
Scilla verna	+		Present on Canna; overlooked?
Silene latifolia	+		
Trifolium arvense	+		Former crop weed?
Tripleurospermum inodorum		+	Former crop weed?

TABLE 6. SUMMARY OF TAXA RECORDED ON RUM BY J. W. HESLOP HARRISON BUT NOT RELIABLY RECORDED SINCE 1957

	Taxa recorded as native			Species recorded as introduction			
	Species	Subsp.	Hybrids	BI native	Archaeophytes	Neophytes	Total
Dubious	10	-	-	2	1	-	13
Critical	16	9	5	-	-	-	30
Introduction	-	-	-	19	15	12	46
Extinct native	23	-	1	-	-	-	24
Total	49	9	6	21	16	12	113

which established from imported seed or hay.

A detailed discussion of the reasons for the introduction of these species is beyond the scope of this paper; however, we suspect that his primary motive was scientific. In a series of phytogeographical papers Heslop Harrison discussed the possibility that many of the Arctic and alpine species in the Hebrides survived the height of the last ice age in ice-free refugia along the western seaboard (Heslop Harrison 1939a, 1941a, 1948c). At that time this glacial (or perglacial) "survival theory" was gaining widespread support as an explanation for the disjunct distributions of many Arctic plants in the Northern Hemisphere (e.g. Dahl 1946). The discovery of five amphi-Atlantic species in northwest Scotland was therefore viewed by Heslop Harrison as "weighty evidence" for the existence of "scattered nunataks" where "most of the arctic and alpine plants, exemplified by the sedges *Carex capitata*, *C. bicolor* and *C. glacialis*, the woodrush, *Luzula spicata*, the grass *Poa alpina*, the Arctic Scurvy Grass (*Cochlearia arctica*), the Fleabane (*Erigeron uniflorus*), the Alpine Saw-wort (*Saussurea alpina*) and the Norwegian Sandwort (*Arenaria norvegica*)...survived the rigours of the ice age" (Heslop Harrison 1948c). Whatever the truth over the origin of these species, the hypothesis of glacial survival has now largely been rejected (Halliday 2002). Although the possibility of survival in a few ice-free areas cannot be ruled out, the results of recent evolutionary and palaeobotanical research suggest that post-glacial immigration followed by retraction into climatic and edaphic refugia is a much more plausible explanation for the disjunct distributions of many Arctic species (Pigott & Walters 1954; Nordal 1987; Birks 1993).

CONCLUSION

There is no doubt that Heslop Harrison made many valuable discoveries on Rum. Some of his most notable discoveries have been substantiated with the passage of time (e.g. *Arenaria norvegica*, *Thlaspi caerulescens*), whereas his work on *Dactylorhiza*, *Euphrasia* and *Rosa* has added greatly to our understanding of the critical flora of the Hebrides. Plausible reasons can be advanced for the disappearance of many of his species which have not been refound since the 1950s (e.g. taxonomic advances, decline in the recording of critical species, land use change). However, the controversy surrounding the Rum "discoveries" has inevitably led some workers to treat all his records with suspicion. We hope the findings presented in this paper illustrate the enduring importance of his work which "remains a major contribution which cannot be ignored by any serious student of the Outer Hebridean flora" (Pankhurst & Mullin 1991), a sentiment that one of us (DAP) found to be true whilst working on the flora of Tiree and Coll (Pearman & Preston 2000).

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A re-assessment of montane willow (*Salix* L., Salicaceae) hybrids in Scotland

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ABSTRACT

A review of the hybrids of willows (*Salix* L.) occurring on Scottish mountains has been undertaken. Field surveys were carried out in selected areas and the hybrids which were found were brought into cultivation for further study and ultimately for their conservation. The distribution of these hybrids in the chosen areas and their status are discussed. Seven hybrid combinations new to Britain have been proposed and described based on morphological characters, whereas seven other hybrid combinations that had recently been published for Britain have now been rejected. The British list of willow hybrids has been tentatively revised as an interim step, although preparation has also been made for DNA studies to be carried out in a programme planned to test the hypotheses of their hybridity and parentage.

KEYWORDS: Hybridization, plant surveys, conservation, chromosomes.

INTRODUCTION

A survey of the willow (*Salix* L.) hybrids occurring on Scottish mountains has been carried out, mainly during the last decade. This is a very difficult but important group in the Scottish mountain flora, especially as extensive hybridization has taken place leading to great variation, which, combined with the inaccessibility and extreme rarity of many individual hybrids in their natural habitat, has led to their neglect for many years. A major revision was published by F. Buchanan White (White 1890) in which several new hybrids were described. White's findings were later incorporated into an extensive monograph on British *Salix* by the Rev. E. F. Linton (Linton 1913), with considerable addition and further revision. Linton described 39 willow hybrid combinations which were likely to have occurred in montane habitats in Scotland. Since that time hardly any further progress was made until a full re-assessment was completed by R. D. Meikle (Meikle 1975) and a handbook published (Meikle 1984) in which several of the willow hybrids accepted by Linton were rejected, either due to lack of satisfactory evidence or due to earlier re-determination by non-British salicologists, notably S. J. Enander and B. Floderus. Two new hybrid combinations found in the Scottish mountains were included in the list prepared by Meikle. However, in many cases *Salix* hybrids are extremely difficult to determine, particularly from herbarium material, and, as fresh specimens of some of the rarer hybrids from montane habitats were unavailable at the time, the 1975 re-assessment left many questions unanswered. Fortunately, R. D. Meikle is still the leading British salicologist and through his considerable help with the determinations a new re-assessment has been possible.

In this paper willows have been divided into two groups according to their usual natural habitat. First are those species which are more or less confined to mountain habitats in Scotland, and usually with an alpine or sub-arctic distribution elsewhere ('montane willows'). Second are those species which generally occur at low altitudes but which sometimes extend their upper altitudinal range to overlap in habitat with the first group ('lowland willows'); these are listed and more precisely defined under Materials and Methods. This re-assessment has concentrated primarily on those hybrids which have at least one montane species as a parent, and hybrids which involved only lowland species are generally included only where they were found to occur with or near hybrids or species of montane willows.

The overall distribution of the willow species, montane or lowland, is not given in this paper, but can be seen in Preston *et al.* (2002); however, an indication is provided under Materials and Methods of their frequency in the selected areas surveyed.

In addition to the establishment of a living collection of willow hybrids from Scottish montane habitats, the wider objectives of this re-assessment can be summarised here as follows:

1. To establish the status of previous records and to match them with newly collected material, providing updated records for local county recorders and for databases.
2. To revise the British list of *Salix* hybrids (Stace 1997; Kent & Stace 2000) and to provide information for the *Vice-county census catalogue* (Stace *et al.* 2003).
3. To produce selected hybrids by design in cultivation for comparison with herbarium and newly collected specimens and with published descriptions, and to provide these as control examples for further studies.
4. To provide recently confirmed material to herbarium collections, thus reducing the need for further collection from their native sites.
5. To prepare hybrid descriptions based on recently confirmed material and to build up photographic records for future identification purposes.
6. To provide living material to botanic gardens and other institutions for future research.
7. To consider their conservation. The majority of the hybrids are extremely rare and very vulnerable in their native habitats. Their establishment in botanic gardens will form one type of conservation. However, a carefully controlled programme for the introduction of the rarest hybrids into their original place of collection should also be given consideration.
8. It became apparent during the survey that there was a need to advance identification techniques for willow hybrids. Consequently, an additional objective has been to seek a source where molecular studies could be carried out and then to select and prepare DNA samples from the cultivated plants.

MATERIALS AND METHODS

HERBARIUM RECORDS

The initial step in this survey was the examination of herbarium collections in order to establish the distribution of hybrids and to select the areas for the field studies (Table 1), and also to become familiar with the characters of the willow species and their hybrids and to match these with published data. The following herbarium collections were studied in detail: **BM**, **CGE**, **E**, **K**, **LIV**, **NMW** and **OXF**. The information abstracted from these sources formed the main basis for the field-work. The free exchange of specimens between the early salicologists, and the issue of a set of British willows to major herbaria by E. F. & W. R. Linton in the late 19th century, enabled virtually all of the important hybrid specimens to be traced.

FIELD-SURVEY LOCATIONS

The field-work was commenced in 1991, although a few of the important willow hybrids had been discovered earlier. In the latter part of the 1990s the field surveys were extended after the necessary permits and permissions from land-owners were obtained. The areas surveyed (Table 1) were those which the early salicologists had found to be rich in montane willow hybrids, in order to relocate all of the described hybrids and to bring them into cultivation for further studies. The areas have been given code letters for the sake of brevity.

DEFINITION OF MONTANE AND LOWLAND WILLOWS

Montane willows occurring on British mountains are defined here as those species with a lower altitudinal limit of usually more than 610 m and an upper limit of over 850 m (and usually to 1000 m). All but two of the six species meeting these criteria are now confined to Scotland.

S. lapponum L. Widespread and frequent in locations 2, 3 and 4, more local and usually in smaller numbers (in the pure state) in location 1, not found in the areas surveyed in locations 5, 6 or 7. Descends to 210 m in West Perth, v.c. 87.

S. lanata L. Locally frequent at MNS (location 1), GCS (location 3) and CK (location 4), local and very scarce elsewhere in location 1 and in location 2, absent or very rare elsewhere. Descends to 620 m in Westerness, v.c. 97.

TABLE 1. FIELD SURVEY LOCATIONS

Location	V.C.	Main sites	Grid square	Site code
1. Central Highlands: Mid Perthshire	88	a. Creag Roro	NN 64	CR
		b. Meall na Samhna	NN 43	MNS
		c. Meall Ghaordie	NN54	MG
2. Eastern Central Highlands: East Perthshire	89	a. North and north-west of Spittal of Glenshee	NO 07	GS
3. Eastern Highlands: Angus	90	a. Glen Doll	NO 27	GCD
		b. Glen Fee	NO 27	GCF
		c. Corrie Sharroch	NO 27	GCS
		d. Glen South Esk	NO 28	GCE
		e. Loch Brandy	NO 37	GCB
4. Eastern Highlands: South Aberdeen	92	a. Glen Callater & Coire Kander	NO 18 & 28	CK
		b. Lochnagar	NO 28	LGR
5. Western Highlands: Main Argyll	98	a. Allt nan Giubhas	NN 25	ANG
6. Northern Highlands: West Ross	105	a. An Teallach	NH 08	AT
7. Northern Highlands: West Sutherland	108	a. Inchnadamph	NC 22	IDH

S. arbuscula L. Abundant on MG, much of CR and local and in smaller numbers on MNS (all location 1), not recently reported from locations 3 or 4 and absent from locations 2, 6 and 7 and ANG (location 5). Descends to 460 m in Mid Perth, v.c. 88.

S. myrsinites L. Locally frequent in CK in location 4, local and often rather scarce (in the pure state) in locations 1, 3 and 7 and absent in the areas surveyed in locations 2, 5 and 6. Descends as low as 180 m in West Sutherland, v.c. 108.

S. herbacea L. Very frequent and widespread in all of the locations surveyed, especially at higher altitudes where it is reported to exceed 1300 m, yet it descends almost to sea level in Shetland, v.c. 112.

S. reticulata L. Frequent and locally abundant at CR, MG and MNS (all location 1). Local and rather scarce throughout location 3 and in CK (location 4). Absent from the other areas surveyed. Descends to 650 m in Mid Perth, v.c. 88.

The lowland willows included in this survey are defined as those species with an upper altitudinal limit of at least 610 m in Scotland, but the majority have a maximum limit below 800 m; all have their lower limit more or less at sea-level throughout Scotland. Six Scottish willow species meet these criteria and occur throughout the areas surveyed, although seldom in large numbers at higher altitudes.

S. caprea L. Most frequently represented at high altitudes in the areas surveyed by its subspecies *sphacelata* (Sm.) Macreight, or by intermediates between the latter and subsp. *caprea*.

S. cinerea L. Usually represented in the Scottish mountains by its subspecies *oleifolia* Macreight, but it seldom reaches the altitudes or habitats where the montane species occur in Scotland.

S. aurita L. Frequent even at moderately high altitudes, but absent on the basic rocks favoured by most of the montane willows.

S. myrsinifolia Salisb. Throughout most of the areas surveyed and not uncommon at higher altitudes with the montane species where it often occurs in a much dwarfed form.

S. phylicifolia L. Surprisingly scarce or apparently absent in nearly all of the areas surveyed, although usually frequent in the form of its hybrid with *S. myrsinifolia*. Some of the existing records undoubtedly refer to this hybrid.

S. repens L. Occurs in nearly all of the areas surveyed, although often locally and in small numbers and usually absent at the altitudes and habitats favoured by the montane species, but abundant in location 2.

All of the montane species are known to hybridize with at least one of the others in Scotland, and the lowland species often cross freely with each other. Four of the six lowland willows hybridize directly with montane species in Scotland; the fifth, *S. cinerea*, does not, although such

crosses are known in Scandinavia. The sixth, *S. phylicifolia*, may have crossed with montane species only as a secondary hybrid, after it had first crossed with *S. myrsinifolia*, although direct crosses between *S. phylicifolia* and montane species are reported from Scandinavia.

Cuttings of nearly all of the hybrids given in the list of records below were collected in the field for their propagation and the success rate in rooting these exceeded 95%, which eventually resulted in the establishment of a collection of over 500 pots of living willow hybrids. Most of these are now at the Royal Botanic Garden, Edinburgh, adding to ones earlier donated. A few living willow hybrids were also given to Ness Botanic Gardens, Merseyside, and the remainder (c. 200 plants) is at present in cultivation in my garden in North Yorkshire.

At the time this manuscript was prepared some of the hybrid binomials used below had not been used in recent British publications. These unfamiliar names are taken from *Flora Nordica* (Elven & Karlsson 2000), with the more familiar name placed in parentheses.

RESULTS

FIELD RECORDS OF *SALIX* HYBRIDS

The field records made during this survey and a few earlier records from the areas surveyed are listed below. The sites concerned are indicated by the letter-codes given in Table 1. Except where stated otherwise, especially references to old herbarium specimens, the records are field-records made by me and the identities of specimens were confirmed or initially determined by R. D. Meikle, although in some cases after re-assessment following new evidence. The probable status of individual records is given where known, but this is sometimes uncertain due to lack of published information. More precise details of individual records have been sent to the Biological Records Centre, CEH Monks Wood, and herbarium material has been placed in **E** with the remaining specimens now in **herb. DJT** (later to be placed in **BM**). Unconfirmed or doubtful identifications have been placed in square brackets. The seven combinations asterisked are new to or restored to the British list, and are described in the next section.

Salix caprea × *S. cinerea* = *S.* × *reichardtii* A. Kern. GCF, 1995.

S. caprea × *S. aurita* = *S.* × *capreola* Jos. Kern. ex Andersson. CR, 1997.

S. caprea × *S. myrsinifolia* = *S.* × *latifolia* J. Forbes. GCF, 1996. Not listed in Flora Nordica but a recent gathering in Norway is probably this (H. Väre, pers. comm.).

**S. caprea* × *S. myrsinifolia* × *S. phylicifolia*. CR, 1997, 1st. confirmed British record, 2000; GCF, 1996 (probable). Endemic.

[*S. caprea* × *S. myrsinifolia* × *S. myrsinites*. GCF, 1996 (possibly, but more likely the previous cross and this hybrid combination is therefore rejected)].

S. caprea × *S. phylicifolia*. IDH, 2000 (probable).

S. caprea × *S. repens* = *S.* × *laschiana* Zahn. GS, 1997; CK, 1995; IDH, 2000.

S. caprea × *S. lapponum* = *S.* × *canescens* Willd. (*S* × *laestadiana* Hartm.). GS, 1994, 1997, previous v.c. 89 record 1906 (**E**); GCE, 1981, GCF, 1996, previous v.c. 90 record 1904 (**E**); CK, 1995 (probable).

S. cinerea × *S. aurita* = *S.* × *multinervis* Döll. IDH, 2000.

S. aurita × *S. myrsinifolia* = *S.* × *coriacea* J. Forbes. GS, 1997; GCF, 1996, 1998.

S. aurita × *S. myrsinifolia* × *S. phylicifolia* = *S.* × *saxetana* F. B. White. GS, 1997; GCF, 1996, 1998; CK, 1996. Not reported from Scandinavia.

[*S. aurita* × *S. myrsinifolia* × *S. myrsinites*. GCF, 1996, initially thought to be this cross, but following cultivation later determined as *S.* × *saxetana*].

S. aurita × *S. phylicifolia* = *S.* × *ludificans* F. B. White. ANG, 1994.

S. aurita × *S. repens* = *S.* × *ambigua* Ehrh. CR, 1997; MG, 2000; GS, 1994; GCF, 1996; CK, 1996.

[*S. aurita* × *S. repens* × *S. lapponum*. A few plants collected locally in GS, 1994 and in CK, 1995 and 1996 appeared to be this cross. They were initially determined as *S. repens* × *S. lapponum* but also resembled *S. aurita* × *S. lapponum*, which occurred nearby in both localities. E. F. Linton also considered a specimen collected in CK by E. S. Marshall (No. 2958, **CGE**) was this cross, but did not include it in his *Monograph* (1913). However, these plants could not be determined with complete certainty and, although this cross is reported from Norway, the records must remain tentative].

S. aurita × *S. repens* × *S. herbacea* = *S.* × *grahamii* Borrer ex Baker. Originally found in v.cc. 108 and H35, but not found in the areas surveyed.

S. aurita × *S. lapponum* = *S.* × *obtusifolia* Willd. CR, 1997; MG, 2000, probable 1st. recent v.c. 88 records; GS, 1994, 1997, previous v.c. 89 record 1906 (**CGE**); GCB, GCD, GCF, GCS, 1995–2002, 2nd v.c. 90 record, 1st post 1930 record (**E**); CK, 1995, 1996.

**S. aurita* × *S. lapponum* × *S. herbacea*. GCS, 1998 (3 plants); CK, 1996 (2 plants). These were found to match artificially-produced hybrids of the same cross between *S.* × *obtusifolia* and *S. herbacea*. 1st British record. Endemic.

S. aurita × *S. herbacea* = *S.* × *margarita* F. B. White. GS, 1997 in two widely separated localities, previous v.c. 89 record 1892 (**CGE**); CK, 1996, single plant, 1st v.c. 92 record.

S. myrsinifolia × *S. phylicifolia* = *S.* × *tetrapla* Walker. CR, MG, MNS, 1991–2002; GS, 1994; GCD, GCF, GCS, 1995–2002; CK, 1995–1996.

**S. myrsinifolia* × *S. phylicifolia* × *S. repens*. GS, 1997, two plants, 1st. British record. (However, *S. phylicifolia* × *S. repens* (below) reported from v.c. 90 in 1959 (Meikle 1975) might refer to this cross). Endemic.

[*S. myrsinifolia* × *S. phylicifolia* × *S. lapponum*. A specimen was obtained from CK, 1996, but the determination is not certain. Very similar plants were collected from CGD and MG in 2002].

[*S. myrsinifolia* × *S. phylicifolia* × *S. arbuscula*. Some specimens determined as *S. myrsinifolia* × *S. arbuscula* from CR and MG, 2000, 2002, might represent this cross as these two hybrids are extremely difficult to separate, but none of these specimens has been definitely confirmed as this hybrid].

S. myrsinifolia × *S. phylicifolia* × *S. myrsinites* = *S.* × *blyttiana* Andersson. MG, 1994, 2000, previous v.c. 88 record 1918 (**E**); GCF, 1996; GCS, 1995, previous v.c. 90 records 1918 (**E**) and 1955 (**K**).

S. myrsinifolia × *S. repens* = *S.* × *felina* Buser ex E.G. & A. Camus. GS, 1997. Two separate gatherings were determined as this cross and on this basis it is included in the records; however, it is very difficult to distinguish from *S. myrsinifolia* × *S. phylicifolia* × *S. repens* above. A specimen collected in 1898 (**E**) is labelled as the former but has not been recently confirmed, so the recent determinations probably represent the 1st confirmed v.c. records.

S. myrsinifolia* × *S. lapponum* (= *S.* × *dalecarlica* auct., non Rouy). No. LGR 1/59, D. J. Tennant, 1959 (E**), determined recently by R. D. Meikle. Single gathering, 1st. confirmed British record. Endemic?

**S. myrsinifolia* × *S. arbuscula* (= *S.* × *breadalbensis* Druce, nom. nud.). CR, 2000 (possibly); MG, 1998, 2002, previous v.c. 88 record 1896 (Linton 1913), but all old records were doubted by Meikle (1975), so this possibly represents the 1st confirmed British record. Endemic?

S. myrsinifolia × *S. myrsinites* = *S.* × *punctata* Wahlenb. MG, 1992, 2000; GCF, GCS, 1995–2002 (frequent); CK, 1995, 1996 (locally frequent).

[*S. myrsinifolia* × *S. myrsinites* × *S. herbacea*. Specimens collected in GCS, 1998, were initially thought to represent this cross. However, following cultivation they have been found to match *S. aurita* × *S. lapponum* × *S. herbacea* (above), and although this hybrid is likely to exist in Scotland it has now been removed from the list].

[*S. myrsinifolia* × *S. herbacea* = *S.* × *semireticulata* F. B. White. Recorded in v.c. 90 in the late 19th century but in my opinion none of the specimens is convincing and none of the specimens collected during this survey was determined as this cross, so there is now no strong evidence for its existence in Britain].

S. phylicifolia × *S. repens* (= *S.* × *schraderiana* auct., non Willd). Occurs in Orkney, v.c. 111, but was not found in the areas surveyed. A record from v.c. 90 (**K**) in 1959 (Meikle 1975) might alternatively refer to *S. myrsinifolia* × *S. phylicifolia* × *S. repens* (above).

S. repens × *S. lapponum* (= *S.* × *pithoensis* Rouy, nom. nud.). GS, 1996, 1997. Previous British confirmed record GS, 1906 (**E, CGE**).

**S. repens* × *S. arbuscula*. MG, 1994. 2 plants, 1st confirmed British record. Endemic. A report of this hybrid by Meikle (1978) in v.c. 88 can be discounted as the specimen was doubtful (R. D. Meikle pers. comm.).

[*S. repens* × *S. lapponum* × *S. arbuscula*. A single specimen gathered with *S. repens* × *S. arbuscula*, MG, 1994, D. J. Tennant, appears to be this cross, but has still not been confirmed].

S. repens × *S. herbacea* = *S.* × *cernua* E. F. Linton. GS, 1994,1997, in two widely separated localities, previous v.c. 89 record 1906 (**E**); AT, 1986.

S. lapponum* × *S. lanata* (= *S.* × *stuartii* hort.). GCS, 1995, 1998, previous v.c. 90 record 1918 (E**), [GCF, 1977 (Ingram & Noltie 1981), specimen not traced]; CK, 1996, previous correctly named v.c. 92 record 1897 (**BM**, **CGE**), but an earlier specimen collected in CK by K.R. Wallis in 1884 (**BM**) is possibly also this cross. Not reported from Scandinavia.

S. lapponum × *S. arbuscula* = *S.* × *pseudoglauca* Andersson (*S.* × *pseudospuria* Rouy, nom. nud.). CR, MG, MNS, 1992–2002, locally frequent, previous v.c. 88 record 1933 (**E**); GCS, 2000, 1st recent v.c. 90 record. There are old records for Angus, v.c. 90 (Ingram & Noltie 1981).

[*S. lapponum* × *S. myrsinites* × *S. herbacea*. Two specimens collected in GCS, 1998 and two in CK, 1996, were initially determined as this cross, but following cultivation are now thought to be *S. aurita* × *S. lapponum* × *S. herbacea*. A further specimen collected in GCS, 1998, could represent this cross but might alternatively be a form of *S. lapponum* × *S. herbacea*, which is also the identity of all specimens that were named *S.* × *eugenes* E. F. & W. R. Linton (Linton 1913). This hybrid therefore remains unconfirmed].

S. lapponum × *S. herbacea* = *S.* × *sobrina* F. B. White. CR, 2000, MG, 2002, MNS, 1998, previous v.c. 88 record 1900 (**BM**); GS, 1994, single plant, previous v.c. 89 record 1906 (**E**, **CGE**); GCS, 1995, 1998, previous v.c. 90 record 1918 (**E**); CK, 1996, 2 plants, previous v.c. 92 record 1906 (**E**).

S. × *boydii* E. F. Linton. This hybrid has not been rediscovered since its original collection in GCF over 100 years ago, and is presumed extinct there; it is not known elsewhere. Its parentage, which is discussed later in this paper, is not known with certainty, but it is included here as *S. lapponum* and *S. herbacea* both appear to be involved. Endemic.

S. lanata hybrid. MNS, 1994, single plant. This appears to be a hybrid between *S. lanata* and a lowland species, which was initially thought to be *S. myrsinifolia*. However, a chromosome count on the hybrid suggested that *S. myrsinifolia* could not be involved. See below under chromosome numbers, where it is suggested that either *S. repens* or *S. aurita* might be the other parent. There are no confirmed records of such a cross in Britain, although Linton (1913) produced a hybrid between *S. repens* and *S. lanata* in cultivation.

S. lanata × *S. herbacea* = *S.* × *sadleri* Syme. MNS, 1994, previous v.c. 88 record ?1894 (**BM**) but a 1961 **BM** specimen from v.c. 88 could be correctly named; GCS, 1995–2002, previous definite v.c. 90 record 1918 (**E**), although reported from GCS in 1975 (Ingram & Noltie 1981); CK, 1996 (topotype), previous definite v.c. 92 record 1892 (**BM**, **LIV**). CK specimens collected in 1934 (**E**) could be correctly named but might alternatively be small or juvenile *S. lanata*.

[*S. lanata* × *S. myrsinites* × *S. herbacea*. A single plant collected in GCS, 1998, was determined as this cross. E. F. Linton also suggested that a specimen collected by W. R. Linton in the same locality in 1894 (**LIV**, no. 329) involved both *S. lanata* and *S. myrsinites*, but did not publish the record in his *Monograph* (Linton 1913). Linton's specimen is very similar to my 1998 plant and there is good evidence that *S. herbacea* is also one parent of the **LIV** specimen. However, both of these hybrids might alternatively be unusual forms of *S.* × *sadleri* and therefore this cross should remain as unconfirmed until further evidence becomes available].

S. arbuscula × *S. herbacea* = *S.* × *simulatrix* F.B. White. MNS, 1991, 1998, previous v.c. 88 records 1932 (**BM**) and 1959 (*Proc. B.S.B.I.* **5**: 34 (1963)).

S. arbuscula × *S. reticulata* = *S.* × *ganderi* Huter ex Zahn. MG, 2001, single plants from two widely separated localities, previous v.c. 88 record 1938 (**E**). A single plant collected at CR in 2002 is probably the same cross. A report of this hybrid in v.c. 88 by Meikle (1978) can be discounted (R.D. Meikle pers. comm.). The 1938 specimen represents the only confirmed British herbarium specimen that has been traced; the 2001 gatherings therefore represent the 2nd confirmed British record.

S. myrsinites × *S. herbacea*. MNS, 1998, previous v.c. 88 record 1922 (**BM**); GCS, 1998–2002, previous correctly named v.c. 90 record 1888 (**CGE**); CK, 1995, 1996, previous v.c. 92 record 1878 (**E**).

DESCRIPTIONS OF NEW *SALIX* HYBRIDS

Four of the *Salix* hybrids included in the list of field records given above, i.e. excluding the incompletely determined hybrid of *S. lanata*, are combinations new to Britain which have been

proposed during the course of this study. These are *S. caprea* × *S. myrsinifolia* × *S. phylicifolia*, *S. aurita* × *S. lapponum* × *S. herbacea*, *S. myrsinifolia* × *S. phylicifolia* × *S. repens*, and *S. repens* × *S. arbuscula*. A further hybrid reported previously in Britain, but apparently then in error, is included in the present list and is therefore also new to Britain: this is *S. myrsinifolia* × *S. lapponum*. In addition, two hybrids previously recorded in Britain but later rejected, due to either lack of satisfactory evidence or subsequent erroneous re-determination, have been restored to the present list; these are *S. myrsinifolia* × *S. arbuscula*, and *S. lapponum* × *S. lanata*. One other hybrid, *S. arbuscula* × *S. reticulata*, found during my field studies, had not previously been described from British material, and another, *S. myrsinites* × *S. herbacea*, had been inaccurately described. The above nine 'new' hybrids are described below. Descriptions of most British *Salix* hybrids can be found in Linton (1913) and Meikle (1975, 1984).

SALIX CAPREA *L.* × ***S. MYRSINIFOLIA*** *SALISB.* × ***S. PHYLICIFOLIA*** *L.*

An earlier description of this hybrid was recently published (Tennant 2001), following its discovery, but an extended description is given here.

Vouchers: Near Creag Roro, Glen Lyon, Mid Perth, v.c. 88, GR NN64, D.J. Tennant Nos. CR9/00 (male), 7 July 2000 (**E**); CR 8/01 (female), 25 July 2001 (**E**).

Ascending bush up to c. 3 m high; twigs at first pubescent, becoming dark reddish-brown, glossy and glabrous; buds large, 5–6 × 2–3 mm, narrowly ovoid, blunt, at first pubescent, yellowish; leaves obovate to broadly obovate or subrotund, the larger when mature typically 50 mm long and 35 mm wide, the smaller acute, acuminate, the larger obtuse, mucronate to broadly rounded-obtuse and cuspidate at apex, with narrowly recurved margins, shallowly serrate to remotely serrulate, the smaller narrowly rounded, the larger broadly rounded at base, all coriaceous, dark bright green and glossy on upper surface and rather thinly pubescent with the hairs usually confined to the midrib and near to the apex, or subglabrous, pale green, glaucous and glabrous on lower surface with prominent venation; petioles rather short, 5–15 mm long, mainly moderately pubescent, eventually becoming thinly pubescent; stipules absent or up to 3·5 × 1·5 mm, narrowly ear-shaped, acute, denticulate at margin. Catkins appearing with leaves, broadly cylindrical to cylindrical, usually terminal on lateral shoots; peduncles 4–5 × 1·5 mm, with scattered to dense, medium to rather long, somewhat appressed hairs; catkin-scales 2·5–3 × 0·75–0·9 mm, oblanceolate to narrowly obovate, narrowly obtuse at apex, pale green with upper part usually brown, with numerous hairs on surface projecting by 1·0–2 mm beyond apex. Male catkins c. 18 × 15 mm, with two free stamens; filaments 5·5–7·5 mm, glabrous, pale greenish-white; anthers 0·9 × 0·8 mm, yellow; nectary single, oblong, green. Female catkins c. 35 × 10 mm; ovary flask-shaped, c. 3 × 1 mm, green, moderately pubescent; pedicel c. 2 mm long, shortly pubescent; style c. 5 mm long, pale olive-green; stigmas 0·5–0·7 mm long, fused but deeply notched; nectary single, 0·8 × 0·3 mm, linear-oblong, truncate at apex, greenish. Capsule c. 5 × 1·5 mm, with scattered pubescent hairs. Endemic.

SALIX AURITA L. × ***S. LAPPONUM*** L. × ***S. HERBACEA*** L.

Vouchers: Coire Kander in Glen Callater, South Aberdeen, v.c. 92, GR NO18, 28 July 1996, D.J. Tennant No. CK 18B/96 (**E**); Corrie Sharroch in Glen Clova, Angus, v.c. 90, GR N027, 14 July 1998, DJT Nos. GCS 13/98, GCS 18/98 (**E**).

Ascending or semi-procumbent dwarf shrub, usually less than 30 cm high; twigs at first glossy olive-green or brownish-yellow, thinly lanuginose or with scattered, fine, short pubescent hairs, becoming glossy, reddish-brown and glabrous; buds 2–3·5 × 0·9–1·2 mm, narrowly ovoid, more or less acute at apex, olive-green or yellowish and pubescent at first, becoming glossy, reddish-brown and glabrous; leaves typically 15–23(–33) × 10–13(–18) mm at maturity, broadly elliptic, ovate, oblong-ovate or obovate, often shallowly channelled, broadly acute, subacute or rounded and often twisted at apex, sometimes broadly twisted at margins, slightly recurved, crenulate-denticulate to markedly crenate-serrate with red-tipped teeth, mainly more or less rounded, rounded-subtruncate or subcordate and often irregular at base, at first moderately to densely clothed with short, fine, more or less appressed pubescent hairs, especially towards margins on upper surface, becoming subglabrous, bright or olive-grey-green, glossy and often rugose with impressed veins, slightly paler green, matt and at first shortly villose below with more or less appressed hairs projecting beyond margins and apex, or with shorter fine pubescent hairs, later becoming rather glossy and

subglabrous, but with appressed, fine hairs persisting on the conspicuous, markedly raised reticulate veins; petioles short, 0·5–5(–9) mm long, moderately pubescent; stipules absent or occasional and of two types, linear-lanceolate, truncate at apex, entire, 1·5–4 × 0·5–0·8 mm, or minute and sometimes with three rounded lobes. Catkins appearing with leaves, mainly terminal on lateral shoots; peduncles 2·5–10 × 0·7–1 mm, moderately to densely pubescent or with rather long, appressed, silky hairs; catkin-scales 2–3 × 0·7–1 mm, ovate to rather narrowly spathulate, rounded-obtuse or occasionally acute at apex, pale yellow-green, pale reddish-brown or crimson at apex, with numerous to dense hairs usually confined to upper half or only at apex and projecting by 0·4–1·0 mm or more beyond apex. Male catkins c. 10 × 5–7 mm, with two free stamens; filaments 4–5 mm, glabrous, very pale greenish-white; anthers 0·5–0·65 mm long, deep yellow, often suffused with red; nectary single, linear-oblong, occasionally linear-spathulate, 0·8–1·5 × 0·2–0·4 mm, olive-green. Female catkins 7·5–10 × 4–5 mm, slightly lax with few (c. 8–14) forwardly-directed fruits; ovary flask-shaped, 1·5–2 × 0·6–0·7 mm, olive-green or purplish towards apex, glabrous or with few to numerous short, sometimes very fine, appressed hairs or extremely short hair-like projections towards apex; pedicel 0·25–0·35 mm long, glabrous; style 0·7–1 mm long, pale olive-green; stigmas 0·4–0·8 mm long, largely fused or notched, pale olive-green; nectary single, linear-oblong, apex truncate, 0·7–1 mm long, bright olive-green. Capsules not adequately observed, but pedicel finally extending up to 1·0 mm.

The above description is based on the specimens that were collected in Glen Clova and Glen Callater and hybrids of this cross produced in cultivation by design. The collected specimens had previously defied identification, but the artificially produced crosses were found to match these very closely indeed. This cross was produced readily in cultivation using *S.* × *obtusifolia* and *S. herbacea* as parents and, as both of these were frequent in the two places where the collected specimens were found, it is likely that this is how they arose there. This hybrid has not been recorded previously in Europe. All of these hybrids approach *S.* × *sobrina* (*S. lapponum* × *S. herbacea*) in general appearance, but the presence of some largish stipules and eventually an extended pedicel in some of the collected specimens provides additional evidence that a further parent species, i.e. *S. aurita*, was involved. Endemic.

SALIX MYRSINIFOLIA SALISB. × ***S. PHYLICIFOLIA*** L. × ***S. REPENS*** L.

Vouchers: Near the Spittal of Glenshee, East Perth, v.c. 89, GR NO07, 5 August 1997, D. J. Tennant Nos. GSB 2H/97 & GSB 12/97 (**E**).

Decumbent or semi-decumbent shrub, usually less than 20 cm high, with long spreading branches; twigs slender, at first olive-green or olive-brown and thinly to moderately pubescent, often becoming red and finally purplish-brown and glabrous; buds c. 2 × 1 mm, ellipsoid, blunt or subacute, usually yellow at first and thinly pubescent, soon becoming dark reddish-brown and glabrous; leaves typically 20–30 × 5–15 mm at maturity, elliptic to narrowly obovate, more or less obtuse and often shortly acuminate at apex, revolute at margins, undulate, denticulate or with regular or irregular, often curved, sharply acute, serrate or serrate-dentate teeth, at least towards the base, the teeth and margins reddish-stained, narrowly rounded to cuneate at base, at first with long, appressed, sericeous hairs on both surfaces, projecting beyond the margins and the apex, soon becoming more or less glabrous, glossy and medium to deepish green above, or occasionally purplish towards the apex, paler, almost subglaucous-green below with rather prominent, raised veins and scattered to dense, straight, fine, appressed, sericeous hairs, eventually becoming subglabrous, but hairs usually persisting at least on midrib; petioles very short and slender, 1–5 mm long, sometimes reddish-coloured, thinly pubescent; stipules not found. Catkins appearing slightly before leaves, numerous, in the majority of leaf-axils; peduncles short 3–5(–10) × 1 mm, with rather appressed hairs; catkin-scales 2·5–3·5 × 0·7–0·8 mm, narrowly spathulate to spathulate or obovate, rounded or subacute at apex, largely enclosing ovaries initially, wholly pale green or largely pale brown with moderate to numerous, longish, slightly coarse hairs projecting by 0·4–0·8 mm beyond apex. Male catkins not found. Female catkins 9–18 × 4–8·5 mm, with forwardly-directed fruits; ovary flask-shaped, 2·0–2·5 × 0·7–0·85 mm, green and moderately pubescent, with pubescent pedicel, 0·4–0·85 mm long; style 0·2–0·6 mm long, very shortly bifid, olive-green; stigmas 0·35–0·55 mm long, deeply divided, olive-yellow; nectary single, more or less linear to obspathulate, 0·5–0·9 × 0·2–0·5 mm, dark olive-green. Capsules up to 3·5 × 1·5 mm, eventually becoming subglabrous.

Other material collected in the same area, GSB 9/96 and GSB 10/96, with less densely sericeous, sometimes subentire, slightly larger leaves with more prominent raised veins beneath are possibly also this hybrid but have been excluded from the description given above as their identity is less certain. This appears to be the first confirmed European record of this cross and simple hybrids between either *S. myrsinifolia* or *S. phylicifolia* and *S. repens* also appear to be rare in Britain. The hybrid most probably arose as a cross between *S.* × *tetrapla* and *S. repens*, which are both abundant in the locality. Endemic.

SALIX MYRSINIFOLIA SALISB. × ***S. LAPPONUM*** L.

Voucher: Lochnagar, near Ballater, South Aberdeen, v.c. 92, GR NO28, mid August 1959, D. J. Tennant No. LGR 1/59 (**E**).

Ascending bush, less than 1 m high; twigs at first with dense, white hairs, later becoming thinly pubescent; buds narrowly ovoid, c. 3 × 1·5 mm, blunt at apex, at first densely white-pubescent; leaves up to 55 × 20 mm, rather narrowly elliptic, acuminate at apex, the margins slightly undulate, the younger leaves with very numerous, regular, obtuse, serrate teeth, the larger becoming denticulate, narrowed or very narrowly rounded at base, at first tomentose above, later becoming moderately clothed with longish hairs, greyish-white in appearance, persistently greyish-white tomentose below with numerous, longer, sericeous hairs on the prominent, raised veins; petioles rather short, up to 10 mm long, densely pubescent; stipules 2·5–4·0 × 1·0–2·5 mm, broadly ear-shaped, acute, serrate-dentate, broadly rounded at base, pubescent. Catkins not collected.

The above description is incomplete as it is based solely on the Lochnagar specimen collected in 1959, which is now the only certainly confirmed British example, and other recently collected material queried as this cross remains doubtful. Linton (1913) did not include this hybrid in his list and none of the herbarium specimens collected earlier in Britain tentatively suggested to be this cross is now accepted to be correctly named; there are no confirmed reports of it from elsewhere in Europe. The plant described strongly resembles *S. lapponum*, but is distinguished from it by the presence of numerous, regular, very distinct teeth on the margins of the leaves, which also have prominent, raised veins beneath and darken somewhat when dried, and by the presence of large, ear-shaped, dentate stipules which blacken on drying. It is distinguished from *S. myrsinifolia* mainly by the shape, colour and indumentum of the leaves. Endemic.

SALIX MYRSINIFOLIA SALISB. × ***S. ARBUSCULA*** L.

Although two recent gatherings made during the field-work were determined positively as this cross by R. D. Meikle, no description has been prepared as several other gatherings thought to represent this hybrid were not determined with certainty. Consequently, the range of variation of this hybrid is at present not fully known and further evidence of identity of the remaining material is required before a meaningful description can be prepared. Endemic.

SALIX REPENS L. × ***S. ARBUSCULA*** L.

Vouchers: Meall Ghaordie in Glen Lyon, Mid Perth, v.c. 88, GR NN54, 1 September 1994, D. J. Tennant Nos. MG 2C/94 & MG 8/94 (**E**).

Ascending dwarf bush, less than 30 cm high; twigs at first pinkish-purple and pubescent, soon becoming yellowish-green, glossy and more or less glabrous; buds c. 2 × 1 mm, ovoid, subacute at apex, initially pubescent, later becoming glabrous, glossy and reddish-brown; leaves 6–17(–25) × 3–7(–10) mm, rather narrowly elliptic, broadly acute and often mucronate, or obtuse at apex, serrate-dentate with numerous, small, regular, gland-tipped teeth on margins, cuneate or narrowly rounded at base, medium to deepish green and rather glossy above, at first with scattered to numerous, very short, fine, appressed hairs, finally becoming more or less glabrous, with dense, appressed, shortish, straight, silvery, sericeous hairs and rather obscure venation below; petioles slender and very short, usually 1–5 mm long, moderately and shortly lanuginose to subglabrous; stipules minute or absent. Catkins lateral, appearing with or slightly before leaves; peduncles 3–10 × 1·5 mm, moderately to densely pubescent; catkin-scales 1·7–2·5 × 0·75–0·9 mm, spathulate to narrowly obovate, rounded-obtuse or occasionally emarginate at apex, very pale yellowish-green with brown apex, densely villose with the hairs projecting by up to 1 mm beyond apex. Male catkins not found. Female catkins 12–18 × 5–6·5 mm; ovaries patent, 1·5–2 × 0·75–0·8 mm, ovoid, acute, whitish-green, rather densely clothed with semi-patent hairs; pedicel very short, 0·1–0·5 mm

long; style 0·4–0·8 mm long, olive-yellow; stigmas 0·4(–0·6) mm long, narrow, mainly fused, olive-yellow; nectary single, 0·7–1 mm long, narrowly oblong or furcate, olive-yellow. Capsule c. 2·5 mm long, pubescent.

The described specimens are similar to *S. repens* in the size and shape of the leaves and in their indumentum, but form a generally more upright bush and the teeth on the leaf-margins and the ovaries are more characteristic of *S. arbuscula*. This hybrid does not appear to have been reported previously. Endemic.

SALIX LAPPONUM L. × ***S. LANATA*** L.

Voucher: Corrie Sharroch in Glen Clova, Angus, v.c. 90, GR NO27, 14 July 1998, D.J. Tennant No. GCS 16/98 (**E**).

Ascending bush, usually less than 60 cm high; twigs thick, olive-green, finally becoming purplish-brown, glossy and glabrous; buds 4–6 × 1·5– 2·5 mm, narrowly ovoid, subacute, pubescent, soon becoming glabrous, yellow to reddish-brown; leaves 30–60 × 14–38 mm (or wider in cultivation), rather narrowly elliptic to obovate, acute or acuminate at apex, entire at margins but sometimes undulate with a crenate appearance, narrowly cuneate to rounded at base, at first densely, long, semi-appressed villose above with hairs projecting well beyond margins and apex, later becoming tomentose and sometimes finally glossy, greyish-green and pubescent with scattered to numerous, fine, rather appressed hairs, tomentose below or often villose on veins, finally becoming pale, dull, subglaucous-green with prominent, raised, reticulate veins and thinly to moderately, appressed-pubescent; petioles 3–l0 mm long, with dense, longish, wavy hairs; stipules very small, or foliaceous, broadly lanceolate, 10–15 × 5–6 mm, sharply acute, entire, with dense, long, villose hairs. Catkins appearing just before leaves, usually terminal on lateral shoots, initially sub-sessile, later with densely villose or lanuginose peduncles up to 12 mm long; catkin-scales 2·5–4·0 × 1·5 mm, more or less obovate, subacute at apex, dark brown, clothed with dense, long villose hairs projecting well beyond apex. Male catkins not found. Female catkins usually very large, 40–90 × 17–21 mm, cylindrical, dense; ovary narrowly flask-shaped, c. 3·5 × 1·0 mm, green, with many short, wavy hairs sometimes confined to near base and apex; pedicel short, glabrous; style long, up to 2·0(–2·5) mm, simple or only shortly furcate, pale green; stigmas 0·4–0·65 mm long, mostly fused, pale green; nectary single, narrowly oblong, c. 0·8 × 0·4 mm, truncate at apex, yellowish-green. Capsules 5–7 × 1·4–1·6 mm, with scattered hairs or subglabrous; pedicel extending up to c. 1 mm.

The plants described have foliage which is similar in shape to that of either parent. They differ from *S. lanata* mainly in their usually olive-green twigs with rather narrower, less obtuse buds and sometimes narrowly elliptical leaves, their sometimes lacking stipules, and their often exceptionally long catkins with hairy ovaries and capsules. They are distinguished from *S. lapponum*, when the leaves are similar in shape, by the longer villose hairs on the younger leaves, by the mature leaves often eventually becoming much less hairy, with prominent, reticulate veins below, by the frequent presence of obvious stipules, and by the wider and often longer female catkins with much less hairy ovaries and capsules. Linton (1913) described this hybrid from foliage specimens only, which he had collected in South Aberdeen, v.c. 92, but these specimens were later rejected as this cross and the hybrid was excluded from British lists (Meikle 1975). However, both Linton's specimens and his description match the confirmed specimen described above very well and therefore it is probable that Linton's v.c. 92 specimens were correctly named, as had been suggested by B. Floderus in 1932 on the herbarium sheet in **BM**. Endemic?

SALIX ARBUSCULA L. × ***S. RETICULATA*** L. = ***S.*** × ***GANDERI HUTER EX ZAHN***

Vouchers: Meall Ghaordie in Glen Lyon, Mid Perth, v.c. 88, 1938, W.A. Sledge (**E**); GR NN54, 26 July 2001, D.J. Tennant No. MG 5/01 (**E**); Creag Roro in Glen Lyon, Mid Perth, v.c. 88, GR NN64, July 2002, DJT No. CR 3/02 (**E**).

Dwarf, decumbent shrub forming a loose mat, less than 10 cm high; twigs rather slender and trailing, at first deep olive-green, later becoming very dark reddish-purple-brown, glossy and glabrous; buds 3·5–4·5 × 1·5 mm, more or less shortly cylindrical with a blunt apex, initially deep olive-green, glabrous or with scattered pubescent hairs, later becoming reddish-brown, glossy and glabrous; leaves 5–20 × 2·5–17 mm, mainly ovate and elliptic with the remainder obovate, or sometimes subrotund, usually subacute and sometimes broadly twisted, or broadly rounded and

sometimes slightly retuse at apex, occasionally undulate, slightly revolute, with several to numerous, distinct, very small, often red-tipped, serrate, serrate-dentate or denticulate teeth at margins, broadly cuneate or rounded at base, bright medium to deepish, glossy green and rugose, with markedly sunken veins on the upper surface, at first with many, long, rather appressed hairs but soon becoming glabrous, underside pale, glaucous-green with very conspicuous, raised, dark green or greenish-brown, strongly reticulate veins, with midrib sometimes reddish towards base, at first with numerous, often long, rather appressed hairs, but soon becoming glabrous; petioles short, 10–13 mm long, slender, green or reddish-brown, villose at first, soon becoming glabrous; stipules absent. Catkins not found.

The known British examples are all similar and closer to *S. reticulata*, but differ mainly in their usually smaller, often more ovate, occasionally much narrower, more acute and some distinctly dentate leaves, which generally have shorter petioles.

***SALIX MYRSINITES* L. × *S. HERBACEA* L.**

Vouchers: Coire Kander, Glen Callater, South Aberdeen, v.c. 92, GR NO18, 28 July 1996, D.J. Tennant Nos. CK7C/96 & CK7D/96 (**E**); Corrie Sharroch, Glen Clova, Angus, v.c. 90, GR NO27, 14 July 1998, DJT Nos. GCS 8/98 & GCS 10/98 (**E**); Meall na Samhna, Glen Lochay, Mid Perth, v.c. 88, GR NN43, 16 July 1998, DJT No. MNS 5/98 (**E**).

Dwarf, semi-decumbent shrub, usually less than 10 cm high; twigs rather slender, at first olive-green, pubescent, soon becoming glabrous, very glossy and purplish-brown; buds 2–2·5 × 1 mm, rounded or narrowly obtuse at apex, at first thinly pubescent, soon becoming glabrous and glossy, reddish-brown; leaves 6–25(–37 cult.) × 4–16(–25) mm, ovate, obovate, broadly elliptic or seldom subrotund, subacute to broadly rounded, occasionally retuse or emarginate, sometimes twisted downwards at apex, often undulate with crenate-serrate, often red-tipped teeth, or occasionally with aquiline teeth at margins, narrowed, narrowly subtruncate, more or less rounded, or seldom cordate, and often channelled and irregular at base, very glossy, bright medium green above and below, glabrous above, at first with several, long, semi-appressed hairs below, especially on midvein, margins and apex, but soon becoming glabrous with very conspicuous raised reticulate veins; petioles short and slender, up to 10 mm long, at first pubescent, soon becoming glabrous; stipules absent, or oblanceolate, denticulate and up to 3 mm long. Catkins terminal, appearing with leaves; peduncles moderately to densely lanuginose-pubescent, 2·5–6 mm long; catkin-scales 1·5–3(–4·5) × 0·7–1 mm, linear-oblanceolate to narrowly obovate, convex and fully enclosing the ovary at anthesis, obtuse or notched at apex, silvery-white to pale olive-yellow, concolorous, or suffused with red, or red at apex, usually glabrous on both surfaces with numerous wavy hairs 0·4–1·2 mm long on the apex. Male catkins not found. Female catkins 6·5–10 × 2–4 mm, with few, forwardly-directed fruits; ovary 1–2 × 0·6–0·9 mm, narrowly ovoid or flask-shaped, pale green to amber-brown, often suffused with red or purple towards apex, faintly glossy, glabrous or with scattered, very short hairs; pedicel usually very short, 0·1–0·25 (–0·6) mm long; style 0·2–0·8 mm long, pale olive-green or purplish; stigmas 0·35–0·7 mm long, deeply divided, filiform, curled when long, olive-yellow to deep yellow; nectary 0·3–1·5 × 0·2–0·5 mm, linear-oblong, single or double, occasionally obcordate, deep yellow, sometimes tinged with reddish-brown. Capsule up to 5 × 2 mm, glabrous or with extremely short, hair-like projections, the pedicel extending up to 0·8 mm.

This is a variable hybrid, vegetatively usually either more or less intermediate between the parents or closer to *S. herbacea*. The catkins found are very small and in most respects much closer to those of *S. herbacea*. However, this hybrid is sometimes not readily distinguished from *S.* × *simulatrix* (*S. arbuscula* × *S. herbacea*) and specimens which are in doubt in this respect, having longer catkins and more hairy ovaries with longer pedicels, have been excluded from the description given above. This description is given here because the description published by Linton (1913) for this hybrid incorporated that of *S.* × *grahamii*, which Linton incorrectly referred to this cross.

OTHER BRITISH HYBRIDS

A few other British montane willow hybrids described by Linton (1913) or claimed by other early salicologists were not located during the present survey, either because their location fell outside the areas surveyed, or because they appear to have been originally recorded in error, or are extinct, and some of these deserve mention as follows.

SALIX × *BOYDII* E. F. LINTON

This willow was found in Scotland over 100 years ago and never collected again, but fortunately plants propagated from the type material are widely available in horticulture. Following a re-examination of cultivated plants and much discussion with R. D. Meikle, we now agree that *S.* × *boydii* probably arose as a cross between more than two parents, two of which were *S. lapponum* and *S. herbacea*, the third or further parentage remaining uncertain. We also agree that *S. reticulata* played no part in this hybrid, as originally suggested, but rather the apparent *S. reticulata* characters arose in part from *S. herbacea*. Although the ovaries superficially resemble those of *S. reticulata*, this character could equally have been derived from *S. herbacea*, and the catkins themselves bear no resemblance whatsoever to those of *S. reticulata* but rather to those of *S. lapponum* and *S. lanata*. We thought earlier that *S. aurita* was involved, but more recently that *S. lanata* could have been one parent, yet neither alone as the third parent entirely seems to explain the unique vegetative appearance of *S.* × *boydii*. A further character which *S.* × *boydii* shares with the hybrid *S. lapponum* × *S. lanata* is the distinctive stout, erect, bright olive-green appearance of the twigs arising from the base, which supports the view that *S. lanata* may be involved.

The origin of *S.* × *boydii* also poses some problems because of comments made shortly after its discovery. *Salix* × *boydii* was discovered by William Brack Boyd, and in a letter written by Boyd to E. F. Linton in 1913 (**BM**), he stated that the plant was discovered as a seedling plant in a part of Glen Fee in Clova, v.c. 90 (localised in an annotation by Linton), where *S. lapponum* and *S. reticulata* grew plentifully, which were the parents which Boyd had proposed. However, *S. lapponum* is scarce and *S. reticulata* is now absent at the location described by Linton and, even if the latter had occurred there in Boyd's time, it is doubtful that it was ever plentiful, although it still occurs within 1 km of the supposed site. No fewer than seven of the willow species included in this survey and ten different hybrids are present now at this site where *S.* × *boydii* was discovered. Linton and other salicologists at that time certainly visited the location yet no-one ever refound *S.* × *boydii*, and Boyd stated in his 1913 letter to Linton that he never visited the place again, which, coupled to Boyd's reference to a seedling plant, suggests that he might have dug up the only plant. There is a further discrepancy in the same letter where Boyd implied that the plant was originally collected in 1905 or 1906, whereas a specimen in **BM** is marked by Linton "hort. Faldonside [Boyd's house] 1902, W.B.B." This specimen bears catkins and must therefore have been grown for well over a year by that date to have developed from the seedling, suggesting that it must in fact have been collected by 1900 or earlier. Furthermore, there is another case where Boyd's account of a unique plant which he discovered in Scotland in 1878 is unsatisfactory, namely *Sagina boydii*, which he found in his garden but which he claimed to have had no recollection of collecting (Raven & Walters 1956), and which Raven described as probably the greatest mystery in the annals of British botany. In addition, Boyd produced numerous hybrids in his garden, many of which still exist in horticulture today, and he also received living plants from Switzerland (Raven & Walters 1956). He probably grew other Scottish willows, and perhaps also *S. helvetica* Vill., a then popular European species in cultivation. It is difficult to prevent willow seedlings from straying into adjacent areas, after which growth can be rapid, as Linton (1913) had discovered, and I have had the same experience. Other than the inaccurate statements by Boyd above, there is no evidence to suggest that he did not collect the hybrid where he stated, but the possibility that it arose accidentally in his garden should not be entirely discounted, as the accounts of its discovery are not completely satisfactory.

The absence of *S. reticulata* at Boyd's site tends to support our belief that this species was not involved and, whereas *S. lapponum* still occurs there in small quantity, it is mainly in the form of *S.* × *obtusifolia* Willd., its hybrid with *S. aurita*. A combination of the latter with *S.* × *sadleri* Syme (*S. lanata* × *S. herbacea*), which also occurs in Glen Fee, perhaps might explain the unique characters of *S.* × *boydii*, however remote the chance that this combination arose there. Attempts

have been made by me to recreate *S.* × *boydii* from deliberate crosses of such potential parents, but the resultant seedlings are extremely slow in growth and are still too immature to draw any conclusions. Endemic.

S. × *GRAHAMII* BORRER EX BAKER

R. D. Meikle (1975, 1984) proposed that this hybrid was the triple cross, *S. aurita* × *S. repens* × *S. herbacea*, which in my opinion is almost certainly correct. There is no doubt that two of the parents are *S. repens* and *S. herbacea* but, as Meikle suggests, a third species appears to be involved. I have produced this triple cross by design in cultivation, as described later under 'Hybrid synthesis in cultivation', and the resultant hybrids closely resembled *S.* × *grahamii*, the only obvious differences being the leaves, which were slightly paler beneath.

S. × *grahamii* was first discovered in Scotland, probably in 1827 or 1833 on Foinaven in West Sutherland, v.c. 108. An almost identical hybrid which had been found on Muckish Mountain in West Donegal, v.c. H35, in 1866, was considered to be the same cross by Meikle (1984), but given separate status as variety *moorei* (F. B. White) Meikle; neither has been collected anywhere in Britain or Ireland again. Both varieties were cultivated in botanic gardens and elsewhere in horticulture, but there has been much confusion between the two varieties which has led to doubts concerning their origin and the accuracy of labelling, and this in turn has hindered a comparison of the characters of the two varieties. Variety *moorei* is the most frequently encountered one in horticulture. At the time of writing, although plants that are claimed to represent the Scottish type material have been traced, they have not yet been examined to confirm their identity. The same hybrid possibly occurs in Norway (Elven & Karlsson 2000).

S. HERBACEA × *S. RETICULATA*

There are no recent records from Scotland for this hybrid and none of the old records has been confirmed. The majority of old records undoubtedly referred to *S. lapponum* × *S. herbacea*, and have been redetermined as this cross, especially records from Clova, v.c. 90, and a specimen collected by W. R. Linton on Ben Lawers, v.c. 88, in 1891 (**E**) which was queried as *S. herbacea* × *S. reticulata* on the herbarium sheet by Meikle in 1996 and which is probably the same. On the other hand, E.F. Linton's specimens from MNS, v.c. 88, collected in 1891 (**BM**) and originally thought to be this cross, appear to be *S. lanata* × *S. herbacea*. Linton (1913) cited a specimen collected on MG, v.c. 88, which was determined by S. J. Enander, but this was unsatisfactory as the determination was based solely on a small piece of catkin; Linton claimed the parentage involved *S. myrsinifolia* and not *S. reticulata*. Another specimen determined by Enander, collected in 1896 on Aonach Beg, v.c. 97, by W. A. Shoolbred (**BM**), was later redetermined by B. Floderus as *S. lanata* × *S. herbacea*. Meikle (1975) referred to a specimen collected by D. Patton on Ben Laoigh (Lui), v.c. ?88, a record of which was published in 1924, suggesting this might be correctly named, but I have not traced this specimen. Linton (1913) claimed to have produced this cross in his garden and he distributed specimens; these might have been correctly named, but I know of no surviving living material so cannot confirm them. However, attempts which I have made to produce this cross have so far failed, as the resultant seedlings, assuming that these were the intended cross, died at an early stage after germination. The hybrid could, however, occur in Scotland, as it is reported from Austria and Scandinavia. Linton (1913, p. 85) reported that Enander had stated that the binomial *S.* × *onychiophylla* Andersson, which had been used for this cross, was incorrectly applied, as it had been originally applied to a sheet of specimens containing two different hybrids, neither of which was *S. herbacea* × *S. reticulata*.

Similarly, other old reports of hybrids of *S. reticulata* with *S. lapponum* or with *S. lanata*, other than *S.* × *boydii* as discussed above, also usually refer to either *S. lapponum* × *S. herbacea* or to *S. lanata* × *S. herbacea*.

TREATMENT IN *FLORA NORDICA*

Outside Britain, the montane willow flora which most closely matches that of Scotland occurs in Scandinavia and, fortunately, a recent publication, *Flora Nordica* (Elven & Karlsson 2000), lists the willow hybrids which are at present accepted there. Ten hybrids involving British species and which could occur in Scottish montane habitats but which are so far not recorded or are not

confirmed in Britain are included in the Scandinavian list; nine of these involve montane species, the tenth involves lowland species. Several other hybrids listed involve species which do not occur in Britain. On the other hand, six montane and four lowland hybrids now included in the Scottish list are not given in *Flora Nordica*, and these have been marked above accordingly, or tentatively suggested to be endemic to Scotland.

Flora Nordica also gives several binomials for willow hybrids that are so far unfamiliar in British publications, and those which appear to be valid have been adopted here. However, no attempts have been made to locate the relevant type material, and therefore it has not been established that the new name has in all cases been applied correctly. These unfamiliar binomials which have been used here are *S.* × *canescens* Willd. (*S. caprea* × *S. lapponum*), *S.* × *blyttiana* Andersson (*S. myrsinifolia* × *S. phylicifolia* × *S. myrsinites*) and *S.* × *pseudoglauca* Andersson (*S. lapponum* × *S. arbuscula*). Other binomials used in *Flora Nordica* which appear to be predated by those in current use in British publications have not been adopted here.

HYBRID SYNTHESIS IN CULTIVATION

Attempts to produce hybrids in cultivation have been carried out by me annually for five years, and this has provided useful information about hybrid characters and compatibility between species. However, the period of anthesis was found to be brief and different willow species or hybrids often did not coincide seasonally in this respect, so many of the desired crosses could not be attempted. The majority of species were found to be compatible with each other and the resultant hybrids were usually fertile, but some combinations did appear to be incompatible. As expected, in cultivation the montane willow species were found to produce the earliest catkins, usually in April, *S. lapponum* and its hybrids usually being the first, followed by *S. myrsinites* and *S. herbacea*, then *S. arbuscula* and finally *S. lanata* and *S. reticulata*. Among the lowland species, *S. repens* and its hybrids and pure *S. phylicifolia* were the earliest to flower, although *S. caprea* might have been included here if the cultivated examples had produced catkins.

In these five years 80 separate hybrid crosses were attempted in combinations involving all the montane species. The full results are too extensive to include in this paper, but some of the most interesting results are as follows. Hybrid combinations which were produced without difficulty included *S.* × *obtusifolia* (*S. aurita* × *S. lapponum*) × *S. herbacea*, which was found to match specimens that had been collected earlier in two places in Scotland (see records above) and led to the identification of the latter and the recognition of this cross as a new British hybrid. *Salix* × *grahamii*, which is discussed above, was thought to be *S. aurita* × *S. repens* × *S. herbacea* by Meikle (1984), and successful attempts were made to produce this cross from all three possible combinations, using *S.* × *ambigua* (*S. aurita* × *S. repens*), *S.* × *margarita* (*S. aurita* × *S. herbacea*) and *S.* × *cernua* (*S. repens* × *S. herbacea*); in two cases male and female examples were also used. The resultant hybrids of the cross between *S.* × *ambigua* and *S. herbacea* were close enough to *S.* × *grahamii* to suggest that Meikle's proposed parentage was correct, and this is probably how both it and its variety *moorei* arose, as the other possible parents, *S.* × *margarita* and *S.* × *cernua*, are both rare. *Salix* × *ambigua* also crossed readily with *S.* × *tetrapla* (*S. myrsinifolia* × *S. phylicifolia*), and as both these hybrids are common in Scotland this cross might occur there. Attempts have been made recently to reproduce *S.* × *boydii*, as discussed above, but it is too early to draw any conclusions, although *S.* × *boydii* itself crossed with *S.* × *obtusifolia* with incredible vigour. Another successful and vigorous cross was *S.* × *laschiana* (*S. caprea* × *S. repens*) × *S. lapponum*, suggesting that this combination could occur in Scotland. *Salix* × *obtusifolia* appears to have crossed with *S. myrsinites*, but only very few seedlings have resulted.

A number of other attempted crosses were not successful. These include *S.* × *tetrapla* with *S. lapponum* and with *S.* × *obtusifolia*; *S.* × *tetrapla*, *S. myrsinifolia* and *S.* × *punctata* (*S. myrsinifolia* × *S. myrsinites*) with *S. herbacea*; *S. repens* with *S. lanata*; and all attempted crosses between *S. reticulata* and other montane species. Clearly such experiments should be repeated under controlled conditions.

CHROMOSOME NUMBERS

Published data on chromosome counts of British material (Stace 1997) suggest that all the Scottish montane species and two of the lowland species, *S. caprea* and *S. repens*, are diploid (2n = 38), *S. cinerea* and *S. aurita* are tetraploid (2n = 76), and the remaining lowland species, *S. myrsinifolia* and *S. phylicifolia*, have 2n = 114 and 2n = 88 respectively.

Only a single chromosome count was undertaken on a willow collected during this work, carried out by Dr. H. A. McAllister on a plant which appeared to be a hybrid between *S. lanata* and a lowland species. Assuming that this plant was a hybrid, the resulting figure of 2n = 38 suggested that both parents were diploid, which, if the second parent was a lowland species, should be either *S. caprea* or *S. repens* according to the figures above. However, no evidence of *S. caprea* was found and the presence of *S. repens* was by no means obvious in this plant. Stace (1997) quotes a chromosome count for the hybrid *S. aurita* × *S. phylicifolia* of 2n = 42–64, a range much lower than the theoretical figure (82). The low count of 2n = 64 suggests that one parent was diploid, and the even lower figure of 2n = 42, if correct, might suggest that back-crossing with a further diploid parent has occurred in this case. Earlier reports on chromosome counts (Warburg 1952) state that *S. aurita* is both diploid and tetraploid, which, if correct, might suggest that the above count of 2n = 64 represents either an error for 2n = 63 or an aneuploid of this, derived from a diploid form of *S. aurita* (2n = 38) and *S. phylicifolia* (2n = 88). If diploid *S. aurita* does occur then this might also be an additional possibility as a parent of the hybrid of *S. lanata* mentioned above. The variation in chromosome number of these willows suggests that chromosome counts might be useful in the confirmation of their hybrids, especially those involving *S. myrsinifolia* and *S. phylicifolia*. However, it is not known whether willows behave according to theory in this respect, and chromosome counts on willows are known to be difficult. It is also clear that some of the published data require verification to establish whether more than one ploidy level might occur in some species. In the case of *S. myrsinifolia* and *S. phylicifolia*, special care in the selection of material is essential, as these species are often difficult to distinguish from hybrids between them. Selected plants collected during this survey in areas where these species do not overlap geographically would be ideal material for such studies, and hybrids deliberately synthesized from such cultivated material could also be used as controls to examine the behaviour of chromosomes in crosses of known parentage.

DISTRIBUTION OF HYBRIDS

The distribution of the willow species can be consulted in Preston *et al.* (2002). The extreme rarity of many montane willow hybrids seems to suggest that, where no apparent genetic barriers exist, they originated as the result of rare events, coupled with the probability that few survive to maturity. Many of the rarest hybrids are curiously local, yet may occur in reasonable numbers in their known localities. As the majority appear to be fertile, many extant hybrids may be the progeny of a single original cross, which might also partially explain why given hybrids from one locality can have distinctive characters which are not seen in the same cross from other localities. Triple hybrids, such as *S.* × *grahamii*, discussed earlier, could have arisen theoretically from three different binary hybrids, and male or female examples of any of these, which would be likely to give rise to considerable local variation, and the same would apply to other multiple hybrids and back-crosses.

The earliest British determinations of willow hybrids, and their descriptions, notably those by White (1890), were based on the few initial gatherings available, and the descriptions, although no doubt accurate in content, if not always in conclusion, do not take into account sufficiently the range of variation which was found in subsequently discovered examples.

The local distribution of some willow hybrids is unexpected, and in a few cases seems to bear little relationship to the abundance of the parent species concerned, or at least one of them. However, it is possible that some of these hybrids have been overlooked in Scotland, and one such example could be the apparently rare *S.* × *margarita*, whose parents, *S. aurita* and *S. herbacea*, are both widely distributed and common there. Some unusually hairy examples determined as *S. herbacea*, collected in more than one locality in north-western Scotland, might represent back-

crosses of the latter with *S.* × *margarita*, which itself may have died out. In location 3 (Angus), nearly all examples of apparent *S. myrsinites* which are now present seem to be hybrids, mainly with *S. myrsinifolia*. Pure material does exist locally there in small numbers, but most of these hybrids closely resemble *S. myrsinites*, which suggests that many are probably back-crosses. There is a strong impression that present environmental conditions account for the spread of the hybrids, and this in turn may be one reason for the decline of *S. myrsinites* there. A similar situation appears to occur in parts of location 1 (Mid Perthshire), where the hybrid *S. lapponum* × *S. arbuscula* dominates over one of the parents, *S. lapponum*, but not over the other, and, in a few of the areas surveyed there, seems to have more or less replaced it. Furthermore, in the pure state, *S. phylicifolia* appears to be absent or scarce in all of the areas surveyed within locations 1–4, whereas *S.* × *tetrapla*, its hybrid with *S. myrsinifolia*, is very frequent, although there is otherwise no evidence that *S. phylicifolia* was ever common there. Another very local and scarce hybrid with widespread and common parents in location 1 and further west is *S. arbuscula* × *S. herbacea*, which was found during the fieldwork in many places, but only within a single site (MNS), whereas *S. arbuscula* was not noticed there; yet on a nearby hill (MG), where both parents are locally dominant, the hybrid has not been found. *Salix repens* × *S. herbacea* is a further example of a hybrid with widespread and common parents which is itself widely distributed but apparently rather rare.

DISCUSSION AND CONCLUSIONS

The present list of willow hybrids found on Scottish mountains now includes 36 combinations, 21 of which involve at least one montane species. Five of these proposed combinations are new to Britain and apparently endemic to Scotland. Two further hybrids were earlier included in the list prepared by Linton (1913), but were later rejected and are here reinstated. Three of the hybrids listed in Stace (1997) and a further four added by Kent & Stace (2000) have now been removed on the basis of insufficient evidence. Two of the former three deletions, *S. caprea* × *S. myrsinites* and *S. myrsinifolia* × *S. herbacea*, are already published (Kent & Stace 2000) and the third, *S. myrsinifolia* × *S. phylicifolia* × *S. lapponum*, is rejected here. The four combinations added by Kent & Stace (2000) but now removed from the list are *S. aurita* × *S. myrsinifolia* × *S. myrsinites*, *S. myrsinifolia* × *S. phylicifolia* × *S. arbuscula*, *S. myrsinifolia* × *S. myrsinites* × *S. herbacea*, and *S. lapponum* × *S. myrsinites* × *S. herbacea*.

All but two of the Scottish willow hybrids recorded in montane habitats and now considered to be correctly named have been relocated in the field, and the majority of these have been brought into cultivation. The two remaining hybrids are *S.* × *boydii*, which is considered extinct in the wild state, and *S.* × *grahamii*, which has not been collected recently and was originally found outside the locations included in this survey. Fortunately, both of these hybrids are available from horticulture and therefore have been included in this study.

Even with the availability of freshly collected material and plants in cultivation, determinations which had been positive sometimes required later change, especially when transient characters were exhibited, or when catkins were produced for the first time in cultivation, and suggested the involvement of a previously unsuspected parent species. In addition, it became clear that useful foliage characters such as gloss, texture and raised veins, as well as colour, largely disappeared when some hybrids were pressed, but apparently did not do so in others, which, together with the transient variation mentioned above, emphasizes the hazards of herbarium determinations of willow hybrids. It has also been confirmed from deliberate crossing experiments between known species or hybrids that the characters of at least one of the parents may be more or less fully suppressed in the resultant hybrid, and such plants recognised in the field or herbarium as simple crosses may in fact be triple hybrids. Few of the latter can be determined with absolute certainty. Hybrids with one parent in common often overlap in their characters and at the extremes can be difficult to distinguish, for example hybrids of *S. herbacea* with *S. arbuscula* and *S. myrsinites*. Additionally, as hybrids vary between the parental characters, those at either extreme are likely to have been overlooked, which is also a potential problem in the selection of control material for scientific studies and deliberate hybrid synthesis. Some present determinations are still based largely on matching recently collected material with original herbarium specimens on the

assumption that the latter were correctly named, which has not always later proved to have been the case. The confidence with which the early salicologists named willow hybrids has often been shown to have been misplaced and even today the full range of variation in some species is still not known. This was additionally confirmed where some of the hybrids produced by design in cultivation were found to have few distinctive or diagnostic characters; had they been found in the wild state they would have defied identification.

In view of these difficulties it was decided to admit hybrids to the British list which had been determined as having probable status, as more positive opinion was often not possible, and as a consequence some of the records given in this paper, including some of the seven new combinations proposed, especially the triple combinations, should perhaps be considered as tentative until new evidence is available to confirm their identity beyond doubt. Most of the objectives of this work as listed in the introduction to this paper have been completed. *The List of Vascular Plants of the British Isles* has been revised and information for the *Vice-county census catalogue* has been updated. Some of the descriptions and others in preparation will be made available for the *Flora of Great Britain and Ireland* (Sell & Murrell, in prep.). Herbarium material continues to be gathered, both in the field and from the cultivated plants and will be later distributed to various herbaria. Other than the establishment of living hybrids at botanic gardens, aspects of conservation of montane willow hybrids are still to be discussed. Finally, the difficulties of identification of willow hybrids, as discussed here, emphasize the necessity of a more scientific approach to their determination. Accordingly, a programme which will include molecular studies of the willows and their hybrids that occur in Scottish montane habitats is now underway at the Royal Botanic Garden, Edinburgh and other collaborating institutions. Some 200 DNA samples have been prepared from the cultivated collection and donated to the RBGE for inclusion in this programme in an attempt to confirm identities.

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I should particularly like to thank Desmond Meikle for his extensive contribution to this project and the considerable time he contributed so generously to identification of specimens, and Clive Stace for his encouragement throughout and help with the manuscript. I should also like to express my gratitude to Clive Jermy and the B.S.B.I. Science & Research Committee for an initial grant towards this work, to Douglas McKean, Hugh McAllister, David McCosh, David Mardon, Ken Slater, James Compton and Dr. C. Sydes, who all assisted in various ways, to the Keepers of the herbaria for access to specimens (Peter Sell, Roy Vickery, Phillip Cribb, John Edmondson, Tim Rich and Stephen Harris), and also to Pete Hollingsworth and others involved at the Royal Botanic Garden, Edinburgh.

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Species status, hybridisation and geographic distribution of Irish populations of *Quercus petraea* (Matt.) Liebl. and *Q. robur* L.

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ABSTRACT

The species status of *Quercus petraea* and *Q. robur* in Ireland was investigated through morphological analysis of leaves. A number of different methods were used for the analysis. The consensus findings were that both species were readily distinguished in Ireland, although there are putative hybrids and introgressed individuals. The overall variability in leaf morphology was considerable and the percentage of distinct species based on a hybrid index was only 30% (15% *Q. petraea* and 15% *Q. robur*). The level of hybridisation was estimated at 10%, which is comparable to that reported in other studies in Europe. *Quercus robur* was found to be more distinct than *Q. petraea* as intermediate morphological forms grouped closer to *Q. petraea* in a Neighbour-Joining cluster analysis. *Quercus petraea* individuals were found mainly in peripheral mountainous regions and *Q. robur* individuals mainly in central lowland regions and these distributions roughly corresponded to typical ecological habitats for either species.

INTRODUCTION

OAK TAXONOMY

'*Look at the common oak, how closely it has been studied; yet a German author makes more than a dozen species out of forms, which are very generally considered as varieties; and in this country the highest botanical authorities and practical men can be quoted to show that the sessile and pedunculated oaks are either good and distinct species or mere varieties.*' (Darwin 1859)

This quote from Darwin's '*The Origin of Species*' (1859) illustrates the difficulty in agreeing on an infrageneric classification of *Quercus* (the oaks) and in particular for the species *Quercus petraea* (Matt.) Liebl. and *Q. robur* L. Although the quote may refer to tendencies in national outlook it remains true in a more fundamental and biologically meaningful way. The confusion in the identification of *Quercus* species and varieties still persists and Stace (1975) has suggested species delimitation remains to some extent a matter of opinion. A variety of identification and classification systems have been used in studies on oak, from the more orthodox systems based on morphology to less orthodox systems based on chemical characteristics (Brookes & Wigston 1979) and even classification based on biological aspects such as host specificity in insects

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(Abrahamson *et al.* 1998). There are also suggestions for alternative species concepts in oak such as multispecies and ecological species (Van Valen 1976) and in general the biological species concept has encountered some difficulty in its application to *Quercus* (Burger 1975).

Despite these difficulties in taxonomy, the largely sympatric species *Quercus petraea* and *Q. robur* (Jalas & Suominen 1976) have retained their species status because differences in morphological attributes and ecological 'preferences' are considered to be sufficiently differentiating. The main morphological differences between the species, summarised in Table 1, were compiled from a number of different sources (Aas 1993; Aas 1995; Brookes & Wigston 1979; Carlisle & Brown 1965; Cousens 1963; Jones 1959; Kelly 1996; Rushton 1976; Stace 1991; Tutin *et al.* 1964; Webb *et al.* 1996). Most of these differences are comparative rather than absolute, for example, Rushton (1976) found a significant difference in the size of pollen grains from the two species, but this was not sufficiently distinct to be useful for palynological study. The only species-diagnostic leaf character recognised is that of stellate hairs on the under-surface of the leaf in *Q. petraea* (Aas 1995). All other characters are a matter of degree. One reason for the difficulty in delimiting the species is the level of hybridisation between the species (Anderson 1949; Briggs & Walters 1997; Rushton 1993; Stace 1975; Steinhoff 1993). The dynamics of gene exchange through hybridisation can potentially hinder designating species; these must be thought of in terms of a continual evolutionary process rather than a static endpoint. Most studies of species or populations are 'snap-shots' in time.

TABLE 1. THE MAIN MORPHOLOGICAL DIFFERENCES THAT DISTINGUISH THE SPECIES *QUERCUS PETRAEA* AND *Q. ROBUR* FROM EACH OTHER

Character	*Q. petraea*	*Q. robur*
Infructescence		
Peduncle length	Short or absent (<1 cm)	Long (>1 cm)
Acorn stripe	Not striped	Striped
Peduncle pubescence	Clustered hairs	Absent
Acorn form	Less Elongated	More Elongated
Leaves		
Lamina length	Larger (approx. >10 cm)	Smaller (approx. <10 cm)
Petiole length	Long (>10 mm)	Short (<10 mm)
Auricles at leaf base	Absent	Well developed
Stellate hairs	Plentiful	Absent
Leaf shape	Ovate – broadest near middle	Obovate – broadest above middle
Veins to sinus	Absent	Present
Lobe pairs	≥6	<6
Lobe depth	Shallow	Deep
Pollen		
Pollen size	Larger	Smaller

STUDIES ON LEAF MORPHOLOGY IN OAK

One of the most striking points arising from a review of the literature on morphological studies of oak is that few authors use exactly the same characters or methods in their analyses. Studies on oak morphology have varied from studies on the taxonomic status and levels of hybridisation in individuals to studies on stands of oak and the associated ecology (Aas 1993; Aas 1995; Carlisle & Brown 1965; Cousens 1963; Cousens 1965; Kelly 1996; Kleinschmit *et al.* 1995; Minihan & Rushton 1984; Rushton 1978; Rushton 1993). A number of studies in Ireland have focused on the taxonomic integrity of the species (Cousens 1965; Kelly 1996; Kelly & Moore 1975; Minihan & Rushton 1984). Others have focused on the distribution and ecology of oak woodland types (Kelly 1981; Kelly 1996; Kelly & Fuller 1988; Kelly & Kirby 1982; Kelly & Moore 1975). Cousens (1965) provided an assessment of the status of the species in Britain and Ireland. He sampled from 12 Irish woodlands; almost half of these were confined to the eastern counties of Dublin and

Wicklow. Cousens' analysis used the concept of a Theoretical Species Type to investigate the levels of introgression and the species status. *Quercus petraea* from Ireland was shown to form, in the author's words, a 'good' species (morphologically distinct from *Q. robur*), and introgression was considered to be less extensive than that in Scottish samples (Cousens 1965). Other studies have shown that *Q. petraea* and *Q. robur* form distinct species in Ireland whilst confirming the presence of some hybrids (Carlisle & Brown 1965; Minihan & Rushton 1984; Rushton 1978; Rushton 1979; Rushton 1993). Rushton, using multivariate analysis, found the level of hybridisation in oakwoods in Northern Ireland to be 13% (Rushton 1993).

Although a number of studies on leaf morphology of oak have been completed in Ireland an adequate description of the taxonomy and distribution of the taxa is lacking. This paper aims to address this shortfall and present a firm base to our knowledge of Irish oak across its full geographical and ecological range. The Irish data are also compared to more recent studies from elsewhere in Europe. The data were analysed to investigate if distinct groups of individuals corresponding to the two species could be identified. This could indicate how distinct the species are in Ireland and what relationships, if any, there are between populations of the same species. To do this ordination, clustering analysis and hybrid index techniques were employed.

METHODS

SAMPLING

Sites were sampled from 25 locations across Ireland (Fig. 1). Sites were chosen primarily as putative ancient woodland sites. Some sites have already been recognised as ancient woodland using historic records, floristics and an assessment of woodland structure (Bohan 1997; Kelly & Fuller 1988; Rackham 1995). Where evidence was lacking, sites were chosen for their remoteness, thus lessening the possibility of in-planting from external stock.

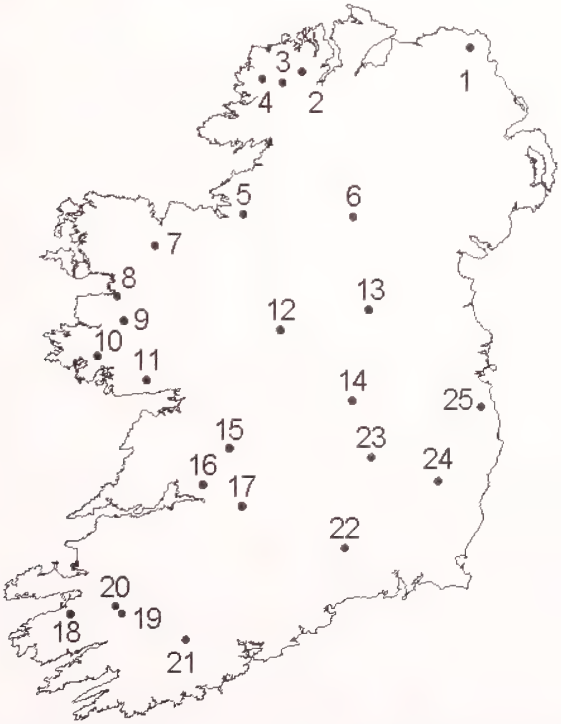


FIGURE 1. Map of sites sampled and their geographic locations. See Table 2 for site details.

TABLE 2. A LIST OF THE SITES SAMPLED, THE CODE USED FOR EACH POPULATION AND THE NUMBER OF INDIVIDUALS SAMPLED PER POPULATION (SEE FIG. 1 FOR LOCATIONS).

Number	Site (Code, Sample Size)	Number	Site (Code, Sample size)
1	Breen (N, n = 13)	14	Charleville (CH, n = 10)
2	Glenveagh (GN, n = 10)	15	Brian Boru Oak (BB, n = 1)
3	Devlin River (P, n = 21)	16	Garannon Wood (CT, n = 22)
4	Crolly (CY, n = 6)	17	Cappercullen Glen (GL, n = 15)
5	Cullentra (S, n = 11)	18	Glencar (GC, n = 7)
6	Crom (CR, n = 13)	19	Royal Oaks (R, n = 7)
7	Pontoon (M, n = 10)	20	Glaisín na marbh (K, n = 19)
8	Brackloon (B, n = 9)	21	The Gearagh (GH, n = 21)
9	Eriff (E, n = 5)	22	Curraghmore (W, n = 10)
10	Derryclare (D, n = 10)	23	Abbey Leix (A, n = 33)
11	Shannawoneen (SH, n = 11)	24	Coolattin (C, n = 11)
12	St. John's Wood (J and JR, n = 11)	25	Glen of the Downs (G, n = 11)
13	Tullynally (T, n = 12)		

Leaf samples were collected from open grown canopy branches to minimise variation in leaf morphology due to environmental factors such as exposure and aspect (Baranski 1975; Blue & Jensen 1988). The canopy was sampled either using a long-handle pruner or by climbing to reach the outer branches. Five well-developed leaves per tree were collected and measured. These leaves were representative samples of each tree. Fruiting shoots were also collected where available. Leaf samples were labelled and pressed.

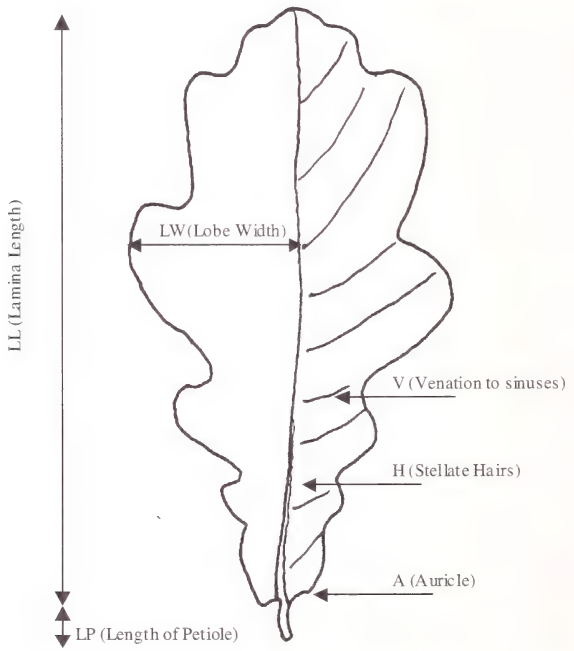


FIGURE 2. A schematic diagram of an oak leaf with illustrations of measurements and observations used in the analysis (see Table 3 also).

CHARACTER MEASUREMENTS

The analysis was limited to leaf morphology, due to the lack of consistent availability of acorn-bearing shoots. The measurements taken and the derived variables used in the analyses are given in Table 3 and represented in Fig. 2. All measurements were assessed by eye and ruler with the exception that a hand lens with a magnification of × 10 was used for viewing the stellate hairs. Although some authors have expressed concern over the use of ratios in multivariate analysis (Pimentel 1979), this did not affect our analysis significantly (data not shown) and we chose to use all measurements to allow direct comparison with other studies that applied the same methodology.

TABLE 3. THE MEASUREMENTS AND CALCULATED RATIOS USED FOR THE MORPHOLOGICAL ANALYSIS OF THE LEAVES (CF. FIG. 2). LEAF MORPHOLOGY WAS ANALYSED USING CLUSTERING, ORDINATION AND HYBRID INDEX

	Measurements
1.	LL (Lamina Length). The length of the leaf lamina from the petiole to the tip of the leaf.
2.	LW (Lobe Width). The width of the lobe at the widest point of the leaf.
3.	SWa (Sinus Width above). The width of the sinus above the widest part of the leaf.
4.	SWb (Sinus Width below). The width of the sinus below the widest part of the leaf.
5.	DW (Distance to Widest part). The distance from the beginning of the lamina to widest part of the leaf.
6.	LP (Length of Petiole).
7.	Lob (Number of Lobe pairs).
8.	A (Auricles). Auricle development on a scale of 0 to 5, 0 being non-existent, 5 being very well developed with curled leaf margins.
9.	H (Stellate hairs). Stellate hairs on the under surface of the leaves. On a scale of 0 to 5, 0 being none, 5 being present in profusion and clearly visible without a lens.
10.	V (Venation to sinuses). Number of veins going to the sinuses.
	Ratios
1.	LP/LL. Ratio of petiole length to lamina length.
2.	DW/LL. Ratio of distance to widest point and lamina length – describes the obversity of the leaf.
3.	LW/LL. Ratio of lamina width to length.
4.	SWb/LW. Ratio of lobe width to sinus width – describes the level of dissection of the leaf.
5.	SWb/SWa. Ratio of Sinus width below and above the widest point. Gives a measure of leaf shape uniformity.
6.	V/Lob. Ratio between number of veins to sinuses and number of lobe pairs.

DATA HANDLING AND ANALYSIS

Principal Coordinate Analysis

The ordination technique Principal Coordinate Analysis (PCoA) (Digby & Kempton 1987; Gower 1966; Legendre & Legendre 1998) was used. Characters were standardised by z-scores to avoid bias in the analysis due to scale differences in the measured variables (Legendre & Legendre 1998; Sneath & Sokal 1973), i.e. all values were divided by the highest record to obtain a range from 0 to 1. A distance matrix was obtained using Euclidean distance in the R Package version 4.0 d1 Development Release (Casgrain *et al.* 1999). The R Package was also used for the PCoA.

Ordination methods are suitable to illustrate continuous variation but are not always statistically appropriate for assigning samples to discrete groups (Legendre & Legendre 1998), as is necessary for determining species identity. Thus, a number of methods were used and assessed for assigning individuals to a morphological grouping. A clustering analysis method and an hybrid index method (Anderson 1949) were selected.

Cluster Analysis

The form of cluster analysis used was the 'Neighbour-Joining' (NJ) method (Saitou & Nei 1987) and the distance measure was Euclidean. NJ analysis allows an objective means of clustering individuals into morphological groups and provides for classification of individuals that lie within known clusters.

TABLE 4. CHARACTERS USED IN THE DETERMINATION OF THE HYBRID INDEX AND THE SCORE ASSIGNED. SCORES OF 0 FOR *QUERCUS ROBUR* AND 1 FOR *Q. PETRAEA* WERE GIVEN TO ALL CHARACTERS EXCEPT THAT OF STELLATE HAIRS WHICH WAS DOUBLE WEIGHTED AS 0 FOR *Q. ROBUR* AND 2 FOR *Q. PETRAEA*.

Character	*Q. petraea*	*Q. robur*
Stellate hairs	Present	Absent
Auricles	≤0·9 (absent or not well developed)	>0·9 (well developed)
Lobe pairs	≥6	<6
Venation tosinuses	<1	≥1
LP/LL	≥0·1	<0·1

Hybrid Index

The hybrid index has been used in previous studies on oak to determine species identity and degree of hybridisation (Carlisle & Brown 1965; Dupouey & Badeau 1993; Kelly 1996). The hybrid index involves designating character states to one or other species and scoring them accordingly, with or without weighting of characters (Anderson 1949). Adding these scores gives a measure of the individual, ranging from extreme *Q. robur* to extreme *Q. petraea* on a scale of 0 to 6. A number of characters were chosen for the assessment of the hybrid index on the basis of their diagnostic utility and their ability to designate the species states objectively. All characters were equally weighted except stellate hairs; this character was double weighted (Table 4) as it has been shown to be species diagnostic (Aas 1995). A hybrid index was calculated for each leaf and then averaged for each individual tree.

The methodology of the hybrid index has been questioned because of the subjective nature of trait designation and thus species assignment (Dupouey & Badeau 1993). This was therefore compared with other more objective methods, such as cluster analysis.

Discriminant Analysis

The utility of NJ clustering and the hybrid index for identifying meaningful groups was assessed using 'Discriminant Analysis' in SPSS for Windows, release 10.0.5. For discriminant analysis raw data are input and groups are defined *a priori*. Discriminant analysis proceeds by first testing for differences in the variables among the predefined groups; next, if the test supports these differences, the analysis proceeds to find linear combinations (discriminant functions) of the variables that best discriminate the groups (Legendre & Legendre 1998). The discriminant analysis used was the Wilks' lambda stepwise method. This method adds traits stepwise to the analysis on the basis of the Wilks' lambda test (at each step the variable that minimizes the overall Wilks' lambda is entered). Thus it can be used to identify those traits most important in discriminating the groups. The SPSS output gives the percentage of cases that match the predefined groupings and from this the utility of these groupings can be assessed.

RESULTS

Samples were analysed from 309 trees (1545 leaves) from 25 sites. The number of samples at each site ranged from 7 to 33, except for one individual, the Brian Boru oak in Co. Clare (Table 2). Collecting was more intensive at some sites rather than others to obtain a sufficiently representative sample in more complex woodlands, i.e. woodlands with more than one species. In addition, these populations were also used for molecular genetic studies and so the sample sizes reflect simultaneous sampling for a variety of analyses.

SPECIES SEPARATION AND HYBRIDS

Neighbour-Joining Cluster Analysis

The NJ tree was rooted at the mid-point to split the data objectively at its maximum divergence. This resulted in the clustering of two groups of individuals that could be morphologically distinguished as *Q. robur* and *Q. petraea* (Fig. 3), as each group of individuals showed the leaf characteristics of the respective species (Table 1). The *Q. petraea* grouping was taken as the most

inclusive cluster farthest from the *Q. robur* group. Putative hybrid and introgressed individuals ('Others') were taken as those individuals that lay between the groups of *Q. robur* and *Q. petraea*. These grouped closer to the *Q. petraea* than *Q. robur* individuals (Fig. 3). The average hybrid index values for each group were as follows; *Q. robur* = 0·8, *Q. petraea* = 4·9 and Others = 3·8. These values also show the intermediate individuals to be more closely related to *Q. petraea* than *Q. robur*. There were many more *Q. petraea* (195) than *Q. robur* (83) individuals and a total of 10% (31) of the individuals could not be clearly distinguished as either species (Table 5).

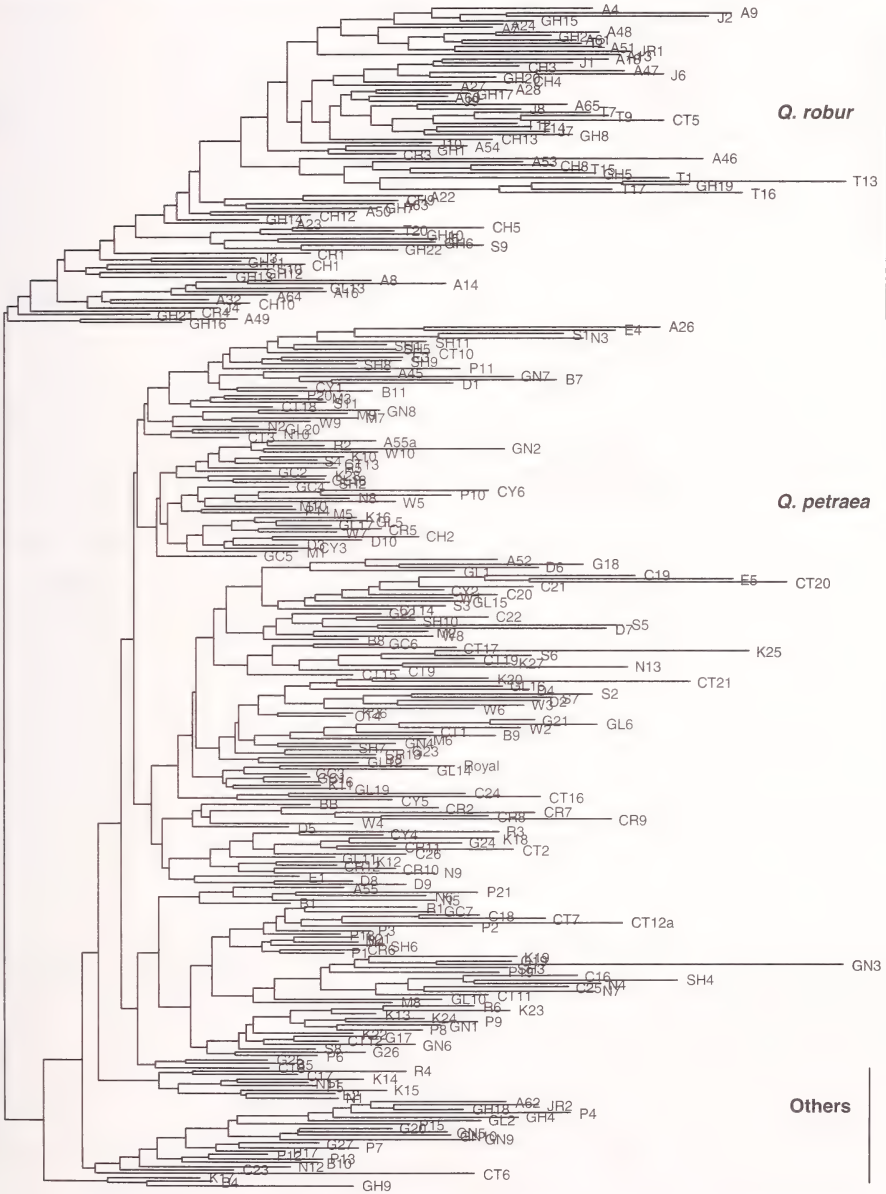


FIGURE 3. A Neighbour-Joining tree of the morphological data of all samples. The tree is mid-point rooted. Three clusters are indicated, *Quercus robur*, *Q. petraea* and Others (putative hybrids and introgressed individuals). Letters indicate the population and numbers the individuals within the respective population.

TABLE 5. THE NUMBERS AND PERCENTAGES OF THE DIFFERENT MORPHOLOGICAL TYPES ACCORDING TO THE NJ CLUSTER ANALYSIS

Morphological Group	Number of Individuals	Percentage of Total
Q. robur	83	27%
Q. petraea	195	63%
Others	31	10%

PCoA with Neighbour-joining

Principal Coordinate Analysis revealed a good separation of the individuals into groups corresponding to the two species (Fig. 4). The NJ designations are overlaid on the PCoA scatter plot (Fig. 4). Both analyses show concordance with respect to the species split, but are less concordant when the intermediate individuals are compared.

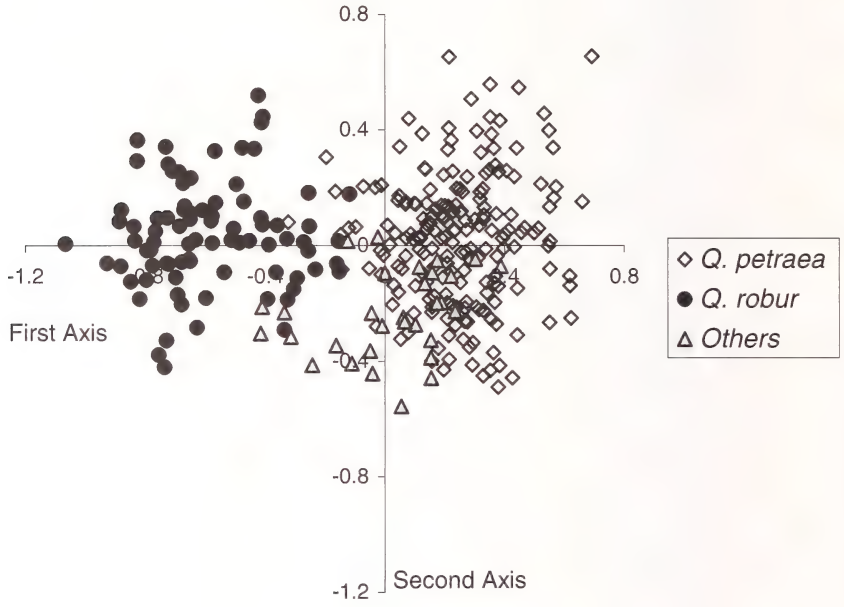


FIGURE 4. Scatter plot of the individuals on the first two principal axes of a PCoA. The first axis accounts for 48% and the second axis 15% of the variation. The overlays are the species designations according to the Neighbour-joining cluster analysis.

Hybrid Index

The hybrid index results show the diversity of the morphological groups and indicate a continuum of variation from *Q. robur* to *Q. petraea* rather than sharp divisions (Fig. 5).

A scatter plot of the first two principal coordinates with an overlay of the hybrid index for each sample shows the relationship between the PCoA and the hybrid index results (Fig. 6).

A comparison of the species designations plotted on the PCoA scatter plots (Figs 4 and 6) reveals similar salient patterns:

- There is a separation of many individuals into groups that can be recognised as *Quercus robur* and *Q. petraea*.
- There are 'intermediate' individuals that fall between the species groups.
- Fully intermediate individuals are relatively uncommon.

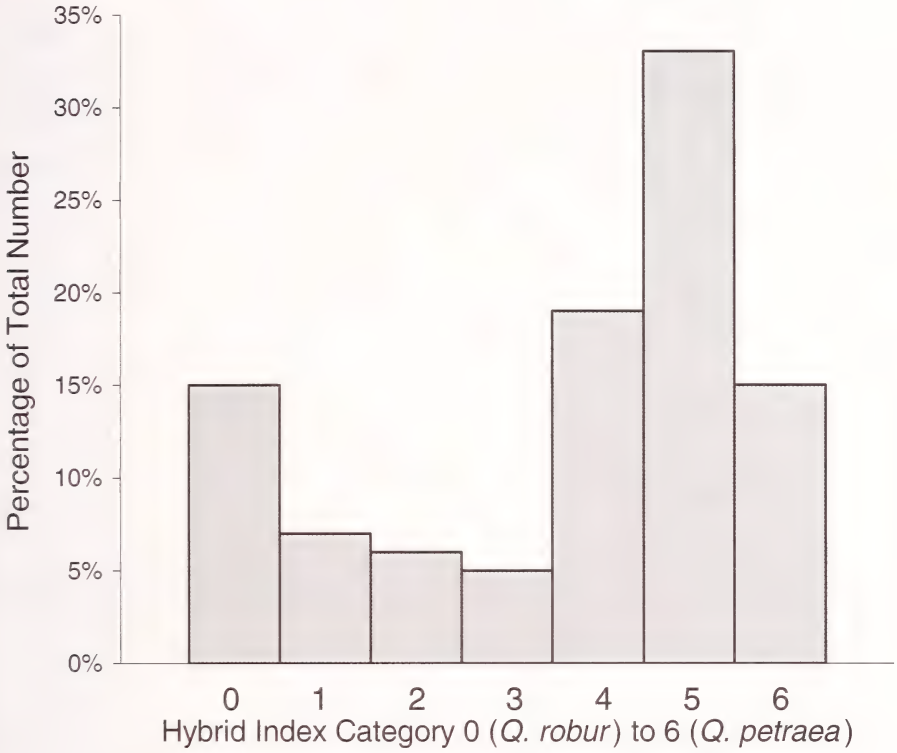


FIGURE 5. A bar chart illustrating the percentage of the total number of individuals in the different hybrid index categories. The hybrid index ranges from 0 (*Quercus robur*) to 6 (*Q. petraea*).

Discriminant Analysis

The two methods used for morphological analysis (cluster analysis and the hybrid index) were assessed for their utility in distinguishing morphological groupings. Discriminant analysis was undertaken using, first, the cluster groupings as predefined groups and then the hybrid index groupings as predefined groups. The results from the Discriminant analysis revealed the most important discriminating variables to be those listed in Table 6. From this table it appears that the groupings obtained from the NJ method are more significant than those from the hybrid index method (93·5% were correctly classified by the NJ analysis as opposed to 63·4% by the hybrid index method). The most diagnostic characters from the discriminant analysis varied according to the method used (Table 6). For the NJ analysis characters describing leaf shape, petiole length and stellate hairs were most important (LW/LL, LP/LL, DW and H – see Table 3) as they had low Wilks' lambda values. For the Hybrid Index analysis characters for leaf shape were not as important, but length of petiole and stellate hairs were the most discriminating (LP, H).

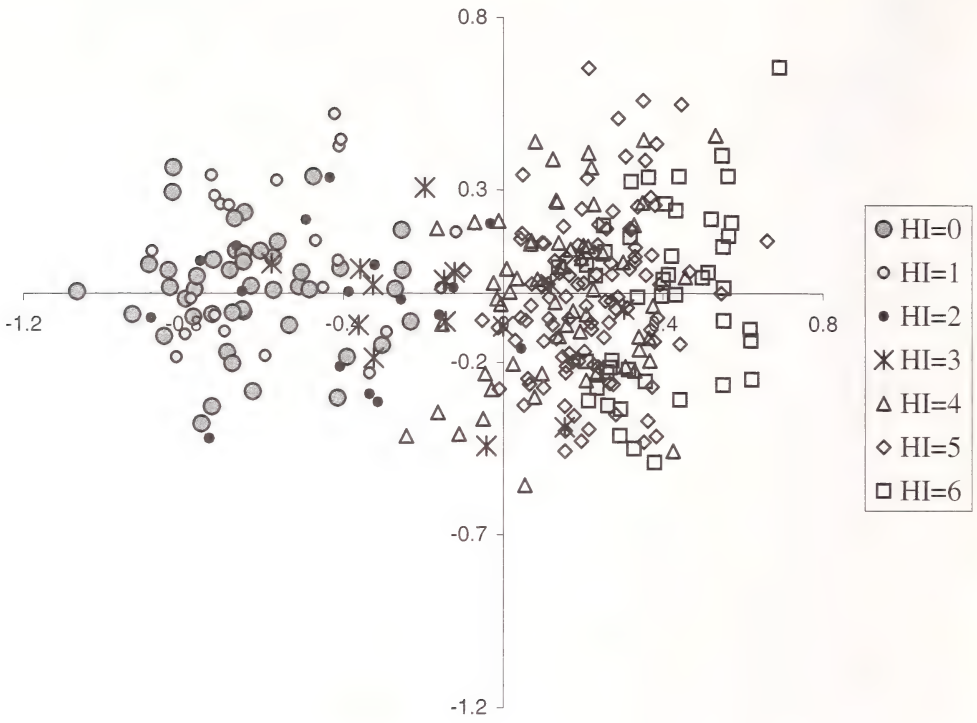


FIGURE 6. Scatter plot of the individuals on the first two principal axes of a PCoA. The first axis accounts for 48% and the second axis 15% of the variation. The overlays are the designations according to the hybrid index (HI), from 0 = *Quercus robur* to 6 = *Q. petraea*.

SPECIES DISTRIBUTION AND POPULATION DIFFERENTIATION

The geographic distribution of the morphological types as determined by the NJ analysis is presented in Fig. 7. Most populations contain a mixture of morphological groups and very few have just one species. A total of 6 populations were composed exclusively of *Q. petraea* individuals and only 1 population was composed exclusively of *Q. robur* individuals. The remaining populations (17) were composed of a mix of each species and intermediates (Fig. 7).

The individuals from each population are scattered in the analyses and do not cluster together into their respective population groupings (Fig. 3). A PCoA plot with an overlay of the populations (not shown) revealed that the populations do not form tight clusters but are dispersed within each species across the first two axes.

DISCUSSION

SPECIES IDENTITY AND SEPARATION IN IRISH OAK

Species Status

It is evident from the results that there is a morphological separation of individuals into groups recognisable as the two Irish *Quercus* species. All the techniques used showed groupings of individuals into the species *Q. petraea* and *Q. robur* and a continuum of intermediate individuals extending between the extremes (Figs 3, 4 and 6). The hybrid index revealed only 30% of the individuals with either extreme *Q. petraea* or extreme *Q. robur* characters, the remaining 70% showed different levels of intermediacy. This shows the extensive variability in leaf morphology

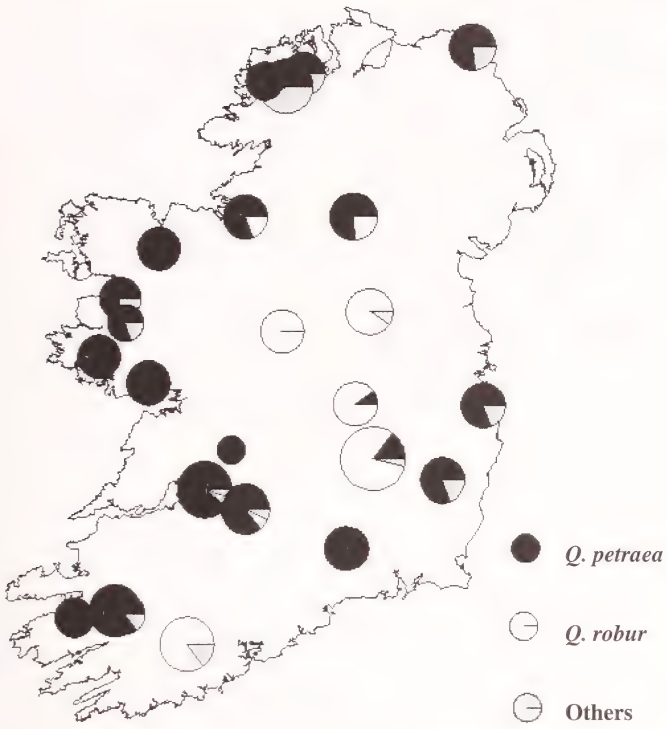


FIGURE 7. The proportions of the different morphological groups in each population sampled. Morphological groupings were designated according to the NJ analysis. Pie charts are sized according to the number of samples at each location, ranging from 1 to 33 samples. The size in the legend is equivalent to one individual.

of oak in Ireland. *Quercus petraea*-type individuals are the dominant morphological group in Ireland (Table 5). While the dominance of *Q. petraea* reflects the particular populations sampled, it is a reasonable reflection of the relative proportions of the species in Ireland as a whole. The NJ cluster analysis showed greater utility than the hybrid index in identifying morphological groups (Table 6). The discriminant analysis for the NJ analysis showed that characters for leaf shape are most important in discriminating the species. While the only species-diagnostic character identified is that of stellate hairs by Aas (1995), this was not found to be the most important discriminating character in either analysis (NJ or hybrid index).

TABLE 6. THE PERCENTAGE OF SAMPLES DETERMINED CORRECTLY IN THE *A PRIORI* CLASSIFICATION FOR EACH GROUPING METHOD

For NJ Groupings 93·5% correctly classified		For Hybrid Index Groupings 63·4% correctly classified	
Character	Wilks' lambda	Character	Wilks' lambda
V/Lob	0·397	V/Lob	0·342
A (Auricles)	0·279	V (Venation)	0·227
H (Stellate Hairs)	0·209	A (Auricles)	0·165
DW	0·176	H (Stellate Hairs)	0·123
LP/LL	0·153	LP	0·101
LW/LL	0·147		

Gives the variables used in the discriminant analysis with the Wilks' lambada satatistic at each step.

TABLE 7. LEVELS OF PUTATIVE HYBRIDISATION DETERMINED FROM STUDIES IN CONTINENTAL EUROPE AND IRELAND

Region	% Hybridisation	Reference
Ireland	10	This study (Table 5)
Ireland (Northern Ireland)	13	(Rushton 1993)
France	3·5	(Dupouey & Badeau 1993)
Germany	11	(Elsner 1993)

Hybridisation and Introgression

The level of hybridisation (10%) determined in this study is comparable to that obtained in other studies in Europe (Table 7). The results from Northern Ireland and Germany agree closely with those determined in this study, but the French values are substantially lower. Dupouey & Badeau (1993) consider the level of hybridisation to be overestimated in general; however, most of the evidence suggests that hybridisation is considerable, under both natural (Bacilieri *et al.* 1996b; Rushton 1993) and artificial conditions (Kleinschmit & Kleinschmit 1996; Rushton 1977). Aas (1993) adds to the debate by arguing that the level of hybridisation will often be over-estimated because of the level of variability within the species. However, this can be a circular argument as hybridisation is likely to add to the variability observed.

The level of introgression is more difficult to determine as the probability of co-occurrence of characters becomes more uncertain with successive events of segregation and recombination in sexual reproduction. Hybrids and the resulting introgressed individuals are not mixtures of equal proportions of their parents' characteristics (Anderson 1949). They are more a mosaic of attributes of the parents (Anderson 1949; Rieseberg 1995; Wilson 1992) and can also contain characters not evident in either parent (Rieseberg 1995). The F_1 (interspecies) hybrid generation has been shown to be relatively stable and more predictable in many species (Anderson 1949; Rieseberg *et al.* 1995) compared to successive crosses. The F_2 (F_1 with F_1) generation or an F_1 individual backcrossed with either parent has less likelihood of being similar to the original parent due to further recombination events. Rather than a progressive cline of intermediates, a mosaic pattern can develop. Wilson (1992) considers that hybridisation cannot be inferred accurately from multivariate morphological intermediacy. A mosaic is evident in the analyses presented (Figs 4 and 6), since 'intermediate' individuals can be found within the grouping of either species, in particular *Q. petraea*. While there are truly intermediate individuals there are also individuals that contain a preponderance of the characters of one species but with some characters intermediate or even typical of the other species. These individuals are most likely introgressed hybrids. From the hybrid index data (Fig. 5), the numbers of individuals assigned to distinct species are low (30%). This suggests a large variability within each group, and/or a considerable amount of gene exchange between the groups.

The intermediate individuals group closer to *Q. petraea* in the NJ tree (Fig. 3). This tree was rooted at the mid-point of divergence, and suggests an asymmetry in the morphological distribution. *Quercus robur* is more clearly differentiated than *Q. petraea*; the putative hybrids and introgressed individuals group closer to *Q. petraea* than to *Q. robur*. Asymmetric hybridisation and gene exchange has been observed in other studies (Bacilieri *et al.* 1996a; Bacilieri *et al.* 1996b; Bacilieri *et al.* 1993). The fertilisation and reproductive success of inter-specific crosses has been shown to be asymmetric with *Q. robur* accepting pollen from *Q. petraea* more readily than vice-versa, and *Q. petraea* more readily accepting pollen from individuals with extreme *Q. petraea* morphology (Bacilieri *et al.* 1996b; Bacilieri *et al.* 1996c; Bacilieri *et al.* 1993; Rushton 1977). This results in the preferential pollen gene flow from *Q. petraea* to *Q. robur*. This could (if traits are inherited equally from either parental species) result in the hybrids and introgressed individuals grouping closer to *Q. robur*. However, this is not the situation in the NJ analysis (Fig. 3) in which the hybrids and introgressed individuals group closer to the *Q. petraea* grouping. This could be the result of human interference due to planting efforts in the *Q. robur* woodlands. The possibility of in-planting of *Q. robur* in some of the populations sampled (in particular in old estates) may bias the outcome of the results. If many of the *Q. robur* individuals were planted then the population dynamics will be disrupted and the gene and thus trait ratios will be skewed.

Evidence to test this hypothesis is hard to obtain because of the scarcity of records concerning planting in Ireland prior to the 19th century.

While we have shown that leaf morphological analyses reveal a distinction between the respective species, both in Ireland and elsewhere in Europe, this is not so evident when using molecular markers. Only a few studies have shown a distinction between the species in European populations based on molecular analyses (Coart *et al.* 2002; Muir *et al.* 2000). Our work has been extended to utilise a variety of molecular markers (Kelleher 2001). Thus far, using chloroplast DNA markers, we have found no species distinction in Irish populations (Kelleher *et al.* 2004) and this reflects findings elsewhere in Europe (Petit *et al.* 2002). Further analyses will help to elucidate the differences between the morphological and molecular differentiation in Irish oak.

GEOGRAPHIC DISTRIBUTION OF THE SPECIES

The geographic distribution of *Q. petraea* and *Q. robur* (Fig. 7) in Ireland confirms the pattern outlined by Kelly (1996). The topography of Ireland is described as being similar to a saucer, with lowland regions mainly in the centre and more mountainous regions mainly on the periphery. The midland regions sampled are dominated by Carboniferous limestone substrata and the peripheral regions by siliceous rock (R.I.A. 1979). *Quercus petraea* individuals were found mainly in peripheral regions and *Q. robur* individuals mainly in central lowland regions (Fig. 7). This reflects the ecological preference of each species, *Q. petraea* being more common on upland acidic soils and *Q. robur* on lowland, more lime rich soils (Jones 1959; Kelly 1996).

POPULATION STATUS

Population structure or substructure could not be determined by the leaf morphology due to the extensive variability observed (Fig. 3). While a reasonable separation of the species can be achieved by PCoA and NJ analysis, variability between individuals is too high to identify population groupings or ecotypes if they do exist.

The proportion of single-species populations in Ireland appears to be low. Out of 24 populations, 17 (71%) contain some mixture of morphological groups, while only seven populations are composed of a single species. The distribution of single species and mixed populations does not show any obvious trend (Fig. 7). Some of these mixed woods may be attributed to human influence through planting efforts, but others probably reflect the natural situation.

CONCLUSIONS

Individuals of *Q. petraea* and *Q. robur* in Ireland can be separated by morphological analysis of the leaves. However, there are putative hybrids and introgressed individuals. The level of hybridisation (10%) is comparable to that found in other studies in Europe. The different techniques used did not agree on details but the overall trend was the same. The overall morphological variability was high and the percentage of individuals allocated to distinct species based on a hybrid index was only 30% (15% *Q. petraea* and 15% *Q. robur*). *Quercus robur* was found to be more morphologically distinct than *Q. petraea* as intermediate morphological forms grouped closer to *Q. petraea* in a NJ cluster analysis. *Quercus petraea* individuals were found mainly in peripheral geographic regions and *Q. robur* individuals in more central lowland regions of Ireland. These distributions roughly corresponded to ecological preferences. Most populations contained individuals from more than one morphological group, indicating the complex and dynamic situation in Irish oak populations.

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Further observations on the ecology and distribution of *Cardamine bulbifera* (L.) Crantz (Brassicaceae) in the British Isles

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ABSTRACT

The distribution of *Cardamine bulbifera*, a Nationally Scarce species, is updated. It has been found as a native in 143 tetrads in 25 10-km squares in south-east England. It is now regarded as introduced to v.c. 39 Stafford. 32 sites recorded in 1989–1992 in East Sussex were revisited in 1999–2002, and it had increased in 50% of the sites though there were some problems in consistency of surveys. The increases may be a consequence of increased woodland light levels resulting from storm damage in 1987 and 1990.

KEYWORDS: Coralroot, Great Storm, scarce plant, Sussex.

INTRODUCTION

Cardamine bulbifera (L.) Crantz, Coralroot, is a Nationally Scarce plant in Britain (Stewart *et al.* 1994). It is a very locally distributed native herb of dry and wet woodlands, shady stream-sides and roadside banks on sand, clay or chalk soils (Showler & Rich 1993). It mainly reproduces vegetatively by axillary bulbils which usually fall near the parent and which may also be locally dispersed by water, but significant fruit set may also occur; the seeds are dispersed by explosive dehiscence of the fruit valves. It is native from England and southern Scandinavia south to the Mediterranean and eastwards to the Black Sea, the Caucasus and northern Iran. It was first recorded in Britain in 1634 and has been known for many years to occur in south-east England, with a possible disjunct series of sites in Staffordshire, central England. It is widely introduced as a garden plant elsewhere in England, Scotland and Ireland (for a recent national map incorporating records up to the end of 1999, see Preston *et al.* 2002).

Showler & Rich (1993) reviewed its distribution and listed all known sites. Since then, new sites have been found and other records have come to light. The Staffordshire sites were revisited by J. Hawksford in 2002, and their status has been reviewed in the light of further information. In addition, R. A. Nicholson has revisited many of the old sites in East Sussex to note any changes after ten years.

NEW AND ADDITIONAL HISTORICAL RECORDS

Since 1992 a number of new and additional historical records, obtained mainly through correspondence with vice-county recorders, other botanists and through personal observations, have been compiled, together with some corrections to Showler & Rich (1993). The records are

summarised in Appendix 1; fuller details have been deposited in the library of the National Museums and Galleries of Wales, Cardiff and with the Sussex Botanical Recording Society. It has now been recorded as a native in c. 143 tetrads in 25 10-km squares and has been seen in 114 tetrads in 22 10-km squares since 1987. Three sites where it was thought to be extinct have been refound. A map showing the tetrads in which it is considered native is given in Fig. 1.

Following additional specimens and information from J. Hawksford about the v.c. 39 Stafford sites, indicating that all material is the alien forma *ptarmicifolia* (DC.) O. E. Schulz, including that from Needworth Forest (cf. Showler & Rich 1993), it is now considered to be introduced in all v.c. 39 sites, updating Showler and Rich's (1993) opinion.

There are five corrections to Showler & Rich (1993). V.c. 14, E. Sussex: Lawyers Wood should be Fir Toll Lane (TQ52). Rivenhall should read Riverhall (TQ63). Goodyer's record for 1634 for Foxhole Wood is more likely to be the Foxhole Wood in TQ72D than TQ62G. V.c. 24, Bucks: The Warren Wood (SU88U) plants were found by M. Walker in 1993 at SU868897. V.c. 62, N.E. Yorks: The Scalby site was first recorded in 1946 (not 1964) and the reference to *The Dalesman* should be 1990 (not 1900). Stace (1994) suggested that K. E. Bull's Tunbridge Wells Common site was not the same as Showler & Rich's (1993) site; the sites are in fact the same, the different interpretation resulted from the use of local place names by Stace and Ordnance Survey map names by Showler & Rich.

There is obviously scope for finding new sites for this remarkably attractive plant. The fact that among the post-1992 records three 'new' sites were large areas of *C. bulbifera* in woodland crossed by public footpaths indicates that there may be many smaller populations to be found either on private land or near less-frequented paths.

SUSSEX SITES REVISITED

The population sizes given in Showler & Rich (1993) were estimated from relatively brief searches between 1989 and 1992. Field work by R. A. Nicholson in East Sussex approximately ten years later revealed many sites where the populations had apparently increased, and therefore a more detailed investigation was carried out.

METHODS

32 sites, mainly in the area of East Sussex with the highest concentration of records in hectads TQ52, TQ62 and TQ72 (Showler & Rich 1993), were visited between March and May in the years 1999–2002. At each locality, a rough estimate of the area occupied was made and the density of the plants noted. As the proportion of plants flowering varied from year to year and site to site, both flowering and vegetative plants were included, though it was not always easy to spot juvenile plants among thick undergrowth. The 1999–2002 data were compared with the Rare Species forms completed during the previous surveys.

RESULTS

Details of the population sizes at the revisited sites are given in Table 1. One or two localities could not be identified but, whilst searching for known places, six new sites were recorded, indicating that more may still be found.

At one site where the plant was thought to be extinct due to the removal of part of a wood for road widening, it was refound in the undisturbed remainder. At the 2/32 (6%) sites where no plants could be found, the most likely reason was that the exact location was not refound as the sites were still intact, or plants were vegetative and overlooked. 1/32 (3%) sites showed a decrease in the number of plants, 11/32 (34%) sites showed little or no change, and 16/32 (50%) sites showed an increase, sometimes dramatically so.

DISCUSSION

There are a number of possible reasons for the apparent changes in population sizes between 1989–1992 and 1999–2002 of which a key one is subjective differences between observers (Rich & Woodruff 1991, Rich & Smith 1996). Whilst we cannot rule this out as a contributing factor in some cases, the large increases observed at some sites are undoubtedly real.

TABLE 1. COMPARISON OF POPULATION SIZES 1989–1992 (CF. SHOWLER & RICH 1993) WITH FIELD SURVEY IN 2000–2002

LOCALITY	1989–1992 STATUS	2000–2002 STATUS	CHANGE
Banky Wood	Four scattered patches	Widespread, covering woodland floor	Increase
Bateman's, dense hedge	140 plants	Scattered small groups, c. 400 plants, 40 flowering	Increase
Bateman's, wood to N.	500 plants	Plants over almost entire floor of wood and onto verge	Increase
Bodiam Wood	One large patch near wet hollow	Three small patches and scattered plants near wet hollow. 3 × 2 m patch, c. 200 vegetative on animal track between wet hollow and wood boundary	Increase
Bog Wood, R. Dudwell	100 flowering on S. bank, 60 on N. bank	Patches both sides river and into field	Little or none
Brookside Farm	10+ plants	Vegetative plants only, 1 × 1m	Little or none
Burwash Weald	325 plants	Patches 20 × 3 m, 2 × 2 m. A few plants in new locality bottom of hill	Small increase
Coggins Mill, bridge	Present by bridge	Patches by bridge, and downstream both banks	Increase
Coggins Mill, stream	Present	Small patch 0·5 × 0·5 m	Little or none
Crossroads Farm	c. 200 plants in wood by A229	Patch 0·5 × 2 m, spreading into wood	Little or none
Fleet Wood	c. 40 flowering plants at bridleway edges	Patches on both sides of bridleway	Increase
Fonthill Farm	60 plants	On bank at edge of copse and onto verge, c. 60 vegetative, 20 flowering	Small increase
Furnace Wood	6 m² patch, E. verge	100 m patch E. verge, small patches W. verge	Increase
Gigmore Wood	20 plants in ancient woodland	c. 2000 plants, 50 flowering	Large increase
Hawksden Wood	c. 15 plants	Large patch 5 × 5 m and more down stream	Increase
Heronry Wood	15 plants	Two large patches E. verge, several patches W. verge	Increase
Little Boarzell	c. 120 flowering, more vegetative in wild garden and on verge	Scattered plants for 300 m along verge and into woodland	Increase
Mayfield, Fir Toll Rd	Fruiting plants seen 1992	Patch 4 × 2 m	Little or none
Merriments Shaw	Several patches, 400 flowering and vegetative plants	Scattered patches throughout wood near road junction	Little or none
Mousehall	110 plants	Scattered on S. side, a few plants on N. side	Little or none
Old Place Farm	One plant on E. verge, present in copse; a few plants W. verge	Area 2 × 100 m E. side, scattered in copse	Large increase
Peagle Wood	85 plants	Wide belt of plants for c. 200 m woodland edge; two large patches on opposite verge	Large increase
Rye Green Farm	100 scattered flowering plants	Patch 1 × 1 m	Decrease
Sharnden	c. 40 plants	One patch, 2 × 2 m	Little or none
Terrace Wood	c. 200 plants each side	Several extensive patches each side	Little or none
Tidebrook, roadside	Large nos plants, 50–100 m S. side 20 flowering N. side	Patches 3 × 2 m, 6 × 4 m, 2 × 1·5 m, S. side scattered plants for 50 m N. side	Little or none
Wardsbrook Farm	c. 500 plants	Two large areas, 5 × 8 m, 4 × 5 m	Little or none
Wet Wood	c. 500 plants	Widespread over woodland floor & on verge; 1 × 1 m on opposite verge	Increase
Wood, N. W. Stonegate Station	c. 100 plants	Patch 7 × 4 m and scattered plants	Little or none



FIGURE 1. Tetrads in which *Cardamine bulbifera* is considered native. ● 1987 onwards, ○ pre-1987, ? location uncertain.

Cardamine bulbifera is a typical vernal, woodland-gap plant, and is noticeably more frequent along streams, by footpaths, animal tracks and at woodland edges where light levels are enhanced compared with the general woodland floor. Any changes in the light regimes by management or natural events might therefore be expected to benefit the species. Stace (1994) stressed that the demise of coppicing was a major factor in the decline of *C. bulbifera*, a practice which had largely ceased in the Weald by the 1960s. Several observations confirm this was an important factor but do not explain the widespread increase as coppicing has not been resumed at most of the sites investigated. A regular increase in the number of flowering stems was noted when Clay Wood, Bivelham Forge Farm was coppiced in the past and the flowers diminished as the trees grew up again (J. Simes, pers. comm., 2000). At Little Calem Wood, one population was flourishing where a tree had fallen, and in Streaks Gill, some tree thinning was carried out in 1996 which may have encouraged the growth of colonies in the wood. Where plants occur on the edges of woods or wide rides, they often flower much more prolifically.

The Great Storms of 1987 and 1990 caused much disturbance in the High Weald woods, especially letting light into over-grown coppice (Kirby & Buckley 1994). At Minepits Shaw several large trees blew over possibly causing an increase from the few plants in 1993 to the hundreds of young plants and many in flower in 2000. As *C. bulbifera* is known to start flowering in its third or fourth year with plants living for about seven years before declining (Pauca-Comanescu 1993), the expansion of the population here may have resulted from the extra availability of light penetrating the woodlands after the storms. The fact that the populations in the Chiltern woodlands, which were relatively unaffected by the storms, do not seem to have increased in the same manner as the Wealden populations, also suggests an increase related to the 1987 and 1990 storms. The field work carried out in 1989–1992 by Showler & Rich (1993) may have been too soon after the storms to see any responses to enhanced light levels. If this is the case, the populations will be expected, in the absence of woodland management or further storms, to decrease over the next decade or so.

C. bulbifera may also have benefited from the recent rise in temperature of about 1·5°C across the British Isles as it is widespread and more abundant in parts of Europe where the climate is warmer. There may also be local increases as plants are dispersed into new places. For instance, flash floods in May 2000 caused many Wealden streams to rise more than two metres overnight, leaving debris high up in trees and over a wide area in fields and woods beside the ghylls; this may have washed bulbils into new places. Similarly, at two flourishing colonies around rabbit warrens, plants were spreading along rabbit runs, and in at least four other places, along badger paths. At several sites on roadsides, the introduction of the Protected Verge Scheme by East Sussex County Council, where flower-rich verges are mown in the autumn rather than the spring, may have helped plants grow as well as allowing production of more bulbils, which have then been dispersed in the slipstreams of local traffic or along the verge edges by road runoff (e.g. along Little Trodgers Lane).

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APPENDIX 1. NEW AND ADDITIONAL RECORDS OF *CARDAMINE BULBIFERA*.

Records are given in order of tetrads (tetrad nomenclature following Ellis 1996) within vice-county. *Sites of the alien introduced forma *ptarmicifolia*. Recorders are listed in the acknowledgements.

V.C.	GRID REF.	LOCALITY	DATE(S)	SOURCE/NOTES
9	SY39	Near Lyme Regis	1939	**LIV**
13	TQ13N	Tickfold Gill, woodland	1997, 1999	
	TQ13X	Rusper, on verge	1995, 2000	Extension of known site
	TQ23D	Rusper, woodland stream bank	1999	
14	TQ33I	E. of Rowfant, on trackside	1995	
	TQ43H	Forest Row, damp woodland	1977	Not refound despite intensive searches
	TQ52C	Buxted Wood, Hadlow Down, hedgebank, ancient woodland, and nearby hedge	2000, 2002	
	TQ52Y	Mayfield, Little Trodgers Lane, verge and bordering woodland	1999	
	TQ52Y	Mayfield, woodland S. E. of Long's Farm	2002	Site known for some time
	TQ52Z	Little Trodgers Lane, Longham Wood, gateway into wood and in wood	1994, 2000	
	TQ52Z	Little Trodgers Lane, by former Mayfield College, hedge and wood	2001	
	TQ52Z	Mayfield, in wood N. of Vicarage Wood and along stream	2002	
	TQ53W & TQ63B	Near Frant, S. of B2099, woodland stream	1995	
	TQ62C	Great and Little Calem Woods, Broad Oak	1995	
	TQ62E	Mayfield, Lake St., copse and field	2002	Site known for some time
	TQ62E	Mayfield, Minepits Shaw, top of stream bank, in gullies and open area between two sections of woodland	1993, 1995, 2000	
	TQ62E	Sharnden, hornbeam wood with wet gullies	1995	
	TQ62E	Coombe Wood, near footpath	2000	
	TQ62I	Rolf's Farm, streamside	2000	
	TQ62J	Manor Farm, Coombe Wood, riverside	2000	
	TQ62J	Tidebrook, Riseden Road, verge	1999	
	TQ62J	Bivelham Forge Farm, Clay Wood, edge of wood	2002	Site known for some time
	TQ62J, N & P	Dens Wood, S. of Wadhurst Park, wood and scattered down stream and near paths	2000	
	TQ62K	Dallington Forest, N. of Glazier's Forge, by footpath and under hornbeam	2000	Possibly P. Hall's 1980 site.
	TQ62K	Blackbrooks, sides of wet track and wood edge	2000	
	TQ62M	Coalpit Wood, by footpath in wood	2000	
	TQ62M	Burwash Common, Brockwood, by path in wood	2002	
	TQ62N	Bivelham Forge Farm, Newbridge Wood, wood and edge of sunny ride	2002	
	TQ62P	Stonegate, Hoadley Wood N. E. section	1996	
	TQ62P	Stonegate, Hoadley Wood, S. E. section, stream junction	2002	
	TQ62S	Burwash, Spring Lane, shaded verge	2001	
	TQ62T	Stonegate, Church Wood Shaw, wet woodland	1994, 2002	
	TQ62U	Stonegate village, wood	1996	
	TQ62W	Brightling, Brown's Oak Farm, shaw between track, by stream and on verge	1998, 2002	

V.C.	GRID REF.	LOCALITY	DATE(S)	SOURCE/NOTES
	TQ62X	Etchingham, Borders Lane near March Farm, wood	1998	
	TQ62Z	Ticehurst, Streaks Gill, wood and verge	1996, 2000	
	TQ63B	N. W. of Wadhurst, wooded stream bank	1995	
	TQ63C	Bell's Yew Green, Manor Farm, damp woodland	1995	
	TQ63K	Shover's Green, shaw on N. side of B2099	2001	
	TQ71F	Bexhill, Park Wood near Watermill, wooded streamside	1996	
	TQ71V	Hastings, Churchwood S.N.C.I.	1993, 1996	Possibly one of the 'about Hastings' sites (Showler & Rich 1993)
	TQ71X	Screen Wood, Beauport Park, clearing under pylons	1993, 1996	Possibly Peatfield's 1943 Beauport Park site (Showler & Rich 1993)
	TQ72B	W. of Robertsbridge, Burgh Wood, by footpath	1997	
	TQ72B	Robertsbridge, Ludpit Lane, shaw	1997, 2000	
	TQ72B	Robertsbridge, Wyland Wood, woodland	1970	
	TQ72D	Lane to Burgham, verge and wood	2000	
	TQ72D	Fleet Wood, west side, track and wood	2000	
	TQ72D	Foxhole Wood, Sheepstreet Lane, Etchingham, ancient woodland and road verge	1993	Probably Goodyer's 1634 long-lost site
	TQ72H	Etchingham, Gigmore Wood, damp hollow	2000	
	TQ72H	N. of Robertsbridge, Park Wood near Bush Barn, wood	2002	Site known for some time
	TQ72I & J	Near Hurst Green, Burgh and Bellhurst Wood, wood and stream	1997, 2000	
	TQ72J	Near Hurst Green, N. of Bellhurst Farm, trackside shaw	1997	
	TQ72J	Copse in fork of A265 and Merriments Lane, wood	2000	Site previously thought extinct
	TQ72M	Salehurst, Rocks Hill, shady wet verge and bank	1993, 2001	
	TQ72P	Merriments Lane, hedge and verge	1996, 2002	
	TQ73A	Flimwell, woodland both sides of the A21	1968	Old site.
15	TQ72Z	Downgate Wood	1999, 2000	
	TQ73Q	N. E. of Highgate, damp woodland	1986	Not refound 2000
	TQ73V	Hawkhurst, Roughland Wood	1999	
	TQ73V & W	Near Iden Green, White Chimney Wood, 2 small colonies in wet woodland by stream	2000	
	TQ83S	Near Tenterden, W. of St Michael's, edge of lane on wooded stream bank	1999, 2000	
	TR25E	Trenleypark Wood, roadside bank	2002	New native eastern limit in England
16	TQ53P	Near footpath to Rusthall Common	1997	
	TQ73K	Mopesden Gill, conifer plantation	1997	Replanted with conifers in 1991
17	TQ13N	Near Oakwoodhill, ancient woodland ghyll	1999	
	TQ13U & Z	S. of Capel, bank of stream N. of Ridge Farm	1942	**LIV**
20	TQ09P	Sawpit Spring, remnant of wood destroyed by M25	1992	Not refound 2002
	TQ09T & U	Blackets Wood	1992	
	TQ09U	Chandlers Cross, Blackets Wood	1992, 2002	
24	SU79X	Piddington, Bottom Wood	1999, 2002	
	SU89G	Sands, Spring Coppice, patch on road verge	2002	
	SU89T	Hughenden Valley, Provost Wood	1993	

V.C.	GRID REF.	LOCALITY	DATE(S)	SOURCE/NOTES
	SU89T	Great Kingshill, beech wood	1998	
	SU99A	Holtspur	1993	
	SU99L	Hodgemoor Woods	1999	
	SU99Q	Seer Green, by footpath to station under beech	1993	
	SU99U	Chesham Bois, beech wood by road	1993	
	SU99Y	Amersham, lane verge	1993	
	SP 90B	Ballinger Common, by footpath on edge of beech wood	2000	
	TQ08J	Denham, Northmoor Hill Wood, edge of old damp chalkpit	1994	
	TQ08P	Denham Common	1988	
39	SJ84Q	*Trentham, Ash Green	2002	
	SK11C	*Rileyhill, Slaish Wood	1994, 2002	
	SK12L	*Newchurch, Slade Covert, woodland and roadside	1972, 2002	
	SK12L	*Yoxall Lodge, replanted ancient woodland near stream	2002	
60	SD74	Clitheroe	1960	**LIV**
64	SE26	*Holden Clough, near Sawley	1961	**LIV**
91	NO89U or 80Q	*Kingussie House, Maryculter, grounds	c. 1980	
113	WV75	*Ivy Castle, Guernsey	1893	**LIV**

Jersey Cudweed *Gnaphalium luteoalbum* L. at Dungeness RSPB Reserve, East Kent

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ABSTRACT

A potentially native population of the Critically Endangered Jersey Cudweed *Gnaphalium luteoalbum* L. was discovered at Dungeness in East Kent (v.c. 15) in 1996. From an original population of a few hundred on an area of pumped silt, the plant has spread rapidly and it now grows on the damp margins of many of the old gravel pits within a 1 km radius of where it was first found. The number of plants and their flowering time are both influenced by the water levels, and the population varies between tens and hundreds of thousands of plants. Even in poor years, the population at Dungeness is much larger than that at the only other native British site on the West Norfolk coast. The cudweed is almost certainly a recent colonist at Dungeness, and its mode of arrival could have been natural or artificial. The Royal Society for the Protection of Birds, which manages the Dungeness reserve, is treating the plant as a native. Areas of suitable habitat are being maintained and the population is monitored annually.

KEYWORDS: native, colonist, monitoring, Red data bank

JERSEY CUDWEED IN BRITAIN

Jersey Cudweed *Gnaphalium luteoalbum* L. is a very rare British plant, classified as Critically Endangered in the British Red Data Book (Wigginton 1999). Until recently, the only extant colony considered to be native was that at Holkham National Nature Reserve in West Norfolk (v.c. 28) — most of the other recent records refer to casual occurrences, but the species is well established in at least one site, in Dorset (v.c. 9) (Fig. 1). Eric Philp's discovery of Jersey Cudweed at the Royal Society for the Protection of Birds' Dungeness nature reserve, East Kent (v.c. 15) in 1996 was therefore of considerable interest because the plant could have colonised the area naturally, adding a second native British site. This paper records the history and spread of Jersey Cudweed at Dungeness, and provides details of the habitat, life-history, and conservation of the plant, and speculation about its origin. Nomenclature follows Stace (1997).

HISTORY OF JERSEY CUDWEED AT DUNGENESS

In 1996, several hundred plants were found in the area of the New Excavations at TR065184. They were growing on silt that had been pumped from the nearby New Diggings pit (central point at TR070190) between September 1993 and June 1994. Figure 2 shows how the plant has spread from this original site. In 1997 it was found on the western shore of Burrowes Pit, and by the south-east corner of the ARC Pit at TR073192, over 1 km away. An estimate of the population size suggested that there were 10,000 plants present that year. The following year, the number of plants around the New Excavations was estimated to be over 12,000, with another 6,000 along the shore of Burrowes Pit, and "several thousand" at the ARC Pit. A single plant was found by a gravel pit in Denge Marsh at TR054183, 1 km from the nearest plants on the New Excavations in 1997.

By 1999, Jersey Cudweed had colonised most of the area it occupies today: the margins of most of the pits in the New Excavations; the western shore of Burrowes Pit; and the north-west and south-east of the ARC Pit. The population had become very large, and the estimate for 1999 was 100,000 plants. Half of these were along the side of one of the pits (Pit C) in the New Excavations, but in spring 2000 the water levels in this pit were much higher, and there were few plants.



FIGURE 1. Distribution of Jersey Cudweed in Britain by 10 km squares. Circles show introductions, squares show native sites. ○ = Pre-1970, ◍ = 1970–1987, ● = 1987 onwards. Data from the Biological Records Centre.

Instead, the bulk of the total population of 17,500 was found at the south-east end of the ARC Pit, where there were an estimated 10,000 plants.

In 2001, the margin of Pit C again supported a huge number of plants, estimated at over 20,000. About 350,000 plants covered the ground to the south-east of the ARC Pit and turned it grey. The large numbers of plants appeared despite high water levels in May and June, and they flowered well into October. A survey at the end of May 2002 found a similar number of plants (25,000) along the edge of Pit C and 3,560 plants around the other pits in the New Excavations. There were no plants around the ARC Pit, but at least 3,000 had appeared here by September.

The size and location of the population at Dungeness clearly varies between years. This is likely to follow the availability of suitable habitat, which is determined by the extent, timing, and location of flooding.



FIGURE 2. Distribution of Jersey Cudweed at Dungeness, 1996–2001. See Figure 3 for names of pits.

On 5 September 2002 Dungeness was visited to look at the habitats and distribution of Jersey Cudweed. Figure 3 shows the areas surveyed:

1. south-east corner of the ARC Pit
2. New Excavations
3. in front of Firth Hide on Burrowes Pit.



FIGURE 3. Jersey Cudweed sites (A–H) used for habitat analysis in September 2002. Grid lines and numbers show 1 km squares of National Grid 100 km square TR.

SOUTH-EAST ARC PIT

Jersey Cudweed was abundant in three damp furrows in the sand at TR072119 (A–C on Fig. 3). The first of these hollows (A) had c. 500 flowering plants and thousands of non-flowering rosettes. Most of the flowering plants were under 15 cm tall and only just starting to flower. The vegetation in the hollow was typical of an open sandy area, with Buck's-horn Plantain *Plantago coronopus* the most abundant species, and the damp nature was clearly indicated by Knotted Pearlwort *Sagina nodosa*, Marsh Pennywort *Hydrocotyle vulgaris*, and Purple Loosestrife *Lythrum salicaria*. The other two hollows (B and C) were similar to the first and each had c. 1,000 plants, most of which were rosettes or at an early stage of flowering. To the south-east of the hollows, Jersey Cudweed was scattered in taller, but still open, vegetation (D) where there were about 100 flowering plants between the Pit and the road, and many more non-flowering rosettes. The cudweed was absent from the drier, more moss-dominated sand around the rabbit warren.

NEW EXCAVATIONS

The Cudweed around the New Excavations was much taller (c. 30–50 cm) than that at the ARC Pit, and most plants had finished flowering. There were very few non-flowering rosettes. One of the largest concentrations (E) was on shingle and sand on the bank above a pit. There were thousands of plants here, but only one non-flowering rosette was found. The vegetation was taller than that in the furrows at the ARC Pit, with lots of Canadian Fleabane *Conyza canadensis* and Black Medick *Medicago lupulina*, and typical of a drier site. Another site (F) had no non-flowering rosettes, but hundreds of fruiting plants. These were in ranker vegetation dominated by Black Medick on fairly moist sand. There were c. 1,000 plants on wetter sand at G, amongst open vegetation typical of seasonally flooded open ground. Most of these plants were in fruit, with a few smaller ones still flowering, and fewer than 20 non-flowering rosettes.

BURROWES PIT

Jersey Cudweed grows on the islands in front of Firth Hide (site H). The islands were not visited but from the hide it could be seen that most of the plants were quite tall and at an advanced stage of flowering. They were growing amongst frequent Water Mint *Mentha aquatica*, Common Fleabane *Pulicaris dysenterica*, and Common Centaury *Centaurium erythraea*, with occasional Scentless Mayweed *Tripleurospermum inodorum*, Silverweed *Potentilla anserina*, Gipsywort *Lycopus europaeus*, and Canadian Fleabane *Conyza canadensis*.

The favoured habitat at Dungeness seems to be seasonally flooded ground. Around the New Excavations this had become quite well vegetated by September, but it would have been more open earlier in the year. The effect of seasonal flooding was demonstrated by the exceptionally high water levels in 2000/2001, when sand at the ARC Pit that had been dry for many years was inundated. It was in this area that a huge stand of c. 300,000 plants was found in 2001. There was no such flood in 2001/2002, and the show of plants was much smaller in 2002 (perhaps only 3000), and they were mostly on the damper, more sparsely vegetated areas. This ability to vary its germination time (Scampion 1993) may allow the species to exploit new areas as this habitat becomes available, and this must give it an advantage over plants with more rigid life cycles.

FLOWERING TIME

In September the plants at the ARC Pit were at a much earlier stage in their life cycle than those around the New Excavations and Burrowes Pit. Variation in the germination time of Jersey Cudweed is probably correlated with water levels (Scampion 1993). The south-east corner of the ARC Pit did not flood in 2002, but it may have been generally damper than the New Excavations, and this could explain the difference in flowering time between the two sites. The RSPB, warden Pete Akers, has seen the plant in flower in December.

It has been suggested that this plant is biennial at Dungeness, but the observations support the conclusion that it is behaving as an annual. There were almost 30,000 plants around the New Excavations in May 2002; these had probably germinated the previous autumn, over-wintered as rosettes, and flowered in the summer. As there were no plants at the ARC Pit in May, these must have germinated during the early summer and flowered in the autumn.

Jersey Cudweed is often considered to be a native British plant. Its status in the floras varies: "introduced" (Keble-Martin 1965), "probably introduced" (Clapham *et al.* 1987), probably native (Simpson 1982), "native" (Stace 1997), "unquestionably a native" (Petch & Swann 1968). Usually, only the populations in the Breckland and coastal sand dunes of East Anglia have been considered to be candidates for native status. It was recorded in Breckland records between 1852 and 1956, since when the only possibly native population has been that at Holkham. Most other records are of casual occurrence (Preston *et al.* 2002), but there is an established population at Holton Heath in Dorset.

The appearance of the species at Dungeness is therefore of considerable interest, because if it has colonised naturally, this would be by far the most important British population, up to a thousand times larger than that at Holkham (Scampion 1993).

The natural history of Dungeness has been very well studied (Riley 1989) and it is inconceivable that a plant like Jersey Cudweed could have been present for long in such large numbers without being detected. This, together with its rapid spread during the last seven years, strongly suggests that it is a recent and successful colonist. But how did it arrive at Dungeness, and how has it spread so rapidly?

The silt where Jersey Cudweed was first found at Dungeness had been pumped from the New Diggings. This pit was excavated during the 1970s and 1980s (Findon 1985) and soon became flooded. It is possible that Jersey Cudweed seeds had found their way into silt at the bottom of the New Diggings whilst it was being worked, been covered by water for up to twenty years, and then germinated when they were pumped on to the New Excavations. If this had happened, it would still not answer the question of how the seeds arrived in the New Diggings in the first place. However, some of the equipment used to pump the silt had come from continental Europe, probably from Germany, and it is possible that the machinery could have been contaminated with Jersey Cudweed seeds (the species is local but widespread in Germany according to Fitter (1979)).

Jersey Cudweed need not have arrived with the silt. This may have simply provided a suitable habitat that the plant was able to colonise. Alternatively, it may have been found here first by chance, whilst it was actually present in low numbers for a few years, undetected in other areas before rapidly expanding.

Another species appeared for the first time at Dungeness reserve on the New Excavations in 1996. This was the Nationally Scarce Annual Beard-grass *Polypogon monspeliensis*, and it too has now spread to the ARC Pit and to other parts of the New Excavations. Like Jersey Cudweed, Annual Beard-grass is present just across the Channel in northern France (Eric Philp *in litt.* 25 August 2003). Both these species appear to have colonised the newly-available habitat at Dungeness and subsequently spread. Does the appearance of the two species together suggest that they had both arrived at the same time and from the same source? If so, this could favour natural colonisation as the origin, if we assume that they both arrived from northern France following conditions that favoured cross-Channel seed movement. Or it could suggest that they were both introduced from the same source. It may be worth noting that no obviously alien species have appeared with these plants, apart from the ubiquitous Canadian Fleabane *Conyza canadensis*, although the alien grass Rough Dog's-tail *Cynosurus echinatus* has started spreading elsewhere on the Dungeness peninsula in a similar manner to *Polypogon monspeliensis* and *Gnaphalium luteoalbum* (Eric Philp, *in litt.* 25 August 2003).

It is more likely that Jersey Cudweed and Annual Beard-grass arrived independently and that they were both present as seed or at very low and undetected densities before their populations spread on the new habitat and became noticed. This is certainly the case for another species, Knotted Pearlwort *Sagina nodosa*. In his 1982 *Flora*, Eric Philp wrote "Repeated searches in the Dungeness–Greatstone area, where it used to occur, have failed to find this plant although there is a chance that it might still linger on there" (Philp 1982). In 2002 Knotted Pearlwort was abundant in the area of the ARC Pit where Jersey Cudweed was found, so it is possible for plants to persist as seed or at low density for many years without being seen, even at a well-known site like Dungeness.

Whatever its true history, Jersey Cudweed could have arrived naturally or it could have been accidentally introduced. Seed from the colonies in northern France may have crossed the Channel by wind or on birds, or it could have travelled in mud attached to vehicles or as a contaminant in bird food or seed sown in the nearby gardens. In the absence of any evidence to the contrary, the RSPB is treating the colonisation as natural, and Jersey Cudweed is recognised as one of the important botanical features of the site (Akers 2002). The plant is currently thriving, and the Management Plan for the reserve includes prescriptions to maintain the damp sand habitats that are important for Jersey Cudweed and many of the rare invertebrates at Dungeness. This will be done by controlling water levels, removing colonising vegetation, grazing, and experimentally disturbing ground to create more open conditions. Staff at the reserve will continue to monitor the cudweed to make sure that the management is effective in maintaining the population.

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Drosera × *belezeana* Camus confirmed for the British Isles

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ABSTRACT

The vigorous hybrid between *Drosera intermedia* Hayne and *D. rotundifolia* L. (*D.* × *belezeana* Camus) is confirmed as British for the first time and described. Previous records, where backed by specimens, have proved to be *D.* × *obovata* Mert. & Koch (*D. anglica* L. × *D. rotundifolia*). The history of the description and subsequent recording of this hybrid is given and its current abundance and distribution assessed. Many of the historical European records of this hybrid are now known to be errors. Both parental taxa are declining throughout continental Europe and the recently discovered British plants may be the only known extant naturally derived examples of this rare and attractive hybrid.

KEYWORDS: Round-leaved Sundew, Oblong-leaved Sundew, hybrid, Dorset.

INTRODUCTION

Drosera × *belezeana* in the British Isles

An unusual Sundew, tentatively identified in the field as the hybrid between *D. rotundifolia* and *D. intermedia* (*D* × *belezeana*), was first discovered from just west of the Agglestone, Godlingston Heath N.N.R. (SZ08), Dorset by DAP in August 1999. The identification was subsequently confirmed by Dr A. Culham at Reading University. On revisiting the site in August 2002 six colonies were found, with a further site in June 2003, both to the east and west of the Agglestone. The best find, however, was in a small dryish self-contained bog about 1 km to the west, where all three British *Drosera* species plus the two hybrids occurred within 15 m of each other.

All colonies grew in peaty bogs with the typical associates of both parents, including *Erica tetralix*, *Narthecium ossifragum*, *Rhynchospora alba*, *Molinia caerulea* (rarer), and *Sphagnum* species, particularly the rare but locally abundant *S. pulchrum* which is such a feature of these Dorset mires. Floristically, all sites were good examples of the M21 *Narthecium-Sphagnum papillosum* valley mire community, described by Rodwell (1991).

There were no obvious differences between the sites that had the hybrid present and those that did not. Most of the vegetation in the areas where the hybrid was found was considered to be too closed for *D. intermedia*, which was more abundant on bare peat on the adjoining wet heath.

The discovery of undoubted *D.* × *belezeana* led to a review of the historical records of this hybrid. Culham (1998) had suggested that this hybrid was "probably very rare". It was not listed in the earlier standard floras and checklists, eg. Clapham, Tutin & Moore, (1987), or Dandy (1958) but it is included in Stace (1991), who merely repeats the localities given by Webb, in Stace (1975). According to Webb this hybrid has been recorded only from v.c. 11 (the New Forest), v.c. 28 (Dersingham) and v.c. 46 (Borth Bog). However, evidence to support and substantiate these records is hard to find. Both of the first two records seem to rely on a note by Druce (1912) in the report of the Botanical Exchange Club where he states "*Drosera longifolia* × *rotundifolia* (*D. rotundifolia* × *intermedia*). Plants having intermediate characters between the above species have been noticed at Dersingham, Norfolk, growing with both the assumed parents, and Mr. H. Balfour



FIGURE 1. *D.* × *belezeana* near the Agglestone, Godlingston Heath N.N.R., Dorset showing growth form and habit. Photo B. Edwards.

brought me from the New Forest plants which he and I thought had the same parentage. Further specimens and observations are, however, required to prove the occurrence of this hybrid in Britain". The most recent floras of these two counties shed no further light. That of Hampshire (Brewis *et al.* 1996) merely lists the record as "New Forest" DAW(ebb) 1975 – i.e. citing the brief account in Stace (1975). The Norfolk Flora (Beckett *et al.* 1999) says "*D.* × *obovata* and *D.* × *belezeana* were both listed from Dersingham in the early years of the 20th Century, but there seems some confusion over the records so neither can be considered as certain." Doubt obviously still resided in Druce's mind as to the exact nature of these unusual plants and his comments are clearly much more equivocal than Webb's later account would suggest.

The record from Borth Bog, v.c. 46, Cardiganshire is more tangible in that it is supported by a herbarium specimen with a well-documented provenance, but it is erroneous. It rests on a specimen (in **NMW**) collected by J. H. Salter in 1940. A. O. Chater has been kind enough to consult Salter's diaries and they show that on 23 July 1940 he (Salter) went out onto the bog, quickly found the commoner hybrid *D.* × *obovata*, and after some searching, one specimen he believed to be of *D.* × *belezeana*. Alas, this has recently been re-determined by A. Culham as *D.* × *obovata*. A trip to the bog in September 2002 by A. O. Chater confirmed Salter's area as completely overgrown, and other *Drosera* areas as holding plentiful colonies of the three species, but only a very few clumps of putative *D.* × *obovata*.

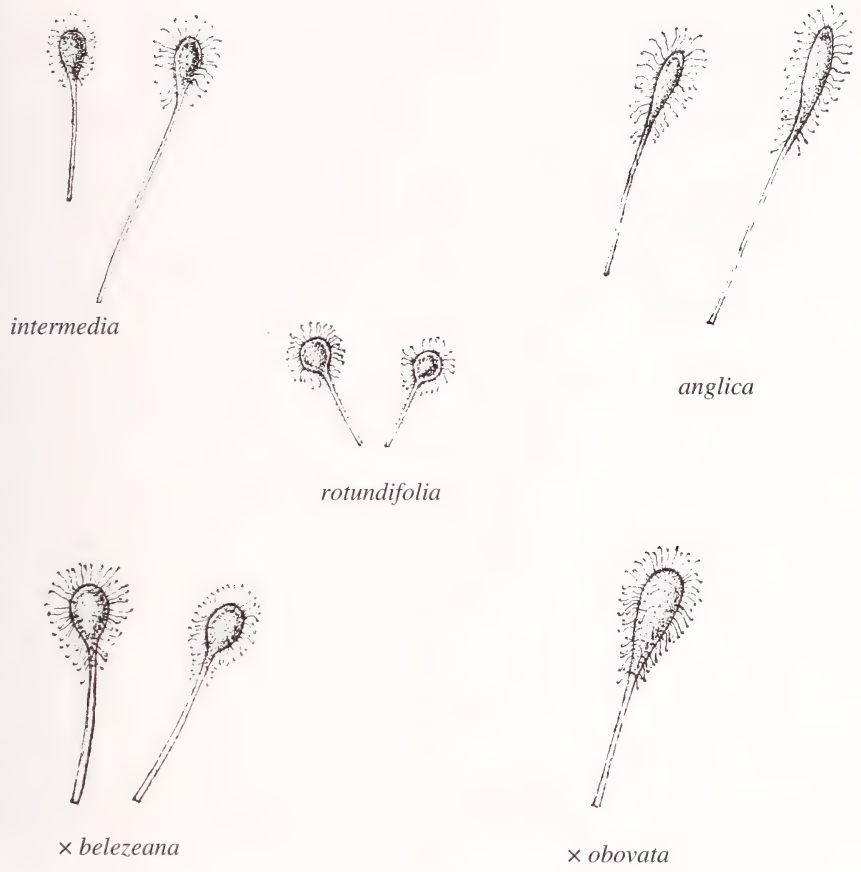


FIGURE 2. Typical leaves of the British *Drosera* species and their recorded hybrids

Prior to the recent Dorset find there is therefore no definite record of this hybrid from the British Isles. There are no British herbarium specimens identified as *D.* × *belezeana* in any of the major British herbaria and checking of material of the parental taxa and *D.* × *obovata* in **BM**, **K**, **E**, **RNG**, **NMW** and **LTR** has revealed no further *D.* × *belezeana* specimens. So, for the moment, that leaves the Dorset record as the first and only confirmed British site.

Both known *Drosera* hybrids are more vigorous than the parents but this is particularly the case with *D.* × *belezeana*. One of the colonies, which was visible from above, could be seen from almost 100 m away, and on closer inspection contained up to 40 leaves with each flowering stem. These leaves, perforce densely packed, are held consistently at an angle of 60°–80° from the ground, immediately differentiating them from the parents (Fig. 1). Leaf shape is most like that of *D. rotundifolia* (see Fig.2) but with a more cuneate base, more abruptly contracted to the petiole than in either *D. intermedia*, or *D.* × *obovata* – the taxon most likely to be confused with it, particularly when stunted. *D.* × *belezeana* has inherited the laterally produced peduncle from its *D. intermedia* parent, however confusion is easily possible when looking at past flowering stems of *D.* × *obovata* which may have become lateral through the continued growth of the shoot axis. In these instances a combination of leaf shape and seed surface characteristics will differentiate these hybrids – the abortive seeds of *D.* × *belezeana* having a faintly tuberculate surface reflecting the papillose surface of its *intermedia* parent as opposed to the reticulate surface of *D. anglica* (and *D. rotundifolia*).

D. × *belezeana* was first described from material collected from the environs of Paris in 1879 (Camus 1891). It was subsequently recorded from Bayern, Schlesien and Brandenburg by Schuster (1907), who regarded it as a somewhat variable entity. Webb (in Stace 1975) lists the hybrid as having been found in Austria, France and Germany. Huber (in Hegi 1961) does little more than re-list the localities given earlier by Schuster. This would appear to be a common pattern with those standard floras which do include the hybrid basing observations on earlier records, eg. Fournier (1977). The veracity of these is also open to question, thus Sebald, Seybold & Philippi (1992) reviewing historical records in the Baden-Württembergs region of Germany found that the three collections in **STU**, two collected by Bertsch and one by Schlenker, were all *D.* × *obovata*. A recent listing of the German flora (Wisskirchen & Haupler 1998) does not include *D.* × *belezeana* and similarly the most recent Austrian (Hartl *et al.,* 1992; Polatschak 1999; Schönfelder & Bresinsky 1990) and French floras (Guinochet & de Vilmorin 1973–1982) fail to include it. Species of *Drosera* have been in general decline throughout Europe through habitat loss and the opportunity for the hybrid to form will almost certainly have also declined.

In contrast to *Drosera* × *obovata* which is undoubtedly under-recorded (Culham 1998) and is frequent wherever its generally ecologically isolated parental taxa meet, *D.* × *belezeana* is obviously a remarkably rare hybrid. While also ecologically somewhat distinct, *D. intermedia* and *D. rotundifolia* probably grow in closer proximity more regularly than do *D. rotundifolia* and *D. anglica* throughout the less extensive, but still amphi-atlantic, range of *D. intermedia*. Clearly there is a more distinct barrier to hybridisation between these two taxa than exists between *D. rotundifolia* and *D. anglica*. This might in part be predicted as the diploid *D. rotundifolia* has long been recognised as one parent to the allopolyploid *D. anglica* (Wood 1955), whereas the diploid *D. intermedia* is more phylogenetically distant. At what stage the barrier(s) to reproduction occur is unclear although the hybrid has been successfully raised artificially using *D. intermedia* from southern U.S.A. (Slack 1986), an area from which the hybrid has never naturally been known to occur (Schnell 2002).

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Sagina maritima Don (Caryophyllaceae) and other halophytes in London

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ABSTRACT

Sagina maritima has been recorded at three sites by the River Thames near central London, much further from the open sea than elsewhere in Britain. Other halophytes occur nearby. Hydrological data and other records suggest that saline water carrying seeds or other propagules penetrated far upstream during periods of unusually low freshwater river flow. These are the first records of *S. maritima* in v.c. 17 (Surrey) and v.c. 21 (Middlesex); *Elytrigia atherica*, *Glaux maritima* and *Triglochin maritimum* are also new to Middlesex. The likely source populations of these halophytes are discussed.

KEYWORDS: Sea Pearlwort, estuarine flora, phytogeography.

INTRODUCTION

Centuries ago many marine and estuarine plants grew along the upper tidal reaches of the River Thames. This flora disappeared as a combination of drainage and embankment eliminated suitable habitats, narrowed the river and increased freshwater flow. Records for 1987–99 in the *New Atlas* (Preston *et al.* 2002) show that very few halophytes penetrate further upriver than hectad TQ57, more than 25 km downstream of London Bridge.

In March 2002 a pearlwort later determined as *Sagina maritima* Don was noticed on sloping river revetments along the Greenwich peninsula. Further stations were subsequently found at Rotherhithe and at Limehouse. Other saltmarsh plants have colonised a mudflat at East India Dock Basin, Blackwall. These stations are between 4–11 km below London Bridge where the river is normally only weakly brackish. This paper briefly reviews the phytogeography of *S. maritima* and describes its London sites. The estuarine flora at East India Dock Basin is described. The occurrence of coastal plants unusually far upstream, and similar changes in the distribution of estuarine algae and invertebrates, is related to increased salinity during periods of extremely low freshwater flow. If current trends in climate change and river use continue, more halophytes are likely to colonise London.

DISTRIBUTION OF *SAGINA MARITIMA*

S. maritima, an annual of open ground with little competition, is widely distributed around the eastern Atlantic and Mediterranean coasts from the Canary Islands north to the Lofoten-Vesterålen archipelago in Norway, and from the Azores to the Bosphorus. It favours upper saltmarshes, dune slacks and rock crevices washed by high spring tides or swept by blown spray. Inland it is native only where haline evaporites of the Keuper (Triassic) beds reach the surface; in Germany it formerly grew in such an area near Magdeburg in Saxony (Hegi 1909), and in England it occurs in the Cheshire plain near salt workings.

The distribution of *S. maritima* in northern Europe (Jalas & Suominen 1983) is strongly correlated with salinity. It is abundant on North Sea and Atlantic coasts (salinity 31–35‰), moderately common on the Baltic coasts of Denmark and south-western Sweden (salinity >10‰), occasional on the coasts of north Germany and east Sweden as far north as the Åland Islands (salinity 6–10‰) and extremely rare elsewhere in the Baltic, being classed as vulnerable in Finland and Estonia. In fact the limits of its distribution follow exactly the 6‰ iso-salinity contour (salinity data are from Rodhe 1998, expressed in gm NaCl per litre or parts per million, ‰).

There seem to be few ecological studies of *Sagina maritima*, perhaps because, unlike typical saltmarsh plants such as *Suaeda maritima* and *Salicornia* spp., it grows in a variety of habitats, dominating none of them, and has only a minor role in phyto-sociological communities (such as the NVC community SM27, "Ephemeral salt-marsh vegetation with *Sagina maritima*", or the continental association *Saginetea*). Like *Suaeda maritima*, which has a very similar distribution and is also rare in the Baltic, it is absent from the brackish waters (salinity <5·5‰) of the Gulfs of Bothnia and Finland. Though these Gulfs are often frozen in winter months, many annuals that are, like *Suaeda maritima*, spring-germinating, are common round their shores. It seems to be low salinity, not ice cover, that excludes *Suaeda maritima*. According to Ellenberg (1988) *Suaeda maritima* has the highest possible indicator value of 3 for salinity and is an obligate halophyte, whereas the value for *Sagina maritima* is 2. Nevertheless its distribution suggests it behaves very much like *Suadea maritima* and requires at least 6‰ salinity to maintain a stable population.

Apart from its Cheshire stations, confirmed records as a British or Irish native are from sites subject, at least occasionally, to inundation by sea water (or spray, as for example a Dorset record from Abbotsbury, 2 km inland from Chesil Beach). Rarely, *Sagina maritima* can penetrate some distance up tidal rivers. It was recorded in the 19th Century from salt marshes by the River Nene below Wisbech, Cambridgeshire (Perring *et al.* 1964; Crompton & Nelson 2000) near where A. C. Leslie found it again in 1983 (Crompton 2003); this is 10 km from the coast but the river is tidal as far as Wisbech. A recent spread to salted road verges was first noticed by Braithwaite (1997), who found it on roads up to 350 m altitude. However, Corner (2002) has convincingly argued that the solitary native record from an inland montane site (Ben Nevis) is erroneous.

THE NEW LONDON RECORDS

A pearlwort with deep green, fleshy, blunt leaves was noticed at Greenwich in early March 2002. Flowering plants gathered in May, from here and from further upstream at Rotherhithe, were determined as *Sagina maritima* Don by Nick Jardine. Flowering plants were also found at Limehouse, across the river from Rotherhithe, in June. Table 1 gives site details.

TABLE 1. LOCATION OF SITES

Locality	Grid reference	Distance below London Bridge in km
Greenwich (v.c.16, West Kent): Blackwall Reach between Alcatel Jetty and Amylum Works	TQ 391787 to TQ 390792	8·9–9·4
Rotherhithe (v.c.17, Surrey): Pageant Stairs	TQ 364805	4·3
Limehouse (v.c.21, Middlesex): Limehouse Hole Stairs	TQ 368805	4·7
East India Dock Basin (v.c.21, Middlesex)	TQ 390808	11·1

At Greenwich *Sagina maritima* was found growing with *Plantago coronopus*, *S. procumbens* and occasional *S. apetala* ssp. *apetala* in muddy cracks between stone and concrete slabs of a sloping revetment at several places along a 500 m stretch of river bank. Plants were on or below the strand line of the highest spring tides, and were matted with filamentous green algae, presumably *Blidingia* and/or *Rhizoclonium*. The plants at Rotherhithe and Limehouse were also close to the tide line, growing in compact colonies amongst green algae in the silty re-entrant angles of stone steps leading down into the river. At these sites *S. procumbens* was the only associated vascular plant. Colonies comprised many separate plants with intertwined root systems, suggesting a common origin from seed clusters. The Rotherhithe and Limehouse records are the first for Surrey and Middlesex respectively. The nearest *S. maritima* has previously come to London appears to be a 1903 record from Stone Marshes (TQ57) in West Kent, 36 km below London Bridge (Grinling *et al.* 1909); the closest modern record is near Gravesend (TQ67), 7 km further downstream. Two pre-1980 records from the Medway estuary (Philp 1982) have not been refound while in Essex, where *S. maritima* has always been rare, Shoeburyness, 75 km from London Bridge, is now perhaps its only station (see "Essex Rare Plants", on the website of the Essex Field Club).

In May 2003 members of the London Natural History Society found *S. maritima* abundant at Greenwich, accompanied by *Plantago maritima* at its highest recorded Thameside site.

Their appearance so far upstream indicates a period of increased salinity in the upper Thames estuary. Support for this come from the discovery of a rich array of saltmarsh plants at East India Dock Basin, a disused tidal basin handed over in 1998 by the London Docklands Development Corporation (L.D.D.C.) to the Lee Valley Park Authority as a wildfowl reserve (Table 1). Infilling by the L.D.D.C. to provide reedbeds for nesting cover produced a small area of mudflats. Halophytes recorded variously by Park ranger David Miller in 2000, by the author in 2001 and by the London Natural History Society in 2002 include *Aster tripolium*, *Bolboschoenus maritimus*, *Cochlearia anglica*, *Elytrigia atherica*, *Glaux maritima*, *Schoenoplectus tabernaemontani*, *Spergularia marina* and *Triglochin maritimum* as well as *Atriplex* spp. (including plants determined as *A. longipes* by John Akeroyd, but possibly closer to *A.* × *gustafssoniana* (Brian Wurzell, *in litt.*, and Knapp & Spiers 2003)). The records for *Glaux maritima*, *Triglochin maritimum* and *Elytrigia atherica* are the first for Middlesex (though the latter occurs nearby on the Essex side of the River Lea) while *Cochlearia anglica* was last recorded, from near this site, in 1869, and *Schoenoplectus tabernaemontani*, which has now been lost from its only other Middlesex station, was also here ("in a pond of breach a little beyond Limehouse") about 1700 (Kent 1975). Mr Wurzell has carried out a full survey of plants at the Basin.

The L.D.D.C. is thought to have introduced *Phragmites australis* deliberately, and the presence of abundant *Cotula coronopifolia* raises the possibility that other halophytes may have been introduced accidentally at the same time. But the swift development of a native flora and its persistence suggests that most arrived naturally (some perhaps brought by birds) and found a suitable habitat. Ellenberg recounts a similarly rapid colonisation of the Baltic island of Bock, formed by dredging in 1945 and "occupied by plants with an almost explosive rapidity presumably because of the masses of viable seeds floating in the sea and deposited on the new land shortly after its formation" (Ellenberg 1988: 363). A less extensive suite of saltmarsh plants, including five of the eight mentioned above, was recorded at Woolwich (v.c. 16) a further 6 km downstream, in 1962 (Lousley 1963) but that site has since been built over.

HYDROLOGY OF THE TIDAL THAMES

At 110 km, the Thames estuary is one of the longest in Britain. It is well-mixed vertically, so salinity varies very little between river bed, mid-stream, and banks; average salt levels vary from zero at Teddington to 2–3‰ at London Bridge and 3–4‰ at Greenwich, reaching open sea values of 32–34·5‰ at Southend. This average salinity profile is sensitive to the relative flows of tidal and fresh water and is by no means linear with distance downstream. Kinniburgh (1998) explains in some detail how low freshwater flows result in increased salinity at various points in the estuary. Fig. 1 shows monthly mean flows at Teddington between 1986 and 2002. The low flows of 1990–92, when a quarterly average salinity as high as 6·8‰ was measured at Greenwich, and the even lower flows of 1996–97 are striking features. The average flow for the whole of 1997 was 27% of the long-term yearly average, the lowest annual flow ever recorded. Monthly mean flows were above 10 $m^3 s^{-1}$ in only four months between July 1996 and October 1997. At such times flow is dominated by daily tidal movements, river water taking on average three months to flow from Teddington to the sea. This long residence time sets the time-scale for changes in salinity; Kinniburgh's data from a monitoring station at Greenwich show salinity in 1990 still rising after two months of low flow. During 1996–97 salinity must have reached or exceeded 5‰ at London Bridge and 7‰ at Greenwich for many months.

DISCUSSION

Changes in the distribution of lower plants and invertebrates in the Thames estuary have been well documented. Upriver migration of marine algae (*Fucus vesiculosus* and, to a lesser extent, *Ulva lactuca*) is described by Titley & John (1998) who postulate changes in salinity due to decreasing freshwater flow as a possible cause. A similar change, attributed unequivocally to lower freshwater

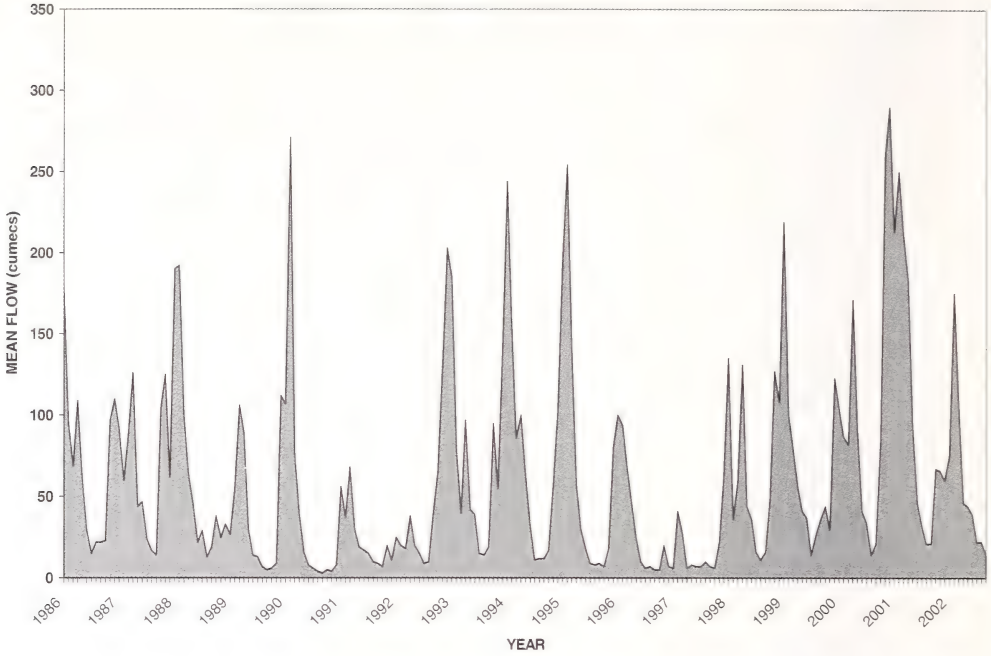


FIGURE 1. Monthly mean gauged flow of the River Thames at Kingston, 1986–2002. 1 cumec = 1 $m^3 s^{-1}$. Data from *Hydrological data UK: Hydrometric Register and Statistics yearbooks*, Institute of Hydrology (1986–1995), and website of the National River Archive at the Centre for Ecology and Hydrology, www.nwl.ac.uk (1996–2002).

flows, was found amongst some *Mollusca* and *Annelida*, at the same time as some freshwater macroinvertebrates were being lost from their upper Thames sites which became too brackish for them (Attrill 1998). Attrill & Rundle (2002) interpret such effects in terms of a "two-ecocline" model in which mid-estuary fauna are at the edges of their range. A similar model may apply to plants, a possible example being a rapid population fluctuation seen in *Plantago maritima* in response to similar edaphic changes over quite short distances (Jerling 1985). An annual such as *Sagina maritima* should be at least as susceptible. During extended periods of very low flow the salinity far upstream rises to at least 6‰ and perhaps even 10‰, allowing *S. maritima* and other halophytes to colonise the upper Thames.

Of course, as in the case of the new island of Bock quoted by Ellenberg, seeds must be present. It is not obvious that *Sagina maritima* plants found at Rotherhithe and Limehouse developed from isolated seeds. Trials on the author's table-top show that seeds of *S. maritima* do not float even in strong brine solution. This, and the presence of compact clusters with intertwined roots suggests that tidal currents deposited fragments of stems including whole capsules. Unger (1978) reports that this is an important dispersal mechanism for *Salicornia* spp., fragments of which float for up to three months.

The possible source of the seeds or other propagules has been investigated using *New Atlas* software. Strong counter-clockwise currents circulate in the North Sea, so most water entering the Thames estuary has flowed southwards down the East Anglian coast. The eight halophytes (excluding *Atriplex* spp.) recorded at East India Dock Basin are common along this shoreline. It is a simple exercise to map the hectads in which these eight occur as natives, together with *Sagina maritima*. Between 1987 and 1999, 54 British hectads had all nine. Fig. 2(a) shows the hectads in south-eastern England, including four on the coasts of Essex and Suffolk. This small number is due primarily to the sparse records for *S. maritima* itself, and *prima facie* it is doubtful whether there are sufficient sites to provide enough fruiting material.

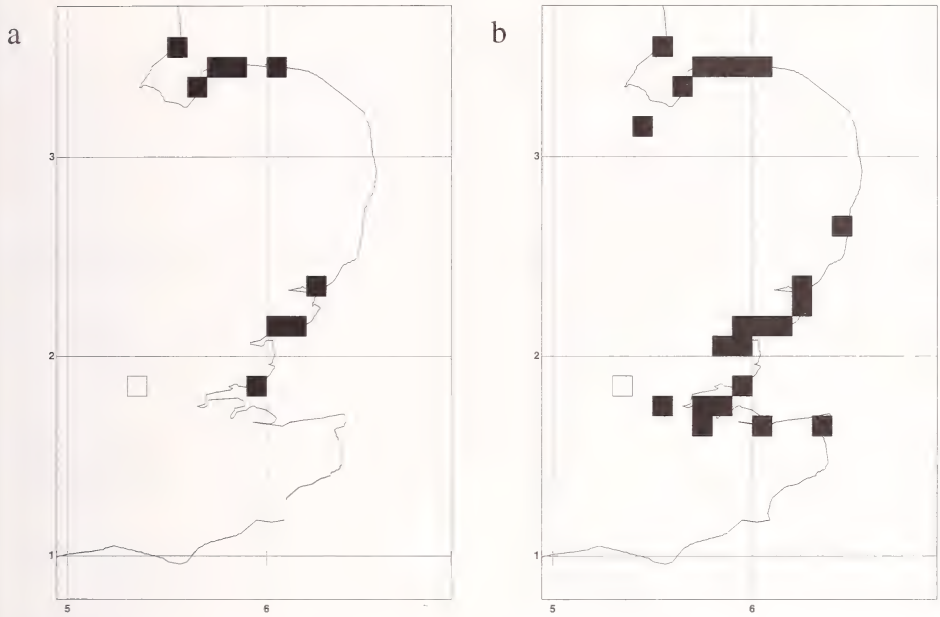


FIGURE 2. (a) Hectads in south-eastern England in which *Sagina maritima* and eight other halophytes (see text) were recorded as native between 1987 and 1999. The southernmost hectad contains the Shoeburyness site for *S. maritima*. (b) As (a) but including all historic records for *Sagina maritima*. The hectad south of the Wash contains the Cambridgeshire site mentioned in the text.
Hectad TQ38 containing the Rotherhithe and Limehouse stations for *S. maritima*, and East India Dock Basin, is shown as an open square on both maps.

Since *Sagina maritima* is an inconspicuous plant one might wonder whether there has been any recording bias. The *New Atlas* records "little significant change" since 1962 (change index = -0·08). However, if one considers records from 1987–99 as a proportion of all historic records, a different picture emerges. Only 62% of all British records of *S. maritima* were found or re-found in 1987–99, compared with 80% or more for most coastal species. This raises the possibility that *S. maritima* may still be present unrecognised (or, as Braithwaite (1997) warns, recorded as *S. apetala* subsp. *erecta*) in some of its former sites. *New Atlas* data were re-analysed as before, but now including all historic records of *S. maritima*. The number of British hectads with all nine rises to 74. As shown in Fig. 2(b), 22 of these are in south-eastern England with 14 clustered around the mouth of the Thames. If *S. maritima* lurks unrecorded in a few of these hectads, much more material is available to be swept up-river. Regular replenishment from such a source is needed if appearance of this annual species in the upper Thames is to be other than sporadic.

The trend to drier summers in southern Britain (Kundzewicz & Parry 2001) suggests that periods of exceptionally low freshwater flow will occur more frequently. The volume abstracted from the Thames for public water supplies continues to rise so that it is now sometimes greater than the natural flow (being compensated by release of treated sewage). It is likely that periods of high salinity will become more common. Given suitable habitats, other halophytes may follow *Sagina maritima* and surprise the London botanist.

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Notes

CAREX VAGINATA TAUSCH (CYPERACEAE): A SEDGE NEW TO ENGLAND

Carex vaginata (Sheathed sedge) has a Circumpolar Boreo-arctic Montane range (Preston & Hill 1997). It occurs in Northern Europe, locally in the mountains of central and southern Europe, in Siberia and in North America (Sell & Murrell 1996). In Greenland it is known from a single locality near the north-eastern coast (Gelting 1934). In the British Isles it was thought to be confined to Scotland, being mainly found in the Breadalbane and Cairngorm mountains of the Highlands, with the most southerly populations centred on the Moffat Hills in the Southern Uplands. Its altitudinal range is from 370–1150 m but it is usually found over 700 m (Preston *et al.* 2002). The first British record was from the Cairngorms by G. Don in 1802 (Druce 1932). J. T. Johnston first recorded it from the Moffat Hills in Dumfriesshire (v.c 72) in 1890 (Scott-Elliot 1896). More recently, further colonies have been discovered in the neighbouring Ettrick Hills in Selkirkshire (v.c 79) to the south and the Tweedsmuir Hills in Peeblesshire (v.c. 78) to the north (Corner 1978). It is a designated scarce species in Britain (Stewart *et al.* 1994).

In June 2002 an extensive colony of this species was discovered on Dufton Fell in the Westmorland (v.c 69) part of northern Pennines some 96·5 km south of the Southern Upland localities and new to England. This site lies 3 km south of the old Moor House field station and just outside the southern boundary of the Moor House National Nature Reserve. Later in the month with F. J. Roberts, another colony of this species was found on Dufton Fell 900 m to the west of the original colony. A further, much smaller colony was found some 10 km north of the original Dufton Fell site on Green Fell to the north of Cross Fell in Cumberland (v.c. 70). All the sites were on slopes below limestone outcrops in flushed grassland at altitudes from 700–720 m above sea level. Plants on the two sites on Dufton Fell were common over approximately 1300 and 300 m² of the south facing slopes and were similarly common over some 60 m² at the north facing Green Fell locality. The Dufton Fell sites for *C. vaginata* are relatively close to Upper Teesdale with its unique assemblage of relict species, so that it could be considered an important addition to the relict flora of that area. Voucher material for both vice-counties given to G. Halliday is in **LANC** and the remainder is in the author's personal herbarium.

Cumbria was the worst affected area in the British Isles during the foot and mouth disease outbreak in 2001 and sheep were culled from this area of the northern Pennines in early 2001 such that the area was ungrazed for two summers. The resurgence of *Alopecurus borealis* on the Cross Fell range had been observed in May 2001 and new populations discovered on Green Fell by L. Robinson (Robinson 2003). The remarkable abundance of flowering *Carex bigelowii* was also noted. In August 1991 an interesting flushed hillside on Dufton Fell had been found during the Flora of Cumbria survey. It contained *Euphrasia scottica, Juncus triglumis* and tiny sterile plants of *Trollius europaeus* which was previously unknown from high level sites in the area. The rare bryophytes *Cinclidium stygium* and *Onchophorus virens* also occurred very locally. In June 2002 the same flush, now ungrazed, was noted to have a thick grassy cover with only small open areas. *Trollius* remained as tiny-leaved sterile plants but thorough searching failed to reveal *E. scottica, J. triglumis* or the two bryophytes. Robust sterile plants of a sedge, thought at first to be rather lighter green *C. bigelowii,* were collected from the flush but were obviously not that species as they lacked the purplish rhizome scales and were difficult to dislodge. The next day these plants were compared with living garden material of *C. vaginata* collected from the Southern Uplands and found to be identical. In order to confirm beyond doubt that the plants were *C. vaginata* it was important to find plants with inflorescences and this was achieved with the help of F. J. Roberts the following week.

Table 1 gives the list of associated species on Dufton Fell with their relative frequency. Common associated bryophytes on Dufton Fell were *Hylocomium splendens, Mnium hornum, Pleurozium schreberi, Polytrichum formosum, Pseudoscleropodium purum,* and *Rhytidiadelphus squarrosus. Rhizomnium pseudopunctatum* was rare. In the wetter and bare areas *Palustriella commutata* and *Cratoneuron filicinum* occurred.

TABLE 1. ASSOCIATED SPECIES ON DUFTON FELL.
C = COMMON, O = OCCASIONAL, R = RARE.

SPECIES	C	O	R
Achillea ptarmica			x
**Anemone nemorosa*		x	
**Anthoxanthum odoratum*	x		
Bellis perennis			x
Caltha palustris		x	
**Cardamine pratensis*	x		
Carex binervis			x
C. dioica			x
**C. nigra*			x
C. panicea		x	
C. pilulifera		x	
**C. viridula ssp. oedocarpa*			x
**Cerastium fontanum*		x	
**Cirsium palustre*			x
Cochlearia pyrenaicum			x
Crepis paludosa			x
**Deschampsia cespitosa*			x
Empetrum nigrum			x
Equisetum palustre			x
E. sylvaticum			x
**Festuca ovina*	x		
Filipendula ulmaria			x
Galium saxatile		x	
G. uliginosum			x
Geum rivale		x	
**Juncus effusus*	x		
J. squarrosus			x
Luzula multiflora			x
Lychnis flos-cuculi			x
Nardus stricta	x		
Persicaria vivipara		x	
Potentilla palustris			x
**Ranunculus acris*	x		
R. flammula		x	
**Rumex acetosa*	x		
Saxifraga hypnoides		x	
S. stellaris		x	
Sedum villosum		x	
**Selaginella selaginoides*			x
Succisa pratensis			x
Taraxacum officinale		x	
**Trifolium repens*	x		
Trollius europaeus			x
Vaccinium myrtillus			x
Valeriana dioica		x	
Veronica scutellata			x
Viola palustris	x		
**Viola riviniana*			x

*Also in the Green Fell flush which had the following additional associated species: *Alchemilla glabra, Carex flacca, C. pulicaris, Eriophorum angustifolium, Festuca rubra, Luzula campestris, Potentilla erecta* and *Thymus polytrichus*. Although *Carex bigelowii* approached the edges of the flushed ground in blanket bog at all the sites, it was not an actual associate.

It is, perhaps, not surprising that *C. vaginata* occurs in the northern Pennines which are climatically similar to the higher parts of the Southern Uplands. Conolly & Dahl (1970) give *C. vaginata* as occurring within the mean annual maximum summer temperature isotherm of 21° C for Highland Scotland. They do not give a figure for southern Scotland because of its restricted distribution there, but suggest that it is in excess of that. An adjusted isotherm map for the above parameters gives the Southern Upland sites falling within the 23°C isotherm and the northern Pennine sites within the 25°C isotherm, although a spot height in the latter gives a figure of 23·2° C. The Southern Upland sites therefore tend to be cooler in summer. This may partially explain why *C. vaginata* descends to lower levels there (down to 490 m in places; Corner 1978). The flora of the Moffat Hills described by Ratcliffe (1959) has several local montane species common to both areas, of which *Epilobium anagallidifolium* and *Alopecurus borealis* are restricted to the northern Pennines in England.

Ferreira (1959) included *C. vaginata* in a group of species that were both acidophilous and indifferent to soil reaction. Ratcliffe & McVean (1962) listed it in a group of local and rare calcicoles of the Scottish Highlands. In the Southern Uplands, *C. vaginata* occurs in moderately base rich flushed grassland, but is also tolerant of more acid conditions. In one of the Ettrick sites it was present in soils of *p*H 3·8–5·6 (Corner 1978). It has recently been given the arbitrary R (*p*H) soil reaction status of 6 on a scale of 1–9 (very acid to very basic) in Ellenberg's indicator values for British Plants (Hill *et al.* 1999). Certainly in these Pennine sites it behaves as a calciole.

There appears to be little doubt that the discovery of *Carex vaginata* in the northern Pennines is partially due to the after-effects of foot and mouth disease. The grazing pressure on these fells over many years has been intense, so that the cropped leaves have rendered the sedge inconspicuous and likely to be confused with commoner species. It is known that inflorescences are rather sporadically produced and grazing would make them even less likely to be observed. The superficial similarity between sterile *C. bigelowii* and *C. vaginata* has not been made as clear in the British Floras as it has in those of Scandinavia, where Lid stated " sterile plantar kan likna *C bigelowii*" (Lid 1963). The shape of the intact mature leaf apices, that are best seen early in the season, is one of the easiest ways of distinguishing the two species when sterile. In *C. vaginata* the leaves are lighter green with flat, blunt or abruptly acuminate apices, compared with the darker green leaves of *C. bigelowii* which have acuminate and trigonous apices. The leaves of *C. vaginata* are wintergreen whereas those of *C. bigelowii* die back completely in winter. The failure to detect the sedge in the same flush eleven years previously could be ascribed to the inconspicuous appearance of these heavily grazed plants at the end of August when any ungrazed leaves would be partially withered.

The performance of these Pennine populations is as yet unknown and although vegetative growth is vigorous, it is not known if they set viable seed. The utricles of the inflorescences examined were empty and poorly formed. This may be a result of reduced fertility, as the plants could be derived from single clones with inbreeding taking place, but more observations are needed. Plants from ungrazed parts of the Ettrick hills in Selkirkshire (v.c. 79) seem much more vigorous and fertile than the Pennine plants, but this may be the result of complete lack of grazing over many seasons. Given time and reduced grazing pressure, the production of similarly robust plants may appear in the Pennine sites. There does, however, remain the possibility that these disjunct Pennine populations could differ biotypically from the Scottish populations as has been shown for some of the other Upper Teesdale rarities (Elkington 1978).

C. vaginata and its habitats do not seem to be under any threat at present. The large number of plants found at two of the sites shows that they are well able to withstand heavy grazing. It seems likely that populations of this species will be found in other parts of the high northern Pennines where flushed grassland occurs below limestone outcrops. Already it has been reported from another flush on Green Fell (R. Groom pers. comm.). It is to be hoped that future sheep grazing levels will be markedly reduced so that the post foot and mouth flora graphically described from this part of the Pennines by F. J. Roberts (Roberts 2003) will be allowed to flourish.

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I would like to thank Jeremy Roberts for his help and valuable observations in the field and Linda Robinson for her infectious enthusiasm for the montane flora of the Northern Pennines.

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Book Reviews

Great Natural History Books and their Creators. R. Desmond. Pp. 176, with numerous colour and black and white plates. The British Library. £25. 2003. Hardback. ISBN 0-7123-4774-7.

This misleadingly titled and packaged book is not just the hopelessly generalised coffee table book one might expect, but rather a series of brilliantly written narratives mostly describing the tortuous genesis of a number of the major illustrated Floras. It opens with a somewhat breathless but very informative account of the book trade from the time of Ray onwards (it is astonishing to learn that Lackington's bookshop in London, the Temple of the Muses, claimed to have over a million books in 1793). After this, Desmond gets into his stride with the discovery of the New World and the investigation of the flora of Asia, and with the stories of the botanists and other naturalists concerned.

The heroic perseverance of many of them is astonishing, none more so than Rumphius, who worked doggedly at his massive and illustrated *Herbarium Amboinense* in the Moluccas in spite of becoming blind, losing wife and a daughter in an earthquake, losing his books, specimens, manuscripts and drawings in a fire, losing a second wife, having his replacement drawings stolen, and finally losing half the completed work in a shipwreck (fortunately a copy had been made). It was not published until the 1740s, nearly forty years after the death of this veritable Job among botanists. Some of the stories have a quite operatic quality. Elizabeth Blackwell became something of a botanical Fidelio by thinking up and illustrating *A Curious Herbal* to get her husband out of a debtor's prison, while he inside wrote the descriptions. When she did get him out, two years later, he went to Sweden and became physician to the King and, after a series of political intrigues that read like a draft for the plot of Verdi's *A Masked Ball*, was beheaded. Scientific intrigue has its place too, none more bizarre then the account of how the ornithologist Audubon took revenge on Rafinesque, who had smashed his favourite fiddle by using it to kill bats invading his bedroom when he was Audubon's guest, by inducing him to publish a series of fictitious fish.

Desmond has vivid accounts of many other works, including *Flora Graeca*, *Banks's Florilegium*, Curtis's *Flora Londinensis* and the *Botanical Magazine*, *The Temple of Flora* and Oeder's *Flora Danica*. This last was seen by the author in the 1760s as the first contribution to an illustrated Flora of the whole of Europe, something that was briefly resurrected in Czechoslovakia two centuries later during the *Flora Europaea* project but has never yet been realised. A chapter on nature printing and similar techniques makes one realise how fortunate we now are with our scanners in being able so easily able to reproduce images of plants on paper. The final chapter is about clerics as authors, including Gilbert White and Keble Martin. The book is lavishly illustrated but, judging from the latter's Primulaceae plate, which has a brownish cast and quite fails to show the freshness of the plate in the first edition that it purports to represent, the colour reproduction is not infallible.

A. O. Chater

Arable plants - a field guide. P. Wilson & M. King. Pp. 312. Wild Guides, Old Basing, Hampshire. 2003. Hardback. £15·00. ISBN 1-903657-02-4

Arable plants – weeds growing among field crops – have over recent decades shown the most dramatic decline of any major group in the British flora. Currently a fifth of the species targeted for conservation action in the UK occur on arable land. Reforms to agricultural policy aimed at steering agriculture away from production towards environmental benefits may help to restore threatened arable weed communities to Britain's fields. As such there is a need for an accessible, comprehensive guide for non-specialists. This book goes a little way to filling that gap.

The first section serves as an introduction to the subject. The authors briefly describe the origins of the arable flora and the impacts that historical changes in land use have had on its development. They continue with a discussion of the effects that increasingly mechanised and intensive farming practices have had on arable plants before concluding with a brief summary of the role that agri-environment schemes are playing in arable plant conservation. The text is upbeat and simple in

style and will be accessible to a wide range of readers although some of the content is repetitive. It is interspersed with a good range of photos, maps and textboxes though the organization is somewhat jumbled and lacks overall cohesiveness. Shakespearean quotes, detailed farm maps, and a sequence of illustrations quaintly charting the effects of agriculture on a landscape through time (best described as "tea towel botany") add little value to the main text.

The next section begins with a discussion of the biology of arable plants and then proceeds to the heart of the matter, a field guide with profiles of 97 plant species. These are separated into broad-leaved species and grasses and ordered alphabetically using common names of genera (for example, Corn Marigold comes after Field Madder). Rather bizarrely, the keys are tucked into the middle of the plant profiles. They are not in fact taxonomic keys, more tables of plant characters. Each profile contains a brief description of the plant with notes on similar and associated species, habitat, soil types and management requirements for conservation. These are clear and provide information often missing from more standard guides. They are accompanied by colour photographs, a distribution map and illustrations of "important features" which are of variable quality (for example a line drawing of a *Viola arvensis* flower accompanies a photo of the same). Regrettably, the profiles focus exclusively on mature plants. The average visitor to an arable field will rarely encounter a perfect flowering individual; readers would surely benefit from illustrations or photos of other development stages e.g. seedlings. Phil Wilson included them in his *Field guide to rare arable flowers* (1994) as indeed do some existing guides, notably Hanf's (1983) *The arable weeds of Europe - with their seedlings and seeds* and Williams & Morrison's *ADAS Colour Atlas of Weed Seedlings* (1987).

The other glaring omission is that profiles are lacking for several major arable species, including *Chenopodium album, Polygonum aviculare* and *Stellaria media*. This is most disappointing. An uninitiated botanist could not take it into the field and confidently identify the majority of plants found. Indeed, the book is not what the title says - it is about *rare and declining* arable plants rather than arable plants *per se*. Just under a tenth of the species featured are extinct! Given the lack of space devoted to common vascular plants, it is surprising to see that a few bryophyte species are included.

The last section of the book, covering the threats and opportunities facing the arable flora, includes brief discussions and speculations about the use of new crops and other approaches to farming. It also includes a section on practical guidelines for the management of land for arable plants, and descriptions of successful conservation projects.

This is an interesting book that will appeal to a wide readership from farmers to policy makers. Botanists may put it on their coffee tables. It falls short as a field guide to arable plants but serves as a useful source book on the conservation of rare and declining arable plant species.

M. S. HEARD

Hewett Cottrell Watson: Victorian plant ecologist and evolutionist. F. N. Egerton. Pp. xxviii + 283. Ashgate Publishing, Aldershot. 2003. Hardback. £47·50. ISBN 0 7546 0862 X.

This biography of one of the most significant English botanists of the 19th Century is welcome – it fills a yawning gap. It has a special resonance for the B.S.B.I. and particularly for this journal which was named after Hewett Cottrell Watson because its contents "reflect all those facets of the study of the British flora which must for ever be associated with the pioneer work of H. C. Watson ..." (*Watsonia* **8**: 1, 1970). Yet I have reservations and cannot agree with the author (an American historian of science with a special interest in ecology who, by his own admission, was unaware of Watson's existence until he chanced upon some letters written to Charles Darwin) that "in plant geography and ecology, Watson's contributions were ... forgotten ...". That is an unjust assessment because it ignores more than a century and a half of botanical work here and in the Azores, not to mention references to Watson in publications other than *Watsonia*.

Hewett Cottrell Watson was not a "lovable" man. With scholarly probity, Egerton does not attempt to disguise this fact. Watson despised his father, writing in 1848 that "I never knew an individual towards whom I felt such a permanent and bitter antipathy as to my own father." Of "independent circumstances", able to "live comfortably" thanks mainly to a bequest from his mother's family, Hewett never had to find paid employment and so was able to pursue a varied

career as student, editor, author and botanist. He studied medicine at the University of Edinburgh but never graduated. Watson's involvement in the pseudoscience of phrenology, discussed at length by Egerton, is an aspect of this enigmatic man that may surprise those who know Watson's name only from his botanical work. He ventured abroad only once. In 1842, at his own expense, he joined a Royal Navy cartographic expedition to the Azores, commanded by Captain Alexander Vidal, and spent several months there, occasionally (when Vidal allowed) collecting on Pico, Faial, Corvo and Flores. From 1834 until his death in 1881, Watson lived a rather solitary life in Thames Ditton. Combative and quick to find fault, Watson eventually fell out with most of his contemporaries with the notable exceptions of Darwin (who acknowledged his debt to Watson in *Origin of species*) and Joseph Hooker.

With a daunting subject such as Watson, it is probably impossible to write a biography that is enjoyable to read and at times I struggled to comprehend Egerton's "Americanized" prose; according to a gracious acknowledgment many Americanisms were removed to accommodate "British tastes" following David Allen's "stylistic intervention". With its scholarly apparatus of footnotes and 40-page bibliography, there is no doubt Egerton's stolid tome is definitive. Of particular value is the 9-page chronological list of Watson's own publications which ranged from a 1829 contribution on phrenology to the posthumous second edition of *Topographical botany* (1883). The list seems to be complete but it isn't judging by the omission of four, albeit brief, signed notes (on "*Erica mackaii*", "*Eriophorum angustifolium* and *pubescens*", "*Crocus nudiflorus*" and "*Festuca loliacea*") published in *Companion to the botanical magazine* **1**: 225 (1837).

Omissions from a bibliography that is not claimed to be comprehensive are forgivable. Other faults are not so easy to excuse or overlook. Given Watson's importance as a botanist and pioneering phytogeographer, why does this biography (in a series devoted to "Science, technology and culture, 1700–1945") lack indexes to places and scientific names? I hope the blame for absent indexes lies with the series editor and the publisher, but the author himself must be responsible for other lapses. I wonder why Egerton consistently refers to the out-of-date 1977 edition of R. G. C. Desmond's *Dictionary of British and Irish botanists and horticulturists* instead of the revised and expanded 1994 edition?

Given my particular interest in European Ericaceae, I noticed two careless errors, surprising from an historian of ecology, which misrepresent Watson's botanical opinions and so are sufficiently serious to warrant detailed comment. On p. 35 Egerton succeeds in making Watson's British vegetation zones nonsensical. Egerton explains that each zone "contained indicator species which were absent from the zone above *and* [my italics] below" – *and* should read *or*. Then he makes a complete hash of the definition of the six zones. Watson's book contained this:

1. Agricultural zone ends where the cultivation of *Wheat* ceases.
2. Upland ~~~~~~~~~~~~~~ *Corylus Avellana* ceases.
3. Moorland ~~~~~~~~~~~~~~ *Carex rigida* begins.
4. Subalpine ~~~~~~~~~~~~~~ *Calluna vulgaris* ceases.
5. Alpine ~~~~~~~~~~~~~~ *Empetrum nigrum* ceases.
6. Snowy ~~~~~~~~~~~~~~ land terminates.

"~~~~~~~~~~~" does mean ditto but only for the three, underlined words, "zone ends where": the words "the cultivation of " should not have been repeated. Egerton's "Snowy zone ends where the cultivation of land terminates", to take only one line, is certainly not what Watson intended. His snowy zone began where *Empetrum nigrum* ceased to grow naturally and ended at the summits of the highest mountains where "land terminates"! Unfortunately anyone reading Egerton without Watson's original at hand will be utterly bewildered.

The other lapse has a similar confusing consequence. It occurs in the first sentence of the first paragraph on p. 93, summarizing Watson's observations and theorizings about the occurrence of "heaths" as he climbed to the summit of Pico ("the Peak" in his account), a magnificent dormant volcano which boast three native heaths representing three separate genera. Egerton has excised a crucial reference to *Calluna vulgaris* which was "that heath" that Watson wrote about thus:

" ... *Calluna vulgaris* had been observed lower down the Peak; and as that heath ascends in Scotland far above the *Pteris aquilina* [*Pteridium aquilinum*], I read the appearance of the latter as a fair indication that we were still within the natural limit of heaths ...".

This is an indubitably erudite tome but it is compromised by flaws that should have been noted and corrected. I hope the author and publisher will together rectify these and other errors promptly by means of an errata slip. Nevertheless, Egerton's biography is an essential reference book for all libraries concerned with the history of botany and plant geography of Great Britain and Portugal. However, given its cost, I cannot wholeheartedly recommend it to "ordinary" members of the B.S.B.I. – there are more enjoyable and readable books to spend your money on.

E. C. NELSON

A catalogue of alien plants in Ireland. S. C. P. Reynolds. Pp. 414. Occasional papers no. 14, National Botanic Gardens, Glasnevin, Ireland. 2002. Softback. ISSN 0792 0422.

This modest title hides what is surely the definitive work on the subject, covering, in addition to a valuable introduction, the history and detailed distribution of all alien plant taxa recorded in Ireland. The catalogue covers 920 alien species, of which 645 have been recorded since 1987. Incidentally *Alien plants of the British Isles* (Clement & Foster, 1994) and *Alien grasses of the British Isles* (Ryves, Clement & Foster 1996) cover between them nearly 5200 taxa, all those ever recorded in the British Isles. The *New Atlas*, with its accompanying CD-Rom (Preston, Pearman and Dines 2002) covers 1712 alien taxa, including archaeophytes, but does not include many of those last recorded before 1987.

So the Irish alien flora is relatively poor, but even so over two-thirds of the taxa covered in this new work were not dealt with in Scannell & Synnott's *Census Catalogue* (ed. 2, 1987), and most are sourced to an impressive Bibliography (850 entries). Indeed alien plants in Ireland (as in Britain) can now be seen to represent over half of the total flora in terms of number of species.

The introductory chapters are very relevant and interesting. After setting the background, covering the historical publications and previous treatments, the major part comprises a history and analysis of the alien flora, covering a historical overview and an analysis of the current situation which includes numbers, sources and impact. Details are given of historical trends and the 'turnover" of alien species – about 30% of those recorded in the past have vanished, for example, and the proportion of the total aliens recorded which originated from cultivation rose from 54% in the 19th century to some 70% today. Ireland has a high (higher than Britain) percentage of its alien flora occurring only as casuals (45%), and many of the others are found in very few sites. Another section covers the impact of alien plants, with a table of plants considered naturalised in natural or semi-natural habitats. A last section covers, in exemplary fashion, explanatory notes to the main catalogue.

The main catalogue – the meat of the book – covers all the species that are included as "certainly introduced" and "probably introduced" in the 1987 *Census Catalogue*, together with about 640 additional taxa not covered there. To these are added 11 taxa treated as "possibly introduced" in the *Census Catalogue*, but which Clement & Foster (1994) have called alien. Otherwise the "possibly introduced" taxa in the Census Catalogue are not covered in this work, which is probably a pity, since there are under 30 in that category and some discussion would have been interesting, though a few are dealt with in the Appendix.

In the main catalogue every species account is prefaced by notes on its history in Ireland. To an outsider this is really valuable information, and it is supplemented by details of the first record, where applicable. This is followed by all the records for those species not covered in the *Census Catalogue*, and updates for those that are. All these records are sourced, mainly to literature, but often from personal communications. This is extremely welcome and valuable and, of course, is additional to that which was covered in Clement's books. This reviewer would very much like the opportunity of achieving what Reynolds has achieved for Britain. The species accounts are in different fonts according to their treatment in the Census Catalogue. The publication of this new work did not wait for that of the *New Atlas*. I can quite see that the correlation of the two works would have been a very big task, but mildly regret the chance lost. There are, I am sure, good additional data in the *Atlas*, but also, I suspect, errors there too, both of identification and data submission. Reynolds includes a few records later than the *Atlas* cut-off at the end of 1999.

By and large the treatment of species between this work and the *New Atlas* is very close. *Fumaria bastardii, F. muralis, F. purpurea, Allium schoenoprasum, Juncus compressus* and

Viscum album, together with *Adoxa moschatellina* and *Lepidium latifolium,* are treated by Reynolds as alien, albeit often with covering notes, thus following the *Census Catalogue*, whereas in the *New Atlas* they are mapped as native. Conversely *Crepis biennis* and *Iris foetidissima* are treated by her as native, as opposed to alien in the *New Atlas*. She sensibly sets out the case for and against *Luronium natans* and *Stratiotes aloides* and sits on the fence! Most of the 139 archaeophytes in the New Atlas that occur in Ireland are treated as aliens by Reynolds, including all the *Salix* species we treated as archaeophytes in the *New Atlas* and, indeed, of the 33 not covered, and thus treated by implication as native, 12 were shown in the *Census Catalogue* as "possibly introduced", reinforcing my regret that she had not dealt with them. Indeed, this is my only significant disappointment, that by "making the pragmatic decision" referred to in the Introduction to follow the Census Catalogue for all status decisions other than the handful covered in Clement & Foster (1994) alluded to earlier, she has unnecessarily circumscribed herself, and omitted discussions that, given the quality of the rest of the book, would have no doubt been an interesting and worthwhile addition to this field that is exceptionally full of people riding their own hobbyhorses! For instance, I would have been interested in her view of the *Census Catalogue* categorising *Medicago arabica* as alien but, say, *Geranium rotundifolium* and *Picris echioides* as native.

The book is concluded by an interesting appendix covering nearly 50 additional species, treated as native, but including *some* of the "possible introductions" from the *Census Catalogue*, a superbly comprehensive bibliography, and a proper index – scientific and common names in one list.

The author must be congratulated in assembling this catalogue. I can unhesitatingly recommend it to anyone interested in the botany of the British Isles.

D. A. Pearman

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The cover illustration of *Meconopsis cambrica* (L.) Viguier (Welsh Poppy) was drawn by Rosemary Wise.

An assessment of the origin of *Alopecurus geniculatus* L. based on 2C DNA amounts, NOR sites, RAPDs and cpDNA analysis

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ABSTRACT

Phylogenetic relationships were investigated between three diploid species of *Alopecurus: A. myosuroides* Huds. *A. aequalis* Sobol. and *A. bulbosus* Gouan. (2n = 14) and two tetraploid species: *A. pratensis* L. and *A. geniculatus* L. (2n = 28). Significant differences in 2C DNA amounts were found between the species: *A. aequalis* = 7·20 pg, *A. myosuroides* = 7·74 pg, *A. bulbosus* = 9·27 pg, *A. pratensis* = 13·25 pg and *A. geniculatus* = 16·17 pg when measured by flow cytometry using propidium iodide as the fluorochrome and *Hordeum vulgare* L. as an internal standard. Differences in 2C amount between diploid and tetraploid species were significant. The 2C DNA amount of *A. geniculatus* was more than twice that of either *A. aequalis* or *A. myosuroides* but less than twice that of *A. bulbosus*. Four nucleolar organiser region (NOR) sites, identified by fluorescent *in situ* hybridisation using a 9kb *Eco* R1 fragment of the 18S-5.8S-25S ribosomal DNA genes isolated from wheat (pTa71), were found in each of the diploid species. Six NOR sites were found in *A. geniculatus* and eight in *A. pratensis*. Cluster analysis of 135 fragments produced after RAPD analysis with twelve primers showed the highest genetic similarity was between *A. bulbosus* and *A. geniculatus*, whose chloroplast (cp)DNA $tRNA^{Leu1}$ intron sequences were shown to be identical. This suggests that *A. bulbosus* was the likely diploid progenitor of *A. geniculatus*. However, polyploidy was accompanied by loss of DNA and a reduction in the number of NOR sites.

KEYWORDS: chromosome number, flow cytometry, 2C nuclear DNA amounts, nucleolar organiser regions (NOR), *in situ* hybridization, pTa71, phylogeny, RAPDs, $tRNA^{Leu1}$ intron, cpDNA sequence.

INTRODUCTION

The genus *Alopecurus* (Poaceae) includes c. 50 species that are distributed in Europe, Asia Minor and North Africa. It is thought to have originated in the Mediterranean basin (Strelkova 1938) and has been introduced into North America and New Zealand. In Britain, *A. pratensis* L. is extensively cultivated as a forage crop and *A. myosuroides* Huds. is a major weed of arable crops.

Three diploid species (2n = 2x = 14), *A. myosuroides*, *A. aequalis* Sobol. and *A. bulbosus* Gouan, and two tetraploid species (2n = 4x = 28) *A. geniculatus* L. and *A. pratensis* are considered in this study as they formed part of earlier studies (Sieber & Murray 1979, 1980, 1981). The chromosomes of all five species are metacentric to sub-metacentric. Chromosomes can only be distinguished on the basis of size or shape in *A. myosuroides,* which contains a large pair of metacentric chromosomes (Sieber & Murray 1979).

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Alopecurus bulbosus is rare in Britain as it is at the northern edge of its distribution. It is restricted to a few populations on the margins of salt-marshes in southern England. Maude (1939), Darlington & Wylie (1956) and Fedorov (1969) reported only diploid plants of this species but Sieber & Murray (1980) found populations with diploid, triploid and tetraploid individuals (2n = 2x = 14, 2n = 3x = 21 and 2n = 4x = 28). It closely resembles *A. geniculatus* (Hubbard 1984) but may be distinguished by its erect habit and swelling of the basal nodes. Hybrids of *A. bulbosus* × *A. geniculatus* (*A.* × *plettkei* Mattf.) are triploid, sterile and morphologically intermediate between the two parental species. *Alopecurus aequalis* is an annual species found in sporadic populations at the margins of lakes and reservoirs in south-eastern England. *A. myosuroides* appears to be more distantly related to the other diploid species on morphology. Furthermore, both terminal and interstitial chiasmata were formed during meiosis in *A. myosuroides*, whereas only terminal chiasmata were found in *A. aequalis*, *A. bulbosus* and *A. geniculatus* (Sieber & Murray 1979). Previous studies have suggested that *A. geniculatus* is an autotetraploid sharing common ancestry with *A. aequalis* and *A. bulbosus*, as does one of the genomes of the allotetraploid *A. pratensis* (Johnsson 1941; Sieber & Murray 1979, 1980, 1981; Murray *et al.* 1984). *A. pratensis* and *A. geniculatus* hybridise in natural populations and B chromosomes have been reported in *A. pratensis* (Sieber & Murray 1981).

Nuclear DNA amounts have been measured by Feulgen microdensitometry (Sieber & Murray 1979; Olszewska & Osiecka 1982; Bennett & Smith 1991; Bennett & Leitch 1997) and are summarised in Table 1. With the exception of Sieber & Murray (1979), the studies are limited as the chromosome number of the plants studied was not recorded and the DNA amounts cannot be compared precisely with those of the present investigation.

Flow cytometry enables DNA amounts to be determined rapidly from leaf tissue. The choice of a suitable fluorochrome is important. The fluorochrome 4′, 6-diamidino-2-phenylindole (DAPI) results in lower coefficients of variation of peaks of DNA content histograms than other commonly used fluorochromes including propidium iodide (PI) but has a preference for AT bases (Doležel *et al.* 1992). Whilst PI shows no base preference and is therefore more suitable than DAPI for the determination of absolute DNA amounts. *Hordeum vulgare* cv Sultan (2C = 11·12 pg) (Bennett & Leitch 1995) was used as an internal standard in this investigation because it is one of the standards recommended by Bennett & Leitch (1997) and its DNA amount is similar to that of *Alopecurus* species.

TABLE 1. ESTIMATES OF 2C NUCLEAR DNA AMOUNTS (MEAN ± SD) OF FIVE *ALOPECURUS* SPECIES ESTIMATED BY FLOW CYTOMETRY, USING PROPIDIUM IODIDE, (THIS INVESTIGATION) AND FEULGEN MICRODENSITOMETRY IN PREVIOUS STUDIES

	Present study (Propidium Iodide)			Previous studies (Feulgen)		
Species	Chromosome no. (2n)	Mean 2C (pg DNA ± SD)	Standard	Chromosome no. (2n)	Mean 2C (pg DNA ± SD)	Standard
A. aequalis	14	7·20 ± 0·11	A	14	8·6 ± 0·35[1]	*C*
A. myosuroides	14	7·74 ± 0·16	A	14	9·4 ± 0·31[1]	*C*
				-	8·61[4]	*A*
A. bulbosus	14	9·27 ± 0·15	A	-	10·4 ± 0·28[1]	*C*
A. pratensis	28	13·25 ± 0·14	A	28	15·1 ± 1·38[1]	*C*
				-	13·62[2]	*B*
A. geniculatus	28	16·17 ± 0·14	A	28	18·5 ± 0·12[1]	*B*
				-	14·93[3]	*D*

(1. Sieber & Murray 1979; 2. Olszewska & Osiecka 1982; 3. Bennett & Smith 1991; 4. Bennett & Leitch 1997). The standards used were A) *H. vulgare* cv Sultan (2C = 11·12 pg), B) *Allium cepa* cv Ailsa Craig (2C = 33·5pg), C) *Allium cepa* cv Suttons A1 (2C = 33·5pg), D) *Senecio vulgaris* (2C = 6·33pg).

In recent years fluorescent *in situ* hybridisation (FISH) techniques have been developed (Heslop-Harrison *et al.* 1991; Kenton *et al.* 1997; Leitch *et al.* 1997). The clone pTa71, containing the 9Kb Eco R1 fragment of wheat ribosomal DNA (rDNA) (Gerlach & Bedbrook 1979), has been used to detect the nucleolar organiser regions (NOR sites) of highly repeated and tandemly arrayed 18S, 5.8S and 25S rDNA sequences (Flavell 1986). This method has been used to clarify relationships and evolution in a number of polyploid species, including members of the Triticeae (Mukai *et al.* 1991; Carbrera *et al.* 1995; Jiang & Gill 1994), *Festuca* (Thomas *et al.* 1997), *Lathyrus* (Murray *et al.* 1992a), and *Saccharum* (Jenkin *et al.* 1995).

Traditional systematics relies on morphological characteristics and meiotic pairing to differentiate between taxa. DNA-based molecular techniques have made considerably more information available. However, limitations in the type and appropriate use of data generated exist (Karp *et al.* 1996). Random amplified polymorphic DNA (RAPD) has been used to evaluate the genetic structure of populations, species and genera in a wide range of plants: *Brachypodium* (Catalan *et al.* 1995), *Festuca/Lolium* (Stammers *et al.* 1995), *Brassica* (Demeke *et al.* 1992), *Rosa* (Millan *et al.* 1996), and *Rubus* (Graham & McNicol 1995). However, phylogenetic trees generated from RAPD data should be treated with caution, as there are a number of problems with using RAPD generated patterns for phylogenetic analysis that introduces noise into RAPD data sets (Reiseberg 1996; Gillies & Abbott 1998) and it has not been possible to produce phylogenies for *Leucaena* (Harris 1995) and *Styloanthes* (Gillies & Abbott 1998) using RAPD data. Nonetheless, conserved bands do occur within closely related species that are useful for phylogenetic analysis (Harris 1995; Stammers *et al.* 1995).

As chloroplast DNA (cpDNA) sequences have a conservative rate of nucleotide substitution and a uniparental (maternal in most plant species) mode of transmission they have been widely used to generate phylogenies within and between genera (Wolfe *et al.* 1987, 1989; Downie & Palmer 1992). Comparison of the rates of mutation in *rbcL* and two non-coding regions of cpDNA, the *trnL* (UAA intron) and the intergenic spacer between the *trnL* (UAA) 3' exon and the *trnF* (GAA) gene, have been made in several genera. These non-coding regions evolve faster and show greater resolution at the generic and intrageneric level (Taberlet *et al.* 1991; Gielly & Taberlet 1994), and phylogenies based on *trnL* intron sequences have been generated for several genera (Taberlet *et al.* 1991; Ferris *et al.* 1993; Gielly & Taberlet 1994; Fennell *et al.* 1998). The *trnL* gene of chloroplasts and eubacteria contain a group I intron that is conserved in primary sequence, secondary structure and its position within the UAA anticodon of the gene. Whilst some regions are highly conserved (Kuhsel *et* al. 1990; Ferris *et* al. 1993) other regions, in particular the region between the sequences of the stem P8, are variable and have been found to contain insertion/deletion mutations and microsatellite variation in addition to simple base substitutions between species within the genus *Spartina* (Ferris *et al.* 1997; Ferris, unpubl.). The conserved regions greatly aid alignment of sequences while the variety of mutations provides useful phylogenetic data. Thus the cpDNA *trnL* intron from the five species of *Alopecurus* was sequenced to provide further phylogenetic comparisons.

The aim of this study was to use the techniques of molecular systematics to study the relationships between the five *Alopecurus* species, in particular to identify the diploid progenitor of the tetraploid species. The DNA amounts of the five species of *Alopecurus* were estimated both to resolve apparent inconsistencies between previously published DNA amounts and to examine the evidence of the possible origins of the tetraploid species. NOR sites were identified using FISH to provide further information on the possible diploid progenitor of the tetraploid species.

MATERIALS AND METHODS

Plants investigated

Plants of each species of *Alopecurus* were taken from natural populations (Table 2) and maintained in pots in an experimental garden.

DNA MEASUREMENTS BY FLOW CYTOMETRY

The 2C DNA content of isolated nuclei obtained from leaves was determined by flow cytometry using *H. vulgare* cv. Sultan (2C = 11·12 pg) as the internal calibration standard and a Partec CA-III flow Cytometer (Partec GmbH, Munster, Germany). The method used to measure DNA amount

TABLE 2. LOCATION OF PLANT COLLECTIONS AND TYPE OF ASSAY PERFORMED ON INDIVIDUAL SPECIMENS AND ASSAY

Species	Site	Grid Reference	Assay
A. aequalis	Boddington Reservoir, Warks.	SP498525	2
A. aequalis	Ruislip Lido, Bucks.	TQ087895	1 + 2
A. aequalis	Heronry Pond, Wanstead Flats, Essex	TQ415871	3
A. bulbosus	Seasalter, Sussex	SY463906	2
A. bulbosus	Bridport, Dorset	SY463906	1 + 2 + 3
A. myosuroides	Epping Forest, Essex	TQ425995	2
A. myosuroides	The Abbey, Tilty, Essex	TL600268	1 + 2
A. myosuroides	Moletrap Pub, Tawney Common, Essex	TL501013	3
A. pratensis	Wanstead Common, Essex	TQ400865	2
A. pratensis	Leamington Spa, Warks.	SP325657	1 + 2
A. pratensis	Plymouth, Devon	SX515626	3
A. geniculatus	Leamington Spa, Warks.	SP325657	1 + 2 + 3
A. geniculatus	St Petersburg, Russia	-	2

1. flow cytometry, 2. RAPD analysis, 3. sequencing *trnL* cpDNA.

using PI as the fluorochrome was that of Doležel *et al.* (1989). Approximately 50 mm^2 of young leaves of the *Alopecurus* under investigation together with a similar area of leaf material of *H. vulgare* cv. Sultan were chopped together in 400µl nuclei isolation buffer (lysis buffer, LB01) (Doležel *et al. 19*89), consisting of 15 mM Tris, 2 mM NaEDTA, 80 mM KCl, 20 mM NaCl, 0·5 mM spermine, 15 mM ß-mercaptoethanol, 1 ml l^{-1}Triton X-100, pH 7·5. All reagents were obtained from Sigma Ltd. unless otherwise stated. The lysate was made up to 2 ml with buffer (LB01) and filtered through nylon gauze (pore diameter 40 µm). 50µg/ml^{-1} ribonuclease A and 50µg/ml^{-1} PI were added and the suspension incubated in the dark for one hour on ice. The samples were filtered through nylon gauze (pore diameter 20 µm) and fluorescence was measured with a 40 × 0·80 quartz objective and an Argon laser light source (488 nm wavelength) used with a TK420 dichromic mirror and an OR610 barrier filter. The data were analysed on DPAC software (Partec GmbH, Münster, Germany). The linearity of measurements of fluorescence intensity obtained was checked by the method of Bagwell *et al.* (1989). However, no correction was required to compensate for non-linear amplification by the flow cytometer. Estimates of the ratio of fluorescence intensities of *Alopecurus* to *Hordeum* (p1/p2) were based on the mean of a minimum of three samples per plant, each with a minimum of 10,000 nuclei giving peaks with a coefficient of variation of less than 5%. The product of this ratio and the DNA amount of *H. vulgare* (11·12pg) was used to provide an estimate of DNA amount for each *Alopecurus* species, measurements were made from at least three individual plants.

Estimates of the 2C ratio of DNA for the five species were also made using 4´, 6-diamidino-2-phenylindole (DAPI) using the method of Yokoya *et al.* (2000).

CHROMOSOME COUNTS

The tips of actively growing roots or shoots were pretreated in a saturated solution of α-bromonaphthalene at 4°C for 20 – 22h. They were then fixed in 3:1 absolute ethanol: glacial acetic acid (v/v). Following hydrolysis for 10 min in 5N HCl at 20°C, the meristems were dissected out and squashed between microscope slide and coverslip in 0·1% aceto-orcein. For each species, a minimum of five metaphases were counted for each of the three plants used for flow cytometry.

NOR SITES

The tips of actively growing roots were pretreated as above. The root was placed in a drop of 0·01 M sodium citrate buffer on a microscope slide and the meristem excised with tungsten needles. Excess buffer was removed and a drop of 0·01M sodium citrate buffer containing 6% cellulase and

2% pectolyase (Kikkoman Ltd.) added. Slides were then incubated in a humid chamber at 37°C for 15–20 minutes, after which the enzyme mixture was removed. Excess epidermal tissue was removed, the root tip was macerated in 45% acetic acid and then squashed between slide and coverslip. Coverslips were removed from frozen preparations. The slides were then air dried, and stored at -70°C in a sealed bag with silica gel.

NOR sites were identified using a 9kb *Eco* RI fragment including the 18S-5.8S-25S ribosomal DNA genes isolated from wheat (Gerlach & Bedbrook 1979) contained in plasmids (pTa71). The method used was essentially that of Heslop-Harrison *et al.* (1991). Root tips were prepared as above. Excess cytoplasm was removed from air-dried squash preparations by treatment with 10µg/ml^{-1} pepsin at 37°C in a humid chamber (Leitch *et al. 199*4). The slides were dehydrated through a series of graded alcohols and stored overnight in a vacuum desiccator at 4°C to stabilise the chromosome morphology (Leitch *et al. 199*4; Leitch *et al.* 1997). Prior to hybridisation the slides were placed in 3:1 absolute ethanol: glacial acetic acid (v/v) for 30 minutes and in 96% ethanol twice for 10 minutes before air-drying (Kenton *et al.* 1997). Hybridisation of the probe to the chromosome preparations followed the protocol of Heslop-Harrison *et al.* (1991) using an Omnigene *in situ* block (Hybaid Ltd). The hybridisation mix (per 40 µl of mix: 20µl 100% formamide, 8µl 50%(w/v) dextran sulphate, 4µl 20xSSC, 2µl of probe DNA (pTa71) (100ng/µl), 2µl of sonicated herring sperm DNA, 0·5µl 10%(w/v) SDS and 3·5µl of water) was heated to 80°C for 10 min, cooled on ice for 5 min before placing 40 µl of the hybridisation mix on a single slide which was covered with a plastic coverslip and placed on the Omnigene *in situ* block. Chromosomes were denatured at 72°C and washed. Post-hybridisation washes, after overnight incubation on the PCR block at 37°C, followed Heslop-Harrison *et al.* (1991). The slides were given two stringency washes in 20% (v/v) formamide in 0·1 × SSC for 5 min at 42°C in a shaking water-bath, followed by three further 3 min washes in 2 × SSC at 42°C. Probe bound to the chromosomes was detected using fluorescein isothiocyanate (FITC) labelled anti-digoxigenin (Boehringer-Mannheim). The chromosomes were counter-stained using PI (2µg/ml) for 10 min in the dark, washed in phosphate buffered saline and mounted in Vectarshield (Vector Laboratories Ltd.) containing 2 µg/ml DAPI. Slides were viewed with a Nikon Optiphot fluorescent microscope with a microflex UFX-11 attachment using the G filter (546nm). The negatives were digitised at 80 dpmm (Boots plc), imported into Adobe Photoshop and converted to greyscale.

DNA isolation

Genomic DNA was extracted from fresh leaves in CTAB buffer using a modification of the method of Weising *et al.* (1995). Excess protein was removed by digestion with protease, followed by washing, to remove carbohydrates (Jobes *et al.*1995; Sul & Korban 1996). All reagents were obtained from Sigma Ltd unless otherwise stated. Briefly, 1g of fresh leaves harvested from greenhouse grown plants was quickly frozen in liquid nitrogen and ground in a pre-chilled pestle and mortar. The powder was mixed with 7 ml 1:1 3% CTAB buffer: 8M LiCl (v/v) and incubated for 1 hr at 60°C (Sul and Korban 1996). The DNA was washed twice with an equal volume of 24:1 (v/v) chloroform/isoamyl alcohol and mixed thoroughly to form an emulsion, which was centrifuged at 4,400 rpm for 10 min and the supernatant transferred to new tubes. The chloroform/ isoamyl step was repeated once. The DNA was precipitated with 2/3 volumes of ice-cold isopropanol held at -20°C for a minimum of 30 min before centrifuging at 4,400 rpm for 5 min and resuspending in TE buffer with 0·5% SDS (Sambrook *et al.* 1989). Excess proteins were removed by treatment with 1mg/ml of protease (from *Streptomyces griseus*) at 37°C for 2hrs. The DNA was precipitated with isopropanol as above and centrifuged at 13,000 rpm for 10 min. The pellet was dissolved in water. 0·5 volume 5M NaCl (v/v) and then two volumes of 95% ethanol were added to precipitate the DNA (Jobes *et al.* 1995). The pellet was resuspended in 500 µl H_2O. The DNA was then washed twice with 25:24:1 (v/v) phenol/chloroform/isoamyl. RNA was removed by treatment with 150 µg/ml of RNAse A for 30 min at 37°C. The DNA was precipitated in 1/10 volumes of 4M LiCl followed by 3 volumes of ice-cold absolute ethanol (v/v), centrifuged at 13 000 rpm for 15 minutes and dissolved in 50 µl of TE buffer. The DNA was stored at 4°C for up to one month or -20°C for up to 6 months. DNA quality and quantity was determined by gel electrophoresis. A 5 µl sample of the DNA was mixed with 3 ml of loading buffer. The electrophoresis was performed on 0·8% agarose gel in TAE buffer (Sambrook *et al.* 1989) containing 0·5 ng of ethidium bromide using a Hybaid Electro4 with an LKB Bromma 2179 power supply. DNA concentration was estimated by visual assessment of band intensities, compared to a lambda *Hind*III ladder (Promega Ltd).

RAPD analysis

DNA from a minimum of two plants per species, each from a different population, (Table 2) was used for RAPD analysis using a modification of Williams *et al.* (1990). Optimised reaction conditions were carried out on approximately 50 ng genomic DNA in 25 µl total volume containing 2·5 µl of 10x *Biotaq* buffer (Bioline Ltd), 2·5µl 25 mM $MgCl_2$, 2·0 µl of 10 mM dNTP's (dGTP, dCTP, dATP, dTTP) (Bioline Ltd), 0·1µl of 5Uμl^{-1} *Biotaq* polymerase (Bioline Ltd.) and 10 µl of primer (10mM concentration, Bioline Ltd). Each reaction mix was overlaid with PCR-grade paraffin oil. The PCR profile was as follows: 1 denaturation cycle of 95°C for 2 min, then 2 cycles of 95°C for 30 sec, 37°C for 1 min, 72°C for 2min, then 2 cycles of 95°C for 30 sec, 35°C for 1min, 72°C for 2 min, then 41 cycles of 94°C for 30 sec, 35°C for 1 min, 72°C for 2 min and terminated with a final extension of 72°C for 10 min.

Amplified DNA fragments were separated by 1·6% agarose gel electrophoresis using TAE buffer (Sambrook *et al. 1*989). A negative control was added in each run to test for contamination. A 100 bp ladder (Promega Ltd.) was included on all gels to provide a standard DNA sample. Gels were stained with 0·5 µg ml^{-1} ethidium bromide and fragment patterns were photographed under UV light using Polaroid 667 film. The presence of bands was verified by eye, however the Polaroid photographs were used for the analysis and to determine the molecular weight of each visible band.

Twenty primers were evaluated for their suitability and twelve 10-base primers (Bioline Ltd) were selected on the basis of the reproducibility and intensity of polymorphic bands (Table 3). The selection of each primer was based, after several trials, on its ability to amplify the DNA from all five species and that each primer gave reproducible bands on more than one occasion from DNA from the same plant. Bands of identical size amplified with the same primer were considered to originate from the same marker. Markers that were considered unreliable were excluded and only data from clear bands were scored.

Bands were scored as present (1) or absent (0), and a matrix constructed such that the columns corresponded to the individual plants analysed and the rows to the presence or absence of bands. Pairwise genetic similarities were calculated using Jaccard's coefficient of asymmetric similarity (F), where $F=M_{xy}/(M_t-M_{xyo})$, where M_{xy} represents the number of bands shared between both individual plants, M_t the total number of bands in the survey and M_{xyo} the number of bands that were not present in either of the individuals (Jaccard 1908; Gillies & Abbott 1998; Virk *et al.* 1995) in RAPDistance v1.01 (Armstrong *et al.* 1994). The unweighted pair group method with arithmetic average (UPGMA) similarity and cluster analysis in RAPDistance and PHYLIP v.3.5 (Felsentein 1993) were used to construct a phenogram showing genetic similarity between the five species.

Sequencing of the cp DNA $tRNA^{Leu1}$ (trnL) intron and parsimony analysis

DNA samples were extracted with a Qiagen extraction kit (Qiagen Ltd). The intron was amplified following the protocol of Taberlet *et al.* (1991) with the following modifications. In a sterile 0·5 ml eppendorf tube 4·0 µl of 10mM dNTPs were mixed with 5 µl of 10 × *Biotaq* buffer (supplied with enzyme by Bioline Ltd), 2·5 µl of 50mM $MgCl_2$, 0·4 µl of *Biotaq* polymerase, 1·0 µl of each 10mM primer (Table 4, Bioline Ltd), 10 µl of the diluted DNA sample (30–50 ng of DNA sample per tube), and 28·1µl of distilled water. The reaction mixture in each tube was overlaid with a drop of sterile mineral oil. For amplification the tubes were placed in a Perkin Elmer 9600 thermal cycler. The PCR programme was 5 minutes at 94°C, 30 cycles of 30 seconds at 94°C, 30 seconds at 55°C and two minutes at 72°C. A final ten minutes at 72°C ensured full extension of all amplified fragments. The amplification product was then purified using a Qiagen PCR Clean-Up Kit (Qiagen Ltd.). Direct PCR sequencing of the purified PCR products was carried out using the DyeDeoxy Terminator sequencing Kit (Applied Biosystems). The $tRNA^{leu1}$ intron was labelled with the supplied fluorescent dye mixture using a Perkin Elmer 9600 thermal cycler set to 25 cycles of the following sequence: 93°C for 30 sec, 50°C for 15 sec and 60°C for four min.

The DNA sequence was determined by automated acrylamide gel electrophoresis (Model 373A, Applied Biosystems). The sequences obtained from the five *Alopecurus* species were analysed with Sequence Navigator v.1.01 (ABI prism transbiosystem Inc.) and then transferred to Editseq v.3.75 (DNAstar). The $tRNA^{Leu1}$ intron sequences of eight species from the Poaceae from the EMBL database were used as an outlying group. The choice of species was made to represent a

TABLE 3. TYPE OF RAPD PRIMER, PRIMER SEQUENCE AND BAND DATA FOR EACH OF THE TWELVE SELECTED PRIMERS USED ON THE FIVE SPECIES OF *ALOPECURUS* PRODUCING A TOTAL OF 135 FRAGMENTS

Primer	Sequence 5'–3'	Total Fragments	Polymorphic Fragments	Monomorphic Fragments	Species Specific Fragments	Fragments Specific to *A. bulbosus* and *A. geniculatus*	Fragments Specific to *A. aequalis* and *A. geniculatus*
G-70-11	GTCTCGTCGG	7	7	0	*A. pratensis* *A. bulbosus*		
G-70-12	GGCCTACTCG	10	9	1	*A. myosuroides* *A. bulbosus* (2) *A. aequalis*		
G-70-16	CAGGGGCATC	8	8	0	*A. myosuroides* (4) *A. aequalis*		
G-70-1	GAGACCTCCG	15	15	0	*A. myosuroides* *A. geniculatus* *A. pratensis* (3) *A. bulbosus*	900bp 976bp	560bp
G-70-18	GGCCTTCAGG	18	18	0	*A. myosuroides* *A. aequalis* *A. pratensis* (2)	1050bp	1300bp
G-17-19	GCTCTCACCG	10	9	1	*A. myosuroides* *A. pratensis*	680bp	440bp 230bp
G-80-21	ACGCGCCAGG	9	9	0	*A. myosuroides*	550bp	
G-80-23	GGCCCCATCG	16	16	0	*A. myosuroides* *A. aequalis* *A. pratensis*	2500bp	
G-80-24	CGCGAGGTGC	8	7	1	*A. pratensis*		
G-80-26	CCCGAGTGCC	9	9	0	*A. myosuroides* *A. pratensis*	400bp	
G-80-28	CGCACCGCAC	12	12	0	*A. myosuroides* (4) *A. pratensis* *A. bulbosus*	930bp	1350bp
G-80-29	ACGGCGGCTC	13	12	1	*A. pratensis* *A. bulbosus* *A. geniculatus*		950bp
Total		135	131	4	42	8	6

TABLE 4. NUCLEOTIDE SEQUENCE AND ANNEALING TEMPERATURE OF PRIMER PAIR USED FOR PCR AMPLIFICATION OF $tRNA^{LEU1}$ cpDNA

Primer pair	Nucleotide sequences	Annealing Temp
trn L (UAA) 5'exon	5'CGAAATCGGTAGACGCTACG3'	55°C
trn L (UAA) 3'exon	5'GGGGATAGAGGGACTTGAA3	55°C

taxonomically closely related taxon, *Puccinellia distans*, to act as a sister to the ingroup, and also several more distantly related genera to adequately root the tree and indicate the general taxonomic position of the genus *Alopecurus* within the Poaceae. The EMBL reference numbers of sequences used to construct the tree are given in Table 5. Sequences for all taxa were aligned using Megalign v.1.05 (DNAstar Inc.) and the resulting matrix corrected manually to provide the optimum sequence alignment. The sequence data for all species were then analysed using PAUP v.4.0 (Swofford, 2002) to produce phylogenetic trees. A matrix scoring deletions and insertions was first added to the sequence data with the alignment gaps scored as missing data. All characters were weighted equally and unordered. A parsimony analysis was run using Branch and Bound with the COLLAPSE and MulTrees options on. Computation was via stepwise with the addition sequence set to furthest. As a test for levels of homoplasy within the data set the tree scores CI (consistency index), RI (retention index) and RC (rescaled consisteny index) were calculated. A bootstrap analysis was run using the same parameters as above with 1000 replicates.

TABLE 5. $tRNA^{LEU1}$ INTRON SEQUENCES USED FOR PHYLOGENETIC ANALYSIS

Species	EMBL accession number	Reference
A. myosuroides	AJ271688	This study
A. aequalis	AJ271686	This study
A. bulbosus	AJ271685	This study
A. geniculatus	AJ271689	This study
A. pratensis	AJ271687	This study
Oryza sativa	X15901	Hiratsuka *et al.* 1989
Hordeum vulgare	X745741	Fangan *et al.* 1994
H. vulgare 2	X757051	Gielly and Taberlet 1994
Puccinellia distans	X75706	Gielly and Taberlet 1994
Spartina alterniflora	Z69914	Ferris *et al.* 1997
S. maritima	Z69911	Ferris *et al.* 1997
Triticum aestivum	X75709	Gielly and Taberlet 1994
Zea mays	X75709	Maier *et al.* 1995

RESULTS

DNA amounts of leaf tissue measured by flow cytometry.

The mean 2C DNA values obtained in this study are shown in Table 1 together with estimates of DNA value from previous studies using Feulgen microdensitometry. The 2C DNA amounts obtained for the five species were significantly different and it was possible to discriminate between species using fluorescence intensities of PI-stained nuclei. There were significant differences between the mean 2C DNA values for species between and within both the diploid and the tetraploid species, (two-way ANOVA: $F = 1{\cdot}57$, $P = 0{\cdot}175$). There was a correlation between measurements made using PI and DAPI as the fluorochrome ($R^2 = 0{\cdot}9858$, $r = (p > 0{\cdot}05)$, $y = 1{\cdot}0658x$). Figure 1 shows the 2C DNA amounts of *Alopecurus* spp. estimated by flow cytometry using PI as the fluorochrome and previously published values obtained by Feulgen microdensitometry. The values obtained by Feulgen microdensitometry were, on average, 15% higher than those obtained by flow cytometry using PI as the fluorochrome. Of the diploid species,

A. bulbosus has the largest 2C DNA content of 9·27pg compared to those of *A. aequalis* (2C = 7·20 pg) and *A. myosuroides* (2C = 7·74pg). The DNA content of the tetraploid species *A. geniculatus* (2C = 16·17pg) is 87% of that of the doubled DNA content of *A. bulbosus*, but is 98% of the sum of the 2C DNA contents of *A. aequalis* and *A. bulbosus*.

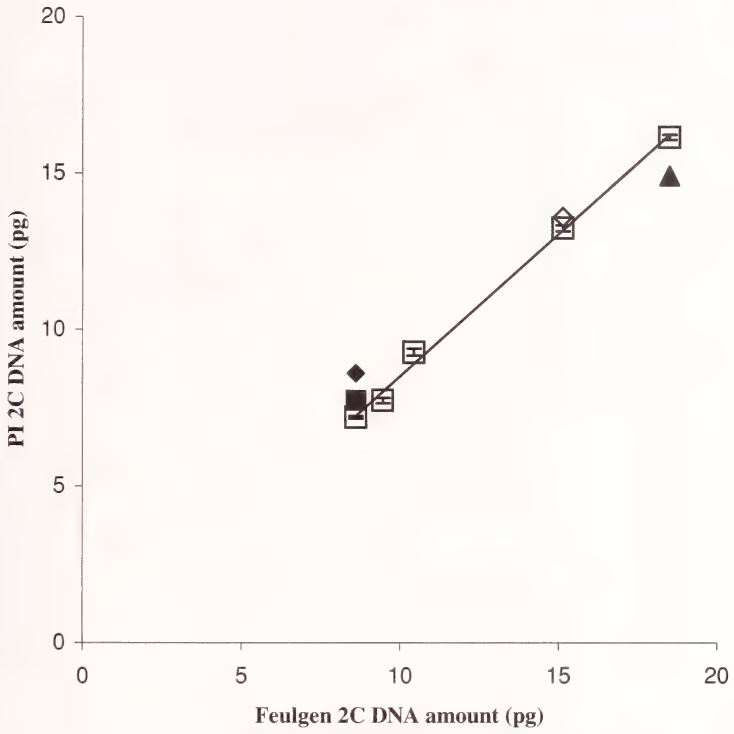


FIGURE 1. The mean 2C values of *Alopecurus* spp. obtained by flow cytometry using PI (□) as fluorochrome with *H. vulgare* cv Sultan as standard compared with values obtained by Feulgen microdensitometry using *A. cepa* cv Suttons A1 (Sieber & Murray 1979). Error bars indicate ± SE. The correlation between PI and Feulgen microdensitometry was R^2 = 0·9964, y = 0·9102x–0·584, r = (p>0·05). 2C values obtained from Feulgen microdensitometry for *A. myosuroides* (◆) (Bennett & Leitch 1997), *A. pratensis* (◇) (Olszewska & Osiecka 1982) and *A. geniculatus* (▲) (Bennett & Smith 1991).

Chromosome numbers and NOR-sites

The chromosome numbers of the populations analysed were found to be 2n = 14 for *A. aequalis*, *A. bulbosus* and *A. myosuroides* and 2n = 28 for *A. pratensis* and *A. geniculatus.* The chromosomes for all the species were metacentric or submetacentic. NOR sites were found at similar sub-terminal positions in all species. All the diploid species had 4 NOR sites whilst 6 NOR sites were found in *A. geniculatus* and 8 in *A. pratensis* (Fig. 2).

RAPDs

A total of 135 bands were scored, with an average of 11–25 bands per primer. 97% of bands were polymorphic, of which 31% were unique to only one species and 3% monomorphic. Fig. 3 shows the RAPD products of *Alopecurus* species generated from primer G-80-23. Table 3 gives the RAPD band data for each of the 12 primers and the 135 bands produced. Each primer had between 7 and 18 bands, which ranged in size from 230–2,500 bp, although the majority of bands occurred between 400–1500 bp. For each primer the species that have species-specific fragments are given, for those that have multiple specific fragments the number of fragments is indicated in brackets. Those fragments that are shared by only *A. bulbosus* and *A. geniculatus* and those that are only

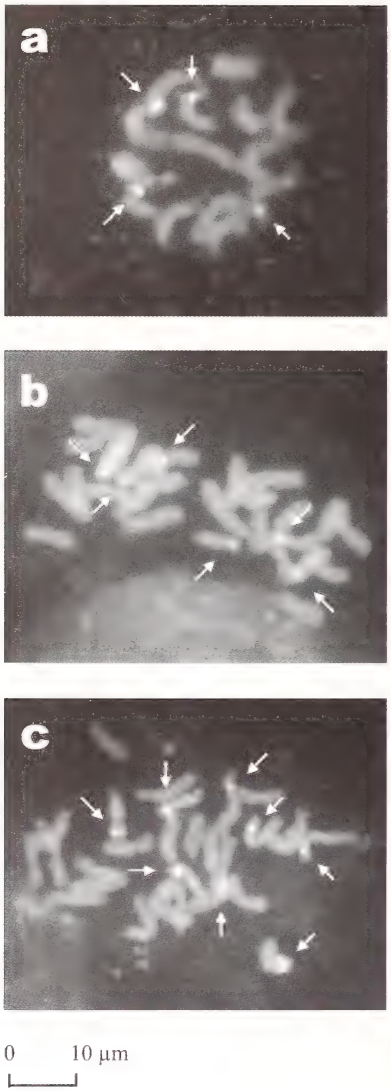


FIGURE 2. NOR-banded metaphases of a) *A. aequalis*, b) *A. geniculatus* and c) *A. pratensis* following FISH using plasmid pTa71 identified by FITC labelled antidigoxigenin and counterstained with PI; the NOR sites appear as bright signals on the chromosomes (arrows).

shared by *A. aequalis* and *A. geniculatùs* are also listed as fragment sizes. However, it is likely that the number of species specific fragments and the bands shared between either only *A. geniculatus* and *A. bulbosus* and only *A. geniculatus* and *A. aequalis* would be reduced if a larger sample size had been used. Although intraspecfic variation occurred for all the species, the sample size used in this study limits any conclusions on this point. UPGMA cluster analysis of similarity showed that the highest degree of similarity occurred between *A. geniculatus* and *A. bulbosus* whilst the greatest differences occurred between *A. geniculatus* and *A. myosuroides* (Fig. 4).

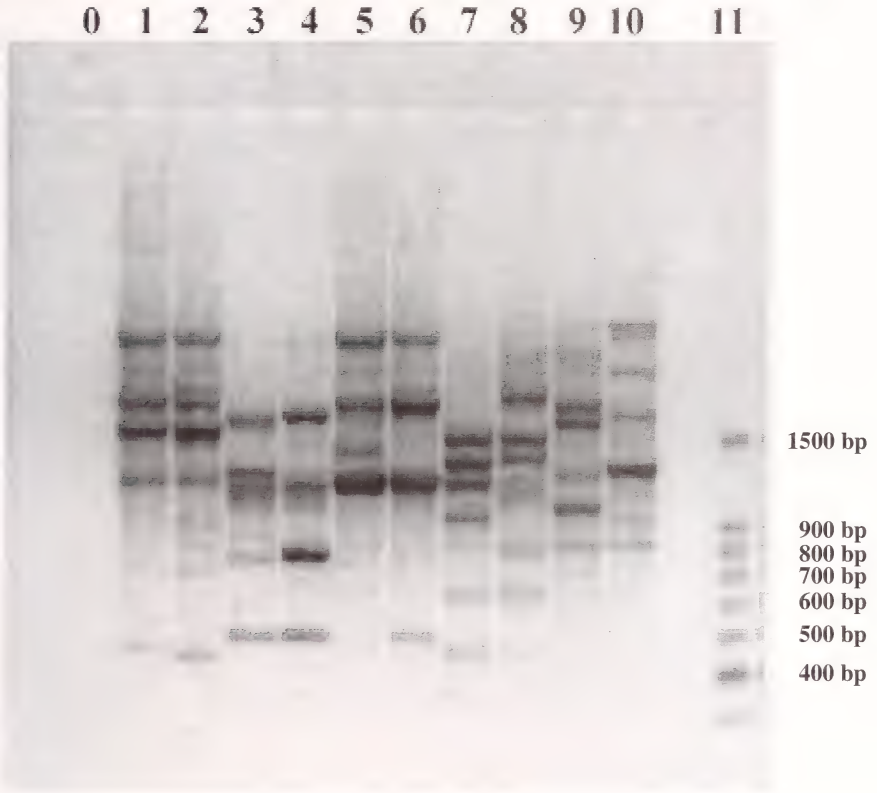


FIGURE 3. A RAPD polymorphism profile generated from primer G-80-23. Lane 0 was negative control, Lanes 1 + 2 *A. bulbosus*; Lanes 3 + 4 *A. aequalis*; Lanes 5 + 6 *A. geniculatus*; Lanes 7 + 8 *A. pratensis*; Lanes 9 + 10 *A. myosuroides*; Lane 11 100 bp (λ) (Promega Ltd) molecular weight marker.

cpDNA parsimony analysis

The single shortest most parsimonious phylogenetic tree of 226 steps is shown in Fig. 5. The observed number of mutations, given as the branch length, was high enough to separate the different taxa analysed, and also to differentiate between species within a genus, e.g. *Spartina*, *Hordeum*, and *Alopecurus*. The chosen cpDNA sequence was thus very informative at all levels. The tree scores were all high; CI (0·858), RI (0·847) and RC (0·727), indicating a low level of homoplasy and therefore high reliability that the data set fit the tree produced. The bootstrap analysis produced values between 70–100% indicating that the tree is robust and the groupings given are statistically reliable. The genus *Alopecurus* form a monophyletic group upheld by a bootstrap value of 99%. Within this clade *A. pratensis* is basal for the genus. There is strong support (92%) for a sub-clade including the three species *A. aequalis*, *A. bulbosus* and *A. geniculatus*. The latter two species had identical $tRNA^{Leu1}$ intron sequences, with the sequence obtained for *A. aequalis* differing from these two by only three mutations.

DISCUSSION

There was a closely correlated relationship between 2C DNA values obtained from the fluorescence intensity of PI stained nuclei and previously published 2C DNA values obtained by Feulgen microdensitometry (R^2 = 0·994, r = (p> 0·05)) (Sieber & Murray *1979*). The 2C DNA values estimated by fluorescence intensity of PI stained nuclei were consistently lower than those

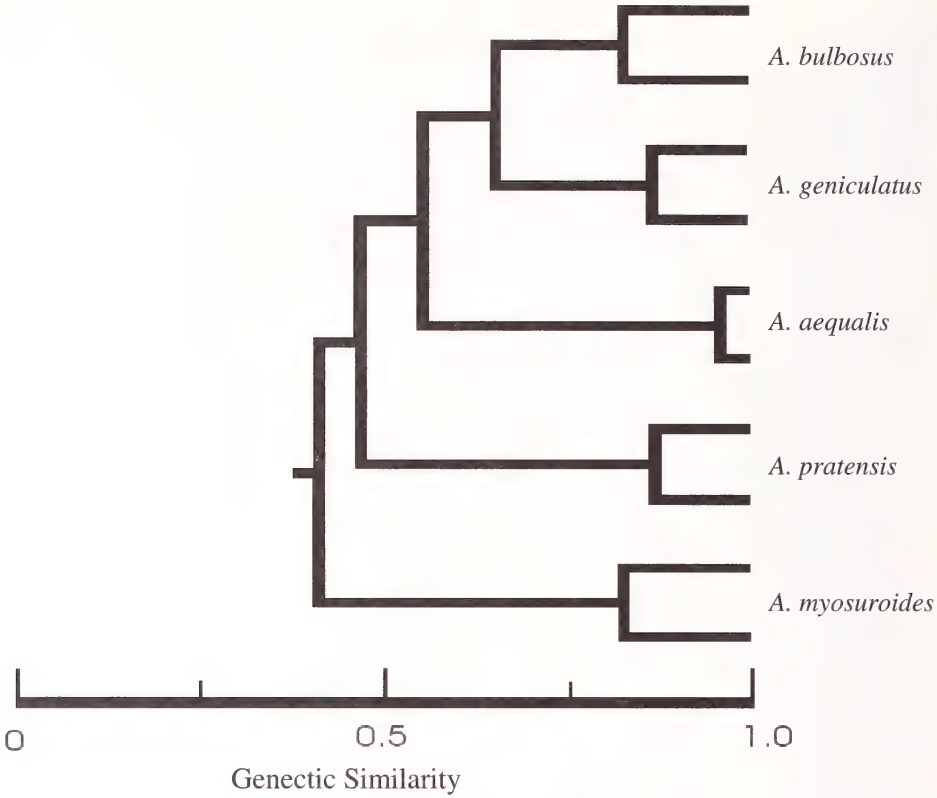


FIGURE 4. Dendrogram of *Alopecurus* spp generated by cluster analysis using genetic similarities generated from 135 RAPD bands produced by 12 primer pairs.

obtained by Feulgen microdensitometry. The discrepancy between estimates of DNA amount of *Alopecurus* by Sieber & Murray (1979) may result from the choice of standards as Sieber & Murray (1979) used *Allium cepa* cv. Suttons A_1 assigning a 2C value of 33·5 pg rather than the recommended standard *A. cepa* cv. Ailsa Craig (Bennett & Smith 1991,1976; Bennett & Leitch 1995; Bennett *et al.*, 2000a). Variation exists between varieties of *A. cepa* (Bennett & Smith 1976) which may account for the differences obtained for 2C values obtained by Sieber & Murray (1979) and those obtained in this study from the fluorescence intensity of PI stained nuclei. By using *A. cepa* cv. Ailsa Craig, Olszewska & Osiecka (1982) obtained a much lower estimate, close to the one obtained here (Table 1). However, Bennett *et al.* (2000b) showed that there was little variation in measurements of the 2C content, by flow cytometry, in either a number of varieties of *A. cepa* or one variety grown at a range of geographical locations. In contrast, Baranyi & Greilhuber (1999) give 2C values for varieties of *A. cepa* ranging from 33·04–35·14 pg DNA with a mean ± S. E. of 34·00 ± 0·14 but attribute much of this variation to a lack of standardisation in the techniques used between different laboratories.

For flow cytometery the calibration standard should ideally have a similar DNA value to that of the species being estimated to minimise technical errors (Bennett & Smith 1976). The 2C DNA amount of *H. vulgare* L. cv. Sultan 2C = 11·12 pg is closer to that of *Alopecurus* than is *A. cepa* (2C = 33·5pg). Use of an internal standard reduces errors resulting from interaction between chromatin and tannins (Greilhuber 1988; Bennett *et al.* 2000a). A further source of variation between the two studies may have been due to differences in DNA content between individual plants used in each study. Specimens were largely collected from the same locations and populations to reduce this variation. However, the composition of the populations studied may

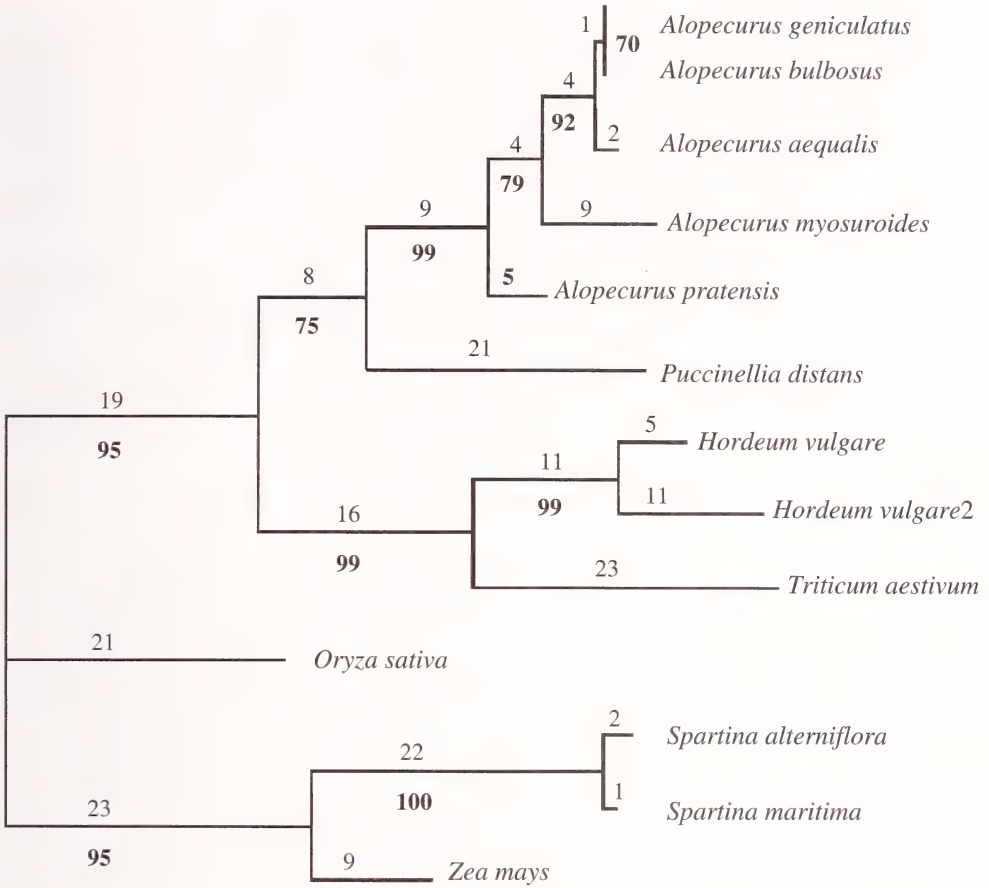


FIGURE 5. The single most parsimonious phylogenetic tree of 224 steps length based on the $tRNA^{Leu1}$ intron sequence data of the five *Alopecurus* species and the $tRNA^{Leu1}$ intron sequences of species from the eight additional Poaceae from the EMBL database. The number of mutations separating each species is given above the branch and bootstrap values are given in bold type below the branch.

have changed during the 20 years separating Sieber & Murray (1979) and the present study. Additional measurements of 2C DNA amount, by Feulgen microdensitometry include: *A. myosuroides* (Bennett & Leitch 1997), *A. pratensis* (Olszewska & Osiecka 1982) and *A. geniculatus* (Bennett & Smith 1991) but are limited as the chromosome number of plants studied was not recorded and the DNA amounts cannot be compared precisely with those of the present investigation.

The DNA amounts in autopolyploids are often a multiplication of the diploid progenitor genome, for example: *Celosia* (Nath *et al.* 1992); *Narcissus*, *Hyacinthus* and *Tulipa* (Brandham & West 1993); *Vaccinium* (Costich *et al.* 1993); *Prunus* (Vance-Baird *et al.* 1994); *Ipomoea* (Ozias-Atkins and Jarret 1994). Allopolyploids may also contain the sum of the 2C contents of their component genomes, for example: *Glycine* (Hammatt *et al.* 1991); *Arachis* (Singh *et al.* 1996); *Allium*, (Ohri *et al.* 1998) and *Salix* (Thibault 1998). Morphologically *A. bulbosus* closely resembles *A. geniculatus* (Hubbard 1984). Sieber & Murray (1979, 1980, 1981) suggested that either *A. bulbosus* or *A. aequalis* might have acted as the diploid progenitor of the *A. geniculatus*. Substantial additional DNA would be required to account for the difference between twice the DNA contents of either *A. aequalis* (2C = 7·20 pg) or *A. myosuroides* (2C = 7·74pg) and the observed 2C DNA content of *A. geniculatus* (16·17 pg). On the basis of 2C DNA values it is possible that *A. geniculatus* originated as a segmental allotetraploid derived from *A. aequalis* and *A. bulbosus*, with loss of a small amount of DNA.

However, meiotic studies of *A. geniculatus* have shown regular multivalent formation, as opposed to the segmental allotetraploid *A. pratensis* that was predominantly bivalent forming, indicating that autotetraploid origins are more likely (Sieber & Murray 1979). Although the frequency of multivalent formation is lower than would be expected from the normal models and formulae for multivalent formation in autopolyploids, it is similar to that found in colchicine induced tetraploids of *A. aequalis* and the low levels multivalent formation in naturally occurring tetraploids of *A. bulbosus* (Murray *et al.*). These studies concluded that the lower levels of multivalent formation seen in *Alopecurus* are the result of genotypic control of preferential bivalent formation (Murray, Sieber & Jackson 1984).

Of the diploid species *A. bulbosus* had the largest 2C DNA content (2C = 9·27 pg) and would appear to be the likely diploid progenitor of *A. geniculatus* if this species is an autotetraploid. However, the nuclear DNA content of *A. geniculatus* is only 87% that of the doubled DNA content of *A. bulbosus*. This suggests that DNA loss may have occurred during the formation of *A. geniculatus*. Evidence for DNA loss during the origin of *A. geniculatus* comes from comparison of the number of NOR sites, the diploid species all have four NOR sites, *A. pratensis* has eight sites whilst *A. geniculatus* has only six sites. This suggests that two NOR sites were lost along with other DNA during the formation of *A. geniculatus*. Loss of NOR sites has been weil documented in polyploid species, and physical elimination has been demonstrated by means of *in situ* hybridisation in a number of cases: *Avena sativa* (Jellen *et al.* 1994; Leggett & Markand 1995); *Scilla autumnalis* (Vaughan *et al.* 1993) and *Parnassia palustris* (Wentworth 1995). The loss of rRNA loci might be interpreted as part of the overall diploidisation process that is believed to occur in polyploids (Wendel, 2000; Pikaard, 2001), although the formation of multivalents at a low frequency in *A. geniculatus* (Sieber & Murray 1979) would indicate that this process is incomplete. Loss of DNA during the formation of polyploids has also been described in a range of other genera: *Festuca* (Seal 1983); *Leucanthemum* (Marchi *et al.* 1983); *Bulbine* (Watson 1987); *Pratia* (Murray *et al.* 1992b). Bennett *et al.* (2000a) describe a number of possible mechanisms leading to variation in C-values of polyploid species. Evidence that autopolyploid genomes may experience substantial changes has been reported from artificially produced autotetraploids in *Vicia*, *Tephrosia* and *Phlox*, with the latter eventually losing up to 25% of the expected amount based on its diploid progenitors (Raina *et al.* 1994).

RAPD analysis showed that of these five species the highest degree of genetic similarity occurred between *A. bulbosus* and *A. geniculatus*. However, further studies are required to confirm the genetic similarity between *A. geniculatus* and *A. bulbosus*. Although this study appears to show that there are RAPDs bands that occur only in *A. geniculatus* and *A. bulbosus*, this is also true of *A. geniculatus* and *A. aequalis*. A larger sample size would likely reduce the number of these bands, and the suggested common origin of *A. aequalis* and *A. bulbosus* may mean that number of distinguishing markers would be more limited. The diversity between *A. geniculatus* and *A. bulbosus* also raises some questions over their closeness. The analysis is hampered by the small sample size of two plants, and does not take account of intraspecific variability. In addition, possible complications may have occurred as a result of over assumptions made on band homology. The difficulty of determining the sources of variation between RAPD fragments limits the use of RAPDs in systematics to comparisons between closely related species (Harris 1995; Catalan *et al.* 1995). RAPD fragments separated by electrophoresis are identified by size. However, bands of similar size from different species may not be homologous (Gillies & Abbott 1998). Some authors have shown that in closely related species fragment size is a good predictor of band homology (Reiseberg 1996). Previous studies have suggested that at least four of these five species are closely related (Johnsson 1941; Sieber & Murray 1979, 1980, 1981; Murray, Sieber & Jackson 1984).

Hybridisation between *A. geniculatus* and *A. pratensis* has been found to occur in natural populations with limited fertility amongst the progeny, *A.* × *brachystylus* (Johnsson 1941; Sieber & Murray 1979, 1980). Trivalent formation occurred during meiosis in artificial hybrids between *A. aequalis* and *A. geniculatus* (Johnsson 1941) and *A. aequalis* and *A. pratensis* (Sieber & Murray 1981) suggesting that reproductive isolation between these species results from differences in ploidy rather than lack of genome homology. Evidence from cpDNA, presented in this paper, further confirmed the close relationship between these species, but a systematic survey of RAPD band homology was not undertaken.

Other experimental errors are also likely to have occurred in the RAPDs analysis. Inconsistencies in the data presented here could include scoring errors, competition in the PCR reactions and low reproducibility. RAPD markers are also assumed to be dominant, which limits their usefulness in estimating genetic diversity. As the genetic basis of RAPD markers is poorly understood in most studies based on natural populations, it can be argued that RAPD profiles should be treated as DNA phenotypes rather than genotypes (Harris 1999). Although RAPDs may be suitable for general description purposes, in order to resolve the specific issue of whether *A. bulbosus* is the sole progenitor of *A. geniculatus* it may be necessary to employ other molecular techniques.

The sequencing of the $tRNA^{Leu1}$ intron showed that *A. geniculatus* and *A. bulbosus* had identical $tRNA^{Leu1}$ intron sequences for this region of cpDNA. Although it may be inappropriate to infer the origin of a species from the type of RAPDs data presented here, the combination of RAPDs and chloroplast sequence data indicates that *A. bulbosus* is at least one of the probable diploid progenitors of *A. geniculatus*. It is unlikely that these species would share the same cpDNA as a result of chloroplast capture as the natural hybrid between the two species, *A.* × *plecktii*, is a sterile triploid (Hubbard 1984). Although the differing habitat requirements for *A. aequalis* and *A. bulbosus* would indicate that an allopolyploid origin of *A. geniculatus* as the result of hybridisation between these species is unlikely, confirmation of the autopolyploid origin of *A. geniculatus*, as indicated by meiotic evidence from previous studies, is still required. This could be achieved by the use of molecular techniques, possibly by a survey of isozymes to establish whether there is a pattern of tetrasomic inheritance in *A. geniculatus*. The construction of a phylogeny using nuclear markers, such as the internal transcribed spacer (ITS) sequences of ribosomal DNA, could also be used to determine whether *A. bulbosus* is the sole progenitor of *A. geniculatus* or if another genome is present.

The RAPD and cpDNA evidence would indicate that *A. aequalis* is closely related to *A. geniculatus* and *A. bulbosus* whilst *A. myosuroides* and *A. pratensis* appear to be more distantly related to them. However, there are differences in the positions of *A. myosuroides* and *A. pratensis* in the RAPDs dendrogram and cpDNA phylogenetic tree presented in Figs 4 & 5. This could be partly a result of the flaws in RAPDs technique outlined above, however, it is most likely the result of data analyses used. The cpDNA analysis parsimony groups according to shared character states, while the UPGMA analysis used similarities. The short branch length between *A. pratensis* and *A. myosuroides* on the UPGMA tree is weakly upheld whereas the branching pattern on the cpDNA tree is upheld by high bootstrap values. This takes into account other members of the Poaceae suggesting the cpDNA phylogenetic tree is likely to be the most accurate.

Spontaneous formation of triploid and tetraploid individuals in natural populations of *A. bulbosus* (Sieber & Murray 1980) supports the hypothesis that this species could be the sole progenitor of *A. geniculatus*. The formation of autopolyploids from unreduced gametes has been shown to occur in a wide range of plant species (De Wet 1980; Bretagnolle & Thompson 1995; Ramsay & Schemske 1998). Establishment and survival of newly formed polyploids is increased in small populations, where genetic inbreeding and environmental factors cause an increase in diploid gamete formation (Fowler & Levin 1984; Thompson & Lumaret 1992). Ecological preferences may separate newly formed polyploid individuals from their diploid progenitor, reducing competition and hybridisation (Lumaret *et al.* 1987; Lumaret 1988). *A. bulbosus* is a rare perennial, which occurs in small populations on the margins of salt-marshes in southern England. *A. geniculatus* is reproductively isolated from *A. bulbosus* as the naturally occurring hybrid *A.* × *plecktii* is sterile (Hubbard 1984). There appears to be strong niche differentiation between *A. bulbosus* and *A. geniculatus* in that the species maintain strict zonation, as *A. bulbosus* tolerates salinity and does not grow in the wet areas usually occupied by *A. geniculatus* (Fitzgerald 1989). The triploid hybrid, *A.* × *plecktii,* may under some conditions be at a competitive advantage to *A. bulbosus* but appears to be unable to compete under conditions of increasing salinity and is sterile, promoting niche differentiation between *A. bulbosus* and *A. geniculatus*.

This study presents both indirect and direct evidence that a diploid species of limited distribution, *A. bulbosus*, is one, or the sole progenitor, of the widely distributed tetraploid species *A. geniculatus*. The indirect evidence for this hypothesis is provided by the DNA content of *A. geniculatus,* which is 87% of that of the doubled genome of *A. bulbosus*, implying that DNA loss has occurred following the duplication of the genome. Evidence of DNA loss is further indicated

by the occurrence of only six NOR sites instead of the eight NOR sites that would be expected. RAPD analysis indicates that of the five species in the study, *A. bulbosus* and *A. geniculatus* have the highest similarity, although as outlined above this data is not conclusive. CpDNA analysis does, however, show that *A. bulbosus* and *A. geniculatus* have identical haplotypes, suggesting that *A. bulbosus* was a diploid progenitor of *A. geniculatus* via auto- or allopolyploidy. Previous meiotic studies have indicated an autopolyploid origin for *A. geniculatus*, but further research is required to provide a definitive answer, possibly by the sequencing of the rDNA ITS regions. It would also be constructive to extend the cpDNA phylogeny and any proposed ITS based phylogeny beyond these five species to include all the diploid species in the genus. This could identify or exclude any species that are implicated in an allopolyploid origin event for *A. geniculatus*.

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Five new species of *Rubus* L. (Rosaceae) mostly from central south England

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ABSTRACT

Five further species of the large, predominantly apomictic *Rubus* sect. *Rubus* are described and their distributions detailed and discussed. *R. pydarensiformis* D. E. Allen, *sp. nov.* (ser. *Discolores* (P. J. Mueller) Focke), closely allied to *R. pydarensis* Rilstone of Cornwall, Devon and Guernsey, has a tricentric trans-Channel range divided between the east side of Southampton Water, southernmost Devon and the northernmost Brittany coast of France, perhaps the relics of a once much wider distribution at a climatically more favourable period. *R. cerdicii* D. E. Allen, *sp. nov.* (ser. *Vestiti* (Focke) Focke), locally common in Hampshire's New Forest and the Southampton region, alone of the five is present also in the adjacent Isle of Wight. *R. clausentinus* D. E. Allen, *sp. nov.* (ser. *Hystrix* Focke), is scattered across 30 km of Hampshire but heavily concentrated east of Southampton; apparently spreading, it may be a comparatively recent immigrant from the European mainland (though as yet unknown there). *R. milesianus* D. E. Allen, *sp. nov.* (ser. *Hystrix*), dubiously identified previously with the Pyrenean *R. lapeyrousianus* Sudre, is known from three south-east English counties but in quantity only in three widely separate areas in two of those. *R. vindomensis* D. E. Allen, *sp. nov.* (ser. *Hystrix*), concentrated in central east Hampshire, has distant outliers on that county's coast and in the Oxfordshire Cotswolds.

KEYWORDS: brambles, apomictic species, distribution.

INTRODUCTION

Across the central belt of Europe, from Ireland to Poland, *Rubus* sect. *Rubus* and sect. *Corylifolii* Lindley have proved to be represented by such an immense number of distinct entities, most of those of sect. *Rubus* certainly or putatively apomictic, that in recent years it has become increasingly accepted among those specialising in their study that only a select proportion out of the total potentially describable should be accorded taxonomic recognition if that study is to be kept within practicable bounds. On this view, any new species should have a range that can be broadly categorised as "regional" – though interpretation of that term varies. In an area such as Britain, in which the genus has been the subject of more or less continuous attention for nearly two centuries now, it is perhaps surprising that there still remain undescribed entities that can meet this criterion, but such is the case. In addition, some entities that do have a distribution of the requisite extent and have therefore borne a name entirely justifiably have turned out to have been bearing one that rightly belongs to another species, a misidentification having occurred. One of the new species that are described below comes into this second category.

DESCRIPTIONS OF NEW SPECIES

1. *Rubus pydarensiformis* D. E. Allen, *sp. nov.*

A R. pydarensi primocanna semper magis minusve sulcata glabra vel subglabra, ejusdem aculeis paucioribus (4–11 nec 5–18 per 5 cm) raro subpatentibus, foliis digitatis foliolo terminali majore plerumque ovato, vix rotundo, sine dentibus tenuibus, floribus majoribus c. 2·5–3·5 cm diametro, petalis saepe vividius roseis et antheris glabris, bracteis ad margines in dimidio superiore glandulis stipitatis conspicuis et nonnunquam aciculis aliquot mediocribus praeditis differt.

Very similar to *R. pydarensis* Rilstone but with the primocane always ± furrowed (not merely angled or subterete) and, in common with the lower rachis, either glabrous or with sparse small



FIGURE 1a. *Rubus pydarensiformis* D. E. Allen *sp. nov.*

and medium tufted, and one or two simple, hairs at most and few to numerous sessile glands, its prickles on average fewer (4–11 as against 5–18 per 5 cm) and apparently only rarely subpatent; the leaves digitate (not subpedate) with the terminal leaflet on average larger, more exclusively ovate or ovate-elliptical and rarely if ever round, not (or at any rate less) finely serrate; the flowers larger, c. 2·5–3·5 cm in diameter (as against c. 2–2·5 cm), often with showy brighter pink petals and the anthers glabrous (instead of hairy); the bracts fringed on the margins in their upper half with frequent prominent stalked glands (as against inconspicuous very short ones that are sometimes rare or lacking) and sometimes also a few medium acicles. (Fig. 1a)

HOLOTYPUS: abundant about Kingston and Ringmore, SX64, South Devon, v.c. 3, 16 July 1894, *E. S. Marshall 1257* – sheet 'A' (**BM**). Isotypi in **BM** and **CGE**.

OTHER EXSICCATAE (COLLECTOR IN ALL CASES *D.E.A.*):

ENGLAND

v.c. 11, S. Hants.: open bushy area on east margin of one-time Titchfield Common, SU529065, 27 July 1987 (**BM**). In plenty on wooded margins, Chark Common (Lee on the Solent golf course), near Gosport, SU5702, 18 June 1990 (**BM**, **NMW**, *herb. L. J. Margetts*). Hedge of car park near Swanwick station, SU519086, 11 July 1994 (**BM**).

FRANCE

Dép. Côtes-du-Nord: occasional, hedge of G.R.34 N.E. of Trébeurden, 8 July 1999 (**BM**, **NMW**). Patch among bracken on field margin by G.R.34 W. of Runigou, N. of Trébeurden, 10 July 1999(**BM**, **NMW**). Near Tropéric entrance to Le Grand Traouïéro, between Trégastel and Ploumanac'h,10 July 1999 (**BM**).



FIGURE 1b. Distribution of *Rubus pydarensiformis* D. E. Allen.

Like *R. pydarensis* best placed in ser. *Discolores* (P. J. Mueller) Focke and closely similar to that species in general aspect, both combining a usually narrow cylindrical inflorescence with conspicuously acuminate leaflets and relatively minute rachis prickles, *R. pydarensiformis* can be told apart from that at once by its glabrous anthers. Its digitate leaves and more or less furrowed primocanes which are sparsely hairy at the most are further distinguishing features that are readily apparent. In contrast to many *Rubus* species, however, the two cannot be separated by the presence or absence of hairs on the young carpels, for the variation in that is the same in both.

So far as is known at present, the ranges of the two are complementary and do not overlap. *R. pydarensis* is frequent and locally common in the west of Cornwall (where it was first discriminated in 1921, only to be dismissed for some years as merely a peculiar form of *R. adscitus* Genev.); eastwards from there it thins out but extends into both Devon vice-counties, and it has also been detected in two districts in Guernsey. *R. pydarensiformis*, by contrast, occurs in three widely-separated but relatively very restricted areas, collectively scarcely sizeable enough to qualify this bramble for taxonomic recognition were it not for the fact that one of the areas is on the European mainland. This is the west-facing stretch of the northernmost part of the Brittany coast popularly known as the Côte de Granit Rose and more particularly towards its south end in the neighbourhood of the resort of Trébeurden. This is almost exactly opposite the area towards the southernmost tip of Devon, round the mouth of the Erme estuary and for about 5 km eastwards, where this was one of several novel brambles encountered by E. S. Marshall on a holiday there in 1894 and collected by him in some quantity. Examples sent by Marshall to Rogers and Focke elicited no more than "a very interesting plant" from the former, and until the discovery of what was manifestly the same bramble in Hampshire in the 1980s his sheets lay in herbaria without attracting further attention. Curiously, in his report on that trip (Marshall 1895) the plant is not listed but, instead, one he collected nearby that had been queried as a hybrid, perhaps between *R. cardiophyllus* Lef. & P. J. Mueller and *R. pyramidalis* Kaltenb. or *R. questieri* Lef. & P. J. Mueller; the specimens of that in **BM** and **CGE** (Marshall 1253), however, are in fact just rather atypical examples of *R. pydarensiformis*.

Marshall omitted to note on his labels the habitats, but they were doubtless the counterparts of the hedges and wood margins adjoining heathland that the species favours in its other two centres. Fuller investigation of the *Rubus* flora of that underexplored corner of Devon may reveal it to be more widespread; however, it is not represented among the very numerous bramble specimens collected round Plymouth by Briggs in the second half of the 19th century and now divided equally between **BM**, **CGE** and **K**, nor has it come to the notice of L. J. Margetts during his many years of intensive work on the group in Cornwall and other parts of Devon. The Hampshire population, similarly, is located in a portion of that county that has long escaped the attention of *Rubus* specialists, namely the same stretch of country between the conurbations of Southampton and Portsmouth that has also yielded the recently-described *R. caesarius* D. E. Allen, otherwise apparently peculiar to Jersey, as well as being the headquarters of *R. clausentinus*, described later in this paper. Between Gosport and the River Hamble, where all the finds of the plant so far are located, there was formerly an extensive tract of heathland that has largely given way to agriculture or, latterly, been built over.

The plant's three centres (Fig. 1b) have in common proximity to the sea combined with some of the highest summer temperatures the western shores of the English Channel have to offer. That the French centre has a climate exceptional on that side of the Channel is suggested by its being the only part of the European mainland in which *R. hastiformis* W. C. R. Watson is known to attain a prevalence comparable with that around Plymouth (and a few other, more-or-less coastal enclaves in southern Britain). The distribution of another species, *R. boreanus* Genev., though a very much wider one, could be explained in terms of the same rather special combination of climatic requirements. Morphologically, indeed, *R. pydarensiformis* suggests itself as one of the possible ancestors of *R. boreanus*. It may well be that the origin of the former lies some considerable way back in the past and that its present fragmented, tricentric range is a relic of a period when the climate of the region was more conducive to its spread.

2. *Rubus cerdicii* D. E. Allen, *sp. nov.*

Primocanna alte arcuata, obtusangula faciebus planis vel leviter sulcatis, atropurpurea, in sole nigrescens, glabrescens vel sparsim pilosa, glandulis sessilibus numerosis sed raro glandulis stipitatis aciculisve brevissimis praedita, aculeis 6–12 per 5 cm, ad angulos dispositis, inaequalibus, nonnunquam geminatis, media longitudine (3–6 mm), e basi lata compressa rubra subulatis, rectis vel curvatis, declinatis vel nonnullis patentibus munita. Folia pedata; foliola terna vel quina, non vel vix imbricata, undulata, supra atroviridia glabra, infra pallidiora vel cinerea, sparsim vel valde pilosa, et nonnunquam coacta; petioli aculeis 6–15 2–5 mm curvatis vel falcatis muniti. Foliolum terminale ovatum vel obovatum vel nonnunquam ellipticum, apice acuto, basi magis minusve emarginata, aequaliter biserrato-dentatum dentibus primis saepe patentibus, petiolulo suo quadruplo vel triplo longius; foliola infima brevissime (1–4 mm) petiolulata. Inflorescentia aut longe racemosa aut laxe pyramidalis, apice saepissime congesto, non usque ad apicem foliata, foliis ternatis inferne et nullis vel paucis simplicibus trilobatisque superne instructa, pedunculis axillaribus usque ad octo brevibus adscendentibus multifloris multo quam foliis suis brevioribus, supra (infimo longe supra) medium divisis, aucta. Rhachis flexuosa, sulcata, dense villosa, superne praesertim ad apicem glandulis stipitatis brevibus mediocribusque et aciculis aculeolisque sparsim praedita, aculeis numerosis subulatis inaequalibus, plerumque curvatis vel falcatis, saepe congregatis munita. Flores c. 2·5–3·0 cm diametro. Sepala grisea, pilis densis et glandulis sessilibus brevissimeque stipitatis paucis vel crebris et aciculis raris vel crebris praedita, albomarginata, nonnunquam attenuata, semper laxe reflexa. Petala 8–9 x 2–4 mm, rosea vel valde rufescentia, plana, ovata vel elliptica e basi cuneata, apice denticulata et ciliata, multo separata. Stamina rufescentia stylos roseos vel virescentes parum vel multo superantia; antherae glabrae vel subglabrae, pallidae suturis purpureis. Carpella glabra vel subglabra. Receptaculum glabrum. Fructus ovoidei, copiosi.

Primocane high-arching, bluntly angled with flat or slightly furrowed sides, deep purple becoming blackish in full sun, glabrescent with sparse or rare simple and tufted medium hairs, numerous sessile glands but rarely with scattered very short-stalked glands or acicles; prickles 6–12 per 5 cm, confined to the angles, unequal, often in pairs, 3–6 mm long, subulate from a broad flattened base, straight or curved, mostly slanting or a few patent, red with a yellow tip. Leaves pedate; leaflets 3–5, not or partly imbricate, undulate, dark green and glabrous above, paler green or grey, velvety with few or many simple and tufted hairs or sometimes also felted beneath; terminal leaflet c. 7–9 × 5–6·5 cm, ovate or obovate or sometimes elliptical, with an acute apex and ± emarginate base, evenly biserrate-dentate with the principal teeth often patent, its petiolule ¼–⅓ as long as the lamina; petiolules of basal leaflets 1–4 mm; petiole longer than the basal leaflet, clothed like the primocane and with 6–15 curved or falcate prickles 2–5 mm. Flowering branch with 3-foliolate grey-felted leaves with obovate-cuneate terminal leaflets below and no or 1–3(–5) simple and sometimes trifid leaves above, not leafy to the apex; inflorescence either a long narrow raceme or laxly pyramidal, with a usually congested apex and up to eight short ascending many-flowered axillary peduncles much shorter than their leaves, divided above the middle (the lowest peduncle divided far above); rachis flexuous, furrowed, clothed with dense patent and adpressed medium simple and tufted hairs, with in the upper half a varying number of scattered short and medium stalked glands, acicles and pricklets all increasing in number towards the apex and extending to the petioles, together with numerous subulate, unequal, mostly curved or falcate and often clustered prickles. Flowers c. 2·5–3·0 cm in diameter; sepals grey-felted with dense stellate and a few longer simple hairs, few or frequent sessile and very short-stalked glands and rare or frequent acicles, white-margined, short- or long-pointed, loosely reflexed in flower and fruit; petals 8–9 × 2–4 mm rose-pink to deep reddish, flat, ovate- or elliptical-cuneate or rarely oblanceolate, notched, with an apical fringe of short and/or long hairs, well separated; stamens short but slightly to much exceeding the styles, filaments reddish and retaining that colour after anthesis, anthers glabrous or with one or two hairs, pale with purple sutures; styles pink or greenish; young carpels glabrous or with one or two hairs; receptacle glabrous; fruit ovoid, copious. Flowering from mid-June to mid-August.

HOLOTYPUS: frequent on gravelly clay, Fattingpark Copse, near Wootton Common, SZ5292, Isle of Wight, v.c. 10, 22 July 1999, *D. E. Allen* (**BM**).



FIGURE 2a. *Rubus cerdicii* D. E. Allen *sp. nov.*

OTHER EXSICCATAE:
Representative further exsiccatae (all collected *D.E.A.*) are in **BM** from seven Hampshire localities and two further Isle of Wight ones. Duplicates from two of those Hampshire gatherings are in **NMW** also.

The epithet *cerdicii* commemorates Cerdic, the West Saxon chieftain who reputedly conquered and settled southernmost Hampshire c. 500 A.D. and the Isle of Wight half a century later as well. Under study for 30 years as "H107" (Fig. 2a), this member of ser. *Vestiti* (Focke) Focke – despite the glabrescent primocane – is occasional to common over an extensive part of south-west Hampshire, v.c. 11, from Southampton north to the terminal line of the Tertiary gravels at Hiltingbury and west to the north and central New Forest, continuing along the north edge of that just into South Wiltshire, v.c. 8. Apart from some outliers round Burley it is rare or absent in the south of the Forest and scarcely strays beyond its boundary yet nevertheless reappears quite widely in the eastern half of the Isle of Wight, v.c. 10 (though in quantity only in Fattingpark Copse, the type locality). An anomalously distant population shared by three pieces of woodland on the north-east side of Havant, close to the border with West Sussex, v.c. 13, may have originated through accidental transfer with New Forest saplings. In all, the species has been noted in 14 hectads: SU20, 21, 30, 31, 41, 42, 61, 71 and SZ29, 39, 47, 58, 59, 68. In terms of its terminal points the range is about 50 km in length and slightly more than that in breadth. Characteristic of damp heathy ground, growing more often in the open than in marginal shade, it can occur also in bogs and fen carr, while in Wight it flourishes on only mildly acid clay (Fig. 2b).

Despite its showy flowers and wide occurrence in the much-visited New Forest, there are surprisingly very few examples of this bramble dating from before 1970 in herbaria and apparently none from earlier than 1919. This could imply a substantial spread in the last hundred years or more recently still.

Though a 1931 specimen in **BM** was misdetermined by Riddelsdell as the species now known as *R. euanthinus* W. C. R. Watson and there is a superficial resemblance to *R. radulicaulis* Sudre of the southern Welsh Marches, there is no British bramble other than *R. cerdicii* that seems to combine reddish floral organs with a flexuous rachis and a primocane bearing curved prickles and typically obovate-cuneate, biserrate-dentate leaflets. A French species, *R. grypocanthus* P. J. Mueller & Lef., of dép. Aisne, however, quite closely approaches it. Authentic specimens of that in **BM**, though, have a hairier and considerably glandular-aciculate primocane with stronger prickles, more acuminate leaflets and shorter stalked glands on the rachis.

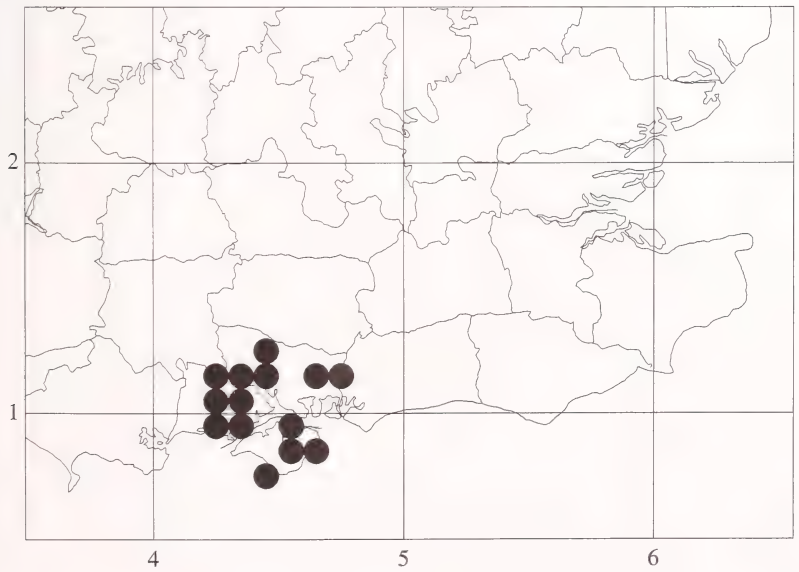


FIGURE 2b. Distribution of *Rubus cerdicii* D. E. Allen.

3. *Rubus clausentinus* D. E. Allen, *sp. nov.*

Planta robusta. Primocanna alte arcuata, obtusangula faciebus planis vel leviter sulcatis, purpurea, glabrescens vel sparsim pubescens, glandulis stipitatis aciculisque nullis vel paucis brevibus brevissimisque sed aculeolis crebris nonnunquam glanduliferis praedita, aculeis c. 7–20 per 5 cm, nonnunquam geminatis, plerumque ad angulos limitatis, valde inaequalibus (2–8 mm), e basi lata compressa rubropurpurea tenuibus, saepissime omnibus declinatis vel falcatis sed nonnunquam omnibus magis minusve patentibus rectisque munita. Folia digitata; foliola quina, plana vel ad marginem undulata, vix imbricata, supra pilis longis paucis vestita, infra sparsim pubescentia (praesertim ad venas) aut insuper copiose longipilosa; petioli pilis stellatis frequentibus vel numerosis simplicibusque sparsis vestiti, aculeolis paucis vel crebris (nonnunquam nonnullis glanduliferis) et aculeis 2–4 mm numerosis (c. 15–20) valde curvatis vel falcatis vel geniculatis muniti; foliolum terminale rotundum vel rotundo-ovatum, apice gradatim acuminato, basi emarginata vel subcordata, (bi-)serrato-dentatum dentibus latis, saepissime saltem inferne incisum, petiolulo suo quintuplo vel quadruplo vel triplo longius; foliola infima brevissime (1–2 mm) petiolulata. Inflorescentia non usque ad apicem foliata, foliis infra albescentibus omnibus ternatis vel etiam usque ad quattuor simplicibus vel trilobatis (et interdum bracteis nonnullis) instructa, late vel anguste pyramidalis, apice truncato vel rotundato, pedunculis mediis nonnullis patentibus, axillaribus distantibus adscendentibus multifloris, infimis longis (9–18 cm), supra medium divisis longe (1–3 cm) pedicellatis aucta; rhachis flexuosa, sulcata, coacta et saepissime sparsim pilosa, praesertim superne glandulis stipitatis et aciculis brevibus mediocribusque (aciculis nonnunquam glanduliferis) praedita et praesertim inferne aculeolis nonnullis et praesertim superne aculeis inaequalibus (1–5 mm) curvatis et falcatis numerosis munita. Flores c. 2–3 cm diametro. Sepala griseoviridia, albomarginata, dense coacta et pilosa, glandulis sessilibus et brevissime breviterque stipitatis et aculeis brevissimis paucis vel multis praedita, longe vel longissime attenuata, in flore et fructu reflexa. Petala alba, obovata vel rhombea, breviter pubescentia, apice ciliato, non contigua. Stamina alba stylos flavovirides saepe rufescentes superantia; antherae glabrae. Carpella dense pilosa. Receptaculum glabrum. Fructus magni (usque ad 1·8 × 1·8 cm), globosi vel perlate oblongi, deliciosi.

Plant robust. Primocane high-arching, stout, bluntly angled with flat or slightly furrowed sides, purple, glabrescent or sparsely pubescent, with no or few short and very short stalked glands and acicles but frequent sometimes gland-tipped pricklets; prickles c. 7–20 per 5 cm, tending to cluster, sometimes in pairs, mostly confined to the angles, very unequal, 2–8 mm long, slender from a broad compressed base, usually all slanting or falcate but sometimes all ± patent and straight, red-purple with a yellow tip. Leaves digitate; leaflets 5, flat or undulate on the margin, slightly imbricate, mid-green and glabrescent with a few long simple hairs on upper surface, pale green or cinerascent with sparse adpressed simple hairs mainly on the veins or, in addition, copiously long-pilose beneath; terminal leaflet (7–)9–10 × (5–)7–9·5 cm, ± round or roundish-ovate with a gradually acuminate apex 1–1·5 cm and emarginate or subcordate base, (bi-)serrate-dentate with broad teeth and usually incised at least in the lower half, petiolule 1/5–1/3 as long as the lamina; petiolules with one or several gland-tipped pricklets, those of the basal leaflets 1–2 mm; petiole equalling or shorter or longer than the basal leaflets, with frequent or numerous stellate and sparse simple hairs, few or frequent (sometimes several gland-tipped) pricklets and c. 15–20 strongly curved or falcate or geniculate prickles 2–4 mm. Flowering branch with leaves whitish-felted on under surface, all 3-foliolate or up to 4 simple or trifid ones above as well as sometimes with 1–3 leaf-like simple or trifid bracts too, not leafy to the apex; inflorescence pyramidal with a truncate or rounded apex, short and compact or long and lax with one or more patent middle peduncles 2·5–3 cm long and distant ascending many-flowered axillary ones, the lowest 9–18 cm and much exceeding their leaves, divided above the middle, with pedicels 1–3 cm; rachis flexuous, furrowed, felted and usually also with sparse simple and tufted hairs, frequent short and medium stalked glands and (sometimes gland-tipped) acicles especially above, occasional pricklets especially below and numerous unequal curved and falcate prickles 1–5 mm long increasing in quantity above. Flowers c. 2–3 cm in diameter; sepals greyish-green, white-bordered, with dense stellate and numerous short simple and tufted hairs, few to many sessile and very short- and short-stalked glands and few or many very short prickles, mostly long- or very long-tipped, reflexed in both flower and fruit or sometimes erect-ascending in fruit; petals 8–12 × 5–6 mm, white, obovate or



FIGURE 3a. *Rubus clausentinus* D. E. Allen *sp. nov.*

rhombic, clothed with numerous short adpressed hairs, with unequal simple and tufted hairs at the apex, not contiguous; stamens exceeding the styles, filaments white, anthers glabrous or with a rare hair; styles yellowish-green or reddish; young carpels densely pilose; receptacle glabrous; fruit large (up to 1·8 x 1·8 cm), globose or very broadly oblong, delicious. Flowering from mid-July to late August.

HOLOTYPUS: margin of copse, Turkey Island, Shedfield, SU568132, South Hampshire, v.c. 11, 28 July 1991, *D. E. Allen* (**BM**).

OTHER EXSICCATAE (ALL **BM**, COLLECTED *D.E.A.*):

v.c. 11, S. Hants.: Weston Common, Sholing, Southampton, SU464119, 25 July 1976. Copse by Fair Oak sandpits, SU500185, 28 Aug. 1977. Chilworth Common, SU411182, 9 Aug. 1978.

v.c. 12, N. Hants.: Fulley Wood, Tichborne, SU5629, 5 Aug. 1977. Hedge of path alongside easternmost branch of R. Itchen N. of Durngate, Winchester, SU487297, 23 July 1999.

Known for three decades now as "H220" (Fig. 3a), this robust, late-flowering member of ser. *Hystrix* Focke can be readily recognised by its pyramids of largish white flowers contrasting with often reddish styles, the large leaves with round incised terminal leaflets, the very pilose carpels and the unusual combination of glabrescent and often eglandular primocanes (with nevertheless plentiful pricklets) with a typically Hystrican armature on the inflorescence (especially above).

If only the district where it principally occurs had received attention from collectors prior to the 1970s, the species would surely be represented in herbaria by more than just a single doubtful earlier specimen. With a range that extends to only nine hectads (SU30, 31, 40–43, 50, 51, 53), of which the two terminal points are about 35 km apart, and virtual restriction to just one vice-county, South Hampshire, its claim to be ranked as a "regional" species is not all that compelling (Fig. 3b). In view of its conspicuousness and often striking abundance locally, however, denying it taxonomic recognition has come to seem increasingly inappropriate.

That abundance is confined to a narrow belt of country extending from the east part of Southampton to the west outskirts of Fareham, a distance of 7 km. Absent from the coastal fringe in all but one place, the species keeps instead to the terrace of Tertiary gravel above that and mainly to the woods along or close to the west banks of the Meon and Hamble Rivers and the main tributary of the latter, Badnam Creek. Near the mouth of this last, at Mallards Moor, it attains its

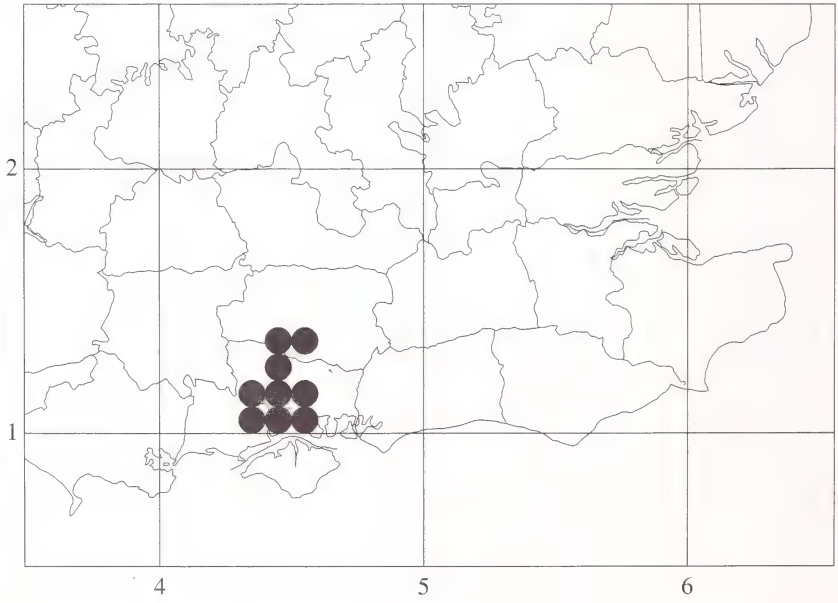


FIGURE 3b. Distribution of *Rubus clausentinus* D. E. Allen.

maximum ascertained abundance, dominating the ground flora. Within Southampton it also occurs in quantity along two deep stream valleys that have survived as public open spaces, Weston Common and Sholing Common. These two are close enough to Bitterne, the site of Clausentum, to justify naming this bramble after that Romano-British settlement, the only one of that period known in the Southampton area.

Outside the belt of abundance isolated patches or bushes are normally the most that are met with. These are oddly scarce to the immediate east and south but extend west across Southampton Water well into the New Forest at Matley Wood and as far as the Beaulieu River near Bucklers Hard, while to the north they penetrate a short way into North Hampshire in two places. Like many of the commoner brambles of the Southampton region, however, the species is absent from the Isle of Wight. Viewed as a whole, this distribution pattern is of a kind suggestive of a species that has arisen in the comparatively recent past (in this case by hybridization, as predominantly in *Rubus* sect. *Rubus*) and is still in the process of primary spread. Alternatively, it could be an immigrant from the European mainland like two other, similarly robust Wessex species, *R. corbieri* Boulay ex Corbière and *R. thyrsigeriformis* (Sudre) D. E. Allen; however, extensive sampling of the *Rubus* flora of north-west France in recent years has not brought it to light, nor have searches of French herbarium material, nor is it a bramble known to the Belgian *Rubus* specialist, H. Vannerom.

An apparent hybrid with *R. ulmifolius* Schott has been noted near Manor Farm, Botley, at SU506115.

4. *Rubus milesianus* D. E. Allen, *sp. nov.*

Planta robusta. Primocanna alte arcuata, obtusangula faciebus planis vel sulcatis, rubropurpurea, in sole nigrescens, glaucescens, pruinosa, glabra vel pilis sparsis vestita, glandulis stipitatis aciculisque brevibus et longis crebris praedita, aculeolis interdum glanduliferis numerosis et aculeis c. 10–30 per 5 cm saepe geminatis valde inaequalibus (4–7 mm), e basi compressa triangulata atrorubenti vel purpurea gradatim subulatis, declinatis vel falcatis munita. Folia magna, digitata vel pedata; foliola quina vel rarius terna, subimbricata, supra atrovirentia glabrescentia nitentia, infra pallidiora molliter pubescentia; petioli aculeis c. 15–20 curvatis vel retrorsofalcatis 2–4 mm muniti. Foliolum terminale magnum (c. 11–13 × 6·5–8 cm), ellipticum vel obovatum vel rotundo-ovatum, apice longissimo (2–3 cm) gradatim acuminato, basi emarginata, serrato-dentatum (vel in umbra crenatum) dente saltem uno patenti, ad marginem undulatum, petiolulo suo triplo longius; foliola infima modice (2–5 mm) petiolulata. Inflorescentia non usque ad apicem foliata, foliis inferne ternatis et superne duobus magnis integris vel uno solo instructa, nutans, longa, anguste pyramidalis, apice congesto saepissime truncato, pedunculis axillaribus omnibus adscendentibus, supra medium divisis, mediis et inferioribus magis minusve corymbosis paucis, infimis c. 10–15 cm. Rhachis recta vel flexuosa, angulata, copiose hirsuta, in modo primocannae munita. Flores c. 2–3 cm diametro, cupulati. Sepala extra tandem griseoviridia, intra albescentia, albomarginata, dense breviterque hirsuta et pilis frequentibus vestita, glandulis stipitatis aciculisque praedita, tandem usque ad 7 mm attenuata, sub anthesi laxe reflexa, post anthesin interdum patentia vel plerumque reflexa vel plerumque erecta. Petala alba vel subrosea, obovata vel ovato-elliptica, copiose utrinque pubescentia, integra, multo separata. Stamina alba, stylos viridulos vel flavos, tandem basi rubros, aequantia vel parum superantia; antherae glabrae. Carpella dense pilosa. Receptaculum glabrum. Fructus magni, longiores quam latiores, copiosi, deliciosi.

Plant robust. Primocane high-arching, bluntly angled with flat or furrowed sides, reddish-purple turning blackish in sun, glaucescent, pruinose, glabrous or with sparse unequal simple and tufted hairs, with frequent, short to long, stalked glands and acicles (the latter often gland-tipped) and numerous sometimes gland-tipped pricklets; prickles c. 10–30 per 5 cm, not confined to the angles, often in pairs, very unequal (4–7 mm), gradually subulate from a flattened triangular base, slanting or falcate, dark red or purple with a yellow tip. Leaves large, digitate or pedate; leaflets (3–)5, subimbricate, dark green, subglabrous and shining on upper surface, paler green and felted and softly pubescent with numerous to sparse simple and tufted hairs beneath; terminal leaflet large (c. 11–13 × 6·5–8 cm), elliptical or obovate or roundish-ovate, with a very long (2–3 cm) gradually acuminate apex and emarginate base, rather finely serrate-dentate (or in shade crenate) with usually at least one tooth patent, undulate on margin, the petiolule ⅓ as long as the lamina;



FIGURE 4a. *Rubus milesianus* D. E. Allen *sp. nov.*

petiolule of basal leaflets 2–5 mm; petiole subequalling the basal leaflets, with frequent stellate and tufted and simple hairs, c. 15–25 curved or retrorse-falcate prickles 2–4 mm, otherwise endowed or armed like the stem. Flowering branch with 3-foliolate leaves below but only 1–2, usually both large, simple ones above, not leafy to the apex; inflorescence nodding, long, narrowly pyramidal with a congested usually truncate top, with the axillary peduncles all ascending, divided above the middle, the middle and lower ones ± corymbose, few (1–4)-flowered, the lowest c. 10–15 cm long; rachis straight or flexuous, angled, felted and with numerous white medium simple and tufted hairs, coloured like the primocane and with a similar but denser armature. Flowers c. 2–3 cm in diameter, cupped; sepals bright green becoming grey-green outside, whitish within, white-bordered, with dense short hairs, frequent longish simple and tufted ones and varying numbers of stalked glands and acicles of different lengths, with a long tip from bud up to 7 mm ultimately, in flower loosely reflexed or (rarely) subpatent, in fruit sometimes patent with erect-ascending tips or mostly reflexed or mostly erect; petals white or pale pink, 6–11 × 3–5 mm, roundish-obovate or ovate-elliptical, with numerous short adpressed hairs on both surfaces, entire at apex, well separated; stamens equalling or slightly exceeding styles, filaments white, anthers glabrous; styles greenish or yellow, ultimately red-based; young carpels densely hairy; receptacle glabrous; fruit large, longer than broad, copious, delicious. Flowering from mid-June to late August (Fig. 4a).

HOLOTYPUS: Tylney Park plantations, near Hook, SU7155, North Hampshire, v.c. 12, 17 Aug. 1996, *D. E. Allen H1158* (**BM**). Isotypus in *herb. H. Vannerom* (Belgium).

OTHER EXSICCATAE:

v.c. 11, S. Hants.: wood margin in east section, Southampton Common, SU422151, 16 July 1988, *D.E.A.* (**BM**, **NMW**).

v.c. 15, E. Kent: quarry between Bigbury and Chartham Hatch, near Canterbury, TR1157, 13 Aug. 1950 *W. C. R. Watson* as *R. gelertii* (**SLBI**). A weak, thinly glandular example.

[v.c. 16, W. Kent; Pembury Wood, Tunbridge Wells, TQ6141, 26 July 1959, *E. S. Edees 13393*, indet. (**NMW**). Specimen too condensed for certainty.]

v.c. 17, Surrey: Tooting [Bec] Common, TQ2972, 30 Aug. 1903, *C. E. Britton*, det. Rogers as *R. pallidus* (**SLBI**). St. Ann's Hill, Chertsey, TQ0267, 7 July 1939, *C. Avery* (**SLBI**); 4 Aug. 1950, *W. C. R. Watson* (**SLBI**, **K**); patch on slope above M3 there, TQ02546785, 22 July 1998, *D.E. A.* (**BM**, **NMW**). (A further specimen from this wood collected in 1867 by *J. G. Baker* cited by Watson (1958) has not been traced.) Blackdown [Hill, Chobham Ridges], SU9057 or 58, 26 July 1948, *C. Avery* (**SLBI**). Chobham Ridges, at crossroads [Redroad Hill], SU907605, 3 July 1963, *B. A. Miles* (**CGE**, **NMW**); 28 July 1969, *E. S. Edees 20383* (**NMW**); 17 July 1997, *D.E. A.* (**BM**). Mound Copse, Lynbrook, Knaphill, SU962591, 16 June 1999, *D.E.A.* (**BM**).

This further member of ser. *Hystrix* is known in quantity in only three areas, two at opposite ends of Hampshire, the third in adjoining West Surrey. The largest population by far is in north-east Hampshire, extending across a series of woodland fragments, doubtless once a single whole, about 3 × 2 km in size, between Hook and Mattingley. The other two occupy the wooded north ends of both sections of Southampton Common, v.c. 11, and at least two copses on the west outskirts of Woking, v. c. 17 (whence the other West Surrey patches have probably come) (Fig. 4b).

The species was first discriminated apparently c. 1940 by W. C. R. Watson, who identified it with – and subsequently consistently determined it as – *R. lapeyrousianus* Sudre, a bramble described from two localities in dép. Ariège in the eastern half of the French Pyrenees (Sudre 1912) but apparently unrecorded from anywhere else in mainland Europe since. Though one or two British-cum-Irish *Rubus* species do have ranges that extend at least that far south, there is not the great disjunctness in those cases that there appears to be in this one, though *R. neomalacus* Sudre, divided between West Surrey and the region round the mouth of the Loire, provides a half-way case.

Its relative unlikelihood geographically, however, is not the only reason for treating Watson's identification with reserve. More seriously, there appears to be no material of *R. lapeyrousianus*, whether collected by Sudre himself or by others and authenticated by him, in any British or Irish herbarium. Sudre omitted it from the two sets of exsiccatae he distributed internationally in 1903–17, presumably in view of its apparently very local occurrence, and potential type specimens of the many other new taxa he described that are not represented in those sets have been found extremely

elusive by subsequent *Rubus* specialists. Even had Watson been in the practice of borrowing material from herbaria outside Britain it is hard to believe that he would have had more success in that direction. In all probability, therefore, he made his identification solely on the strength of the description in Sudre (1912) and the accompanying drawing – as indeed would seem to have been his practice in other instances. While Sudre's description certainly fits the South of England bramble in many respects, there are sufficient differences, in particular glabrescent carpels and leaves white tomentose on the under surface, to render the common identity of the two at best uncertain in the absence of a specimen, a conclusion also reached by Edees & Newton (1988, p. 282).

The impressive consistency with which the English bramble has been determined all along is explained by the plant's distinctiveness. The exceptionally long, narrow leaflets terminating in an ultra-long acuminate apex together with the massive pyramidal inflorescence and Hystrican armature make it unmistakable when growing under optimal conditions in the open. Contrary to what one might expect from that, though, it occurs in greatest quantity, as in the Knaphill and two Hampshire populations, in comparatively deep shade, in which those characters are less in evidence and its identity would be hard to make out in the absence of open-ground specimens close by. In shade it nevertheless retains its robustness, whereas under arid conditions in the open it tends to become deceptively diminutive. The frequent presence outside woodland of what is evidently essentially a sylvestral species is doubtless attributable to the attractiveness to birds of the abundant large fruits. It is possible indeed that their size and particular deliciousness has led this bramble to be taken into cultivation at one time or another. Its puzzlingly isolated occurrence on Tooting Bec Common, deep within London, may perhaps have had that origin.

This was a species that the late Beverley Alan Miles paid special attention to in the course of his intensive but tragically truncated study of *Rubus* in Britain. As *R. milesii* Newton, previously dedicated to his memory, has regrettably proved to be a later synonym of *R. asperidens* (Sudre ex Bouvet) Bouvet (Allen 1996), it seems appropriate that he should be commemorated by this one in its stead. Unfortunately, none of the specimens of *R. milesianus* of his collecting in various herbaria are sufficiently well-developed to be suitable for selection as the holotype.

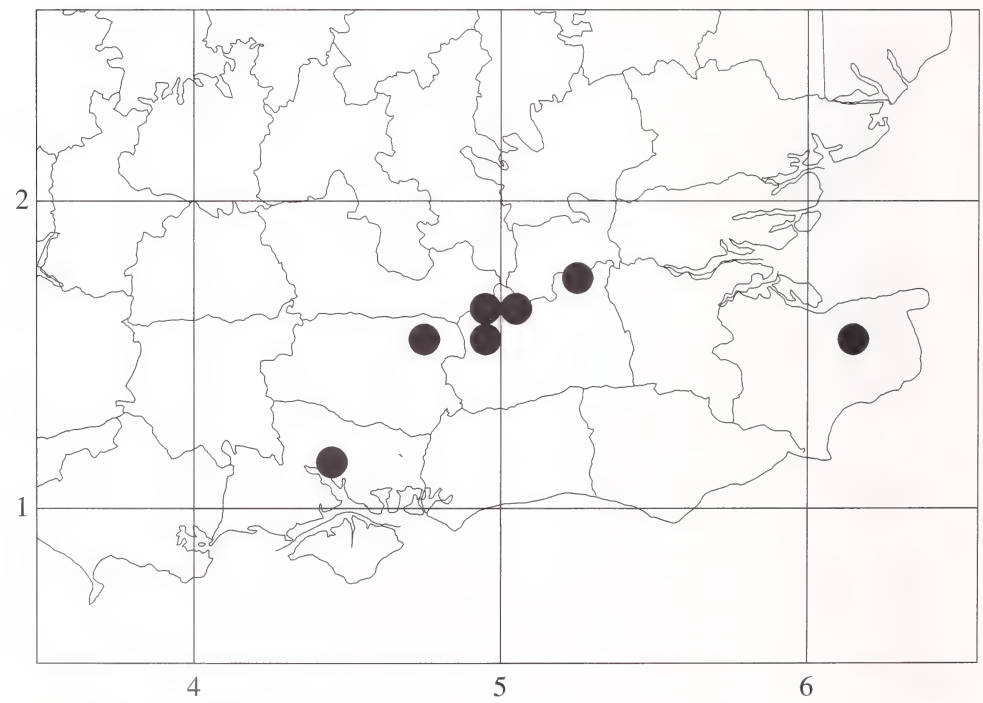


FIGURE 4b. Distribution of *Rubus milesianus* D. E. Allen.

5. *Rubus vindomensis* D. E. Allen, *sp. nov.*

Planta robusta. Primocanna alte arcuata, obtusangula faciebus planis vel sulcatis, atropurpurea nigrescens, pruinosa, pilis crebris vestita, glandulis stipitatis aciculisque paucis vel crebris et aculeolis paucis vel numerosis, omnibus valde inaequalibus, praedita, aculeis c. 10–20 per 5 cm, nonnunquam geminatis, plerumque ad angulos limitatis, valde inaequalibus, usque ad 6–8 mm longis, declinatis vel falcatis vel geniculatis, e basi compressa triangulata rubra gradatim subulatis munita. Folia digitata; foliola quina, non vel vix imbricata, ad marginem undulata, supra atroviridia et glabrescentia, infra pallidiora vel albescentia pilis mediocribus paucis vel numerosis adpressis vestita vel etiam coacta; petioluli glandulis stipitatis inaequalibus crebris vel numerosis et aciculis inaequalibus paucis vel crebris et aculeolis raris et aculeis usque ad tredecim curvatis falcatisque ultra medium costae extensis praediti; petioli primocannae similiter vestiti et muniti; foliolum terminale 6·5–9 × 5–7 cm, rotundum vel rotundo-ovatum, apice gradatim acuminato, basi integra vel emarginata, inaequaliter et nonnunquam tenuiter uni- vel biserrato-dentatum, dentibus saepissime nonnullis patentibus, petiolulo suo triplo vel quadruplo longius; foliola infima modice (2–5 mm) petiolulata. Inflorescentia non usque ad apicem foliata, foliis saepe infra albescentibus, inferne ternatis et superne 0–5 simplicibus lobatisque instructa, nutans, pyramidalis vel racemosa, superne nonnunquam aequalis et congesta, apice truncato, pedunculis axillaribus inferioribus usque ad 22 cm, distantibus, adscendentibus vel rarius subpatentibus, subcorymbosis vel rarius paniculatis, multis (4–20) floribus praeditis, supra medium divisis; pedicelli glandulis stipitatis valde inaequalibus numerosis praediti; rhachis parum flexuosa, saltem inferne sulcata et acutangula, pilis adpressis patentibusque brevibus mediocribusque densis vestita, superne glandulis stipitatis longis crebris praedita, aculeis crebris, valde inaequalibus (1–6 mm), patentibus vel declinatis vel deflexis, rectis vel curvatis vel falcatis munita, aliter primocannae similis. Flores magni et speciosi, (2·5–)3–3·5(–4) cm diametro. Sepala vivide viridia vel griseoviridia, albomarginata, dense coacta et pilosa, glandulis sessilibus numerosis stipitatisque paucis et aciculis paucis praedita, longe vel longissime attenuata, patentia tandem reflexa, et sub anthesi et post anthesin, vel nonnunquam in fructu erecta. Petala alba vel rarius subrosea, plana, rotundata (etiam nonnunquam unguiculata) vel ovata vel late obovata vel elliptica, pubescentia, apice saepe emarginato vel sinuato sparsim piloso, multo separata. Stamina alba stylos viridescentes vel rubros vel basi rubros superantia; antherae glabrae. Carpella dense pilosa. Receptaculum glabrum. Fructus globosi, deliciosi.

Plant robust. Primocane high-arching, bluntly angled with flat or furrowed sides, deep purple, turning blackish, pruinose, with frequent short and medium tufted hairs and fewer simple ones, few or frequent very unequal stalked glands and (sometimes gland-tipped) acicles, and few to numerous very unequal often gland-tipped pricklets; prickles c. 10–20 per 5 cm, sometimes in pairs, mostly confined to the angles, very unequal and grading into the pricklets, the longest 6–8 mm, slanting or falcate or some geniculate, gradually subulate from a flattened triangular base, red with a yellow tip. Leaves digitate; leaflets (4–)5, not or slightly imbricate, undulate on margin, dark green and glabrescent on the upper surface, light green to whitish and felted and/or with few to numerous adpressed medium simple and tufted hairs and prominent veins beneath; terminal leaflet 6·5–9 × 5–7 cm, round or roundish-ovate, with a gradually acuminate apex c. 1–2 cm, entire or emarginate at the base, unequally and sometimes finely uni- or biserrate dentate, usually with some patent principal teeth, the petiolule ⅓–¼ as long as the lamina; petiolules with frequent or numerous short-, medium- and long-stalked glands, few or frequent acicles of a similar size range, rare pricklets and 0–13 curved and falcate prickles which continue more than midway along the lamina midrib, the petiolules of the basal leaflets 2–5 mm; petioles equalling or slightly exceeding the basal leaflets, clothed and armed like the primocane. Flowering branch with 3-foliolate leaves below and 0–5 simple and lobed leaves above, often whitish-felted beneath, not leafy to the apex; inflorescence long, nodding, pyramidal or sometimes racemose, much interrupted below, truncate and sometimes equal and congested at the apex, the mid and lower peduncles distant, long (up to 22 cm), ascending or more rarely subpatent, subcorymbose or more rarely paniculate, with 4–20 flowers, divided above the middle; pedicels with numerous very unequal stalked glands; rachis slightly flexuous, furrowed and sharply angled at least below, with dense adpressed and spreading short and medium tufted and a few simple hairs, frequent long-stalked glands above and frequent, very unequal (1–6 mm) patent or declining or deflexed, straight or curved or falcate prickles,



FIGURE 5a. *Rubus vindomensis* D. E. Allen *sp. nov.*

otherwise similar to the primocane. Flowers large and showy, (2·5–)3–3·5(–4) cm in diameter; sepals bright or greyish-green on external surface, clothed with dense stellate and numerous spreading simple and tufted hairs as well as numerous sessile and a few stalked glands and a few acicles, white-margined, the tips long or very long and sometimes leafy, patent becoming reflexed in flower and fruit or sometimes erect in fruit; petals white, less often pale pink, flat, 12–15 × 7–12 mm, roundish (and sometimes abruptly clawed) or ovate or broadly obovate or elliptical, with numerous short adpressed hairs on the dorsal surface but sparse ones on the other side, often notched or sinuate at the apex with a sparse fringe of medium short and tufted hairs, well separated; stamens long, exceeding the styles, filaments white, anthers glabrous; styles greenish or red or red-based; young carpels densely pilose; receptacle glabrous; fruit globose, delicious. Flowering from mid-June to mid-August.

HOLOTYPUS: Locally abundant in open heathy grassland and scrub, Eastoke Common, Hayling Island, SZ748985, South Hampshire, v.c. 11, 30 June 2001, *D. E. Allen* (**BM**). Isotypus in **NMW**.

REPRESENTATIVE OTHER EXSICCATAE:

v.c. 12, N. Hants.: Alice Holt Forest, locally abundant especially in Goose Green Inclosure, SU8040, 1968, *E. S. Edees 20154* (**NMW**); 2 Aug. 1977 and 18 July 1989, *D.E.A.* (**BM**). Abundant throughout various copses above Lower Froyle, SU7445, SU7545, SU7645, 18 July 1988, *D.E.A.* (**BM**). Clump by cross-paths, New Copse, Four Marks, SU686349, 30 July 2000, *D.E.A.* (**BM**). Along top of M3 embankment, Old Potbridge Road, Winchfield, SU753543, 25 June 2001 (**BM**, **NMW**, *herb. R. D. Randall*).

v.c. 23, Oxon: Heythrop Park, [near Chipping Norton, SP3626 or adjoining square], 1929–32 and 1936, *H. J. Riddelsdell* (**BM**).

This third robust member of ser. *Hystrix*, hitherto "H1219" (Fig. 5a), is readily told by its large, usually white flowers, long-tipped sepals, dark purple axes, typically round, acuminate, biserrate leaflets and long nodding inflorescences. It is mainly a bramble of the eastern half of North Hampshire, in which it has been noted in seven hectads (SU43, 54, 63, 73–75, 84) but with a strong concentration to the east and north-east of Alton, where it is abundant in woods and copses on the Clay-with-flints on the slopes above the valley of the infant River Wey, close to the border

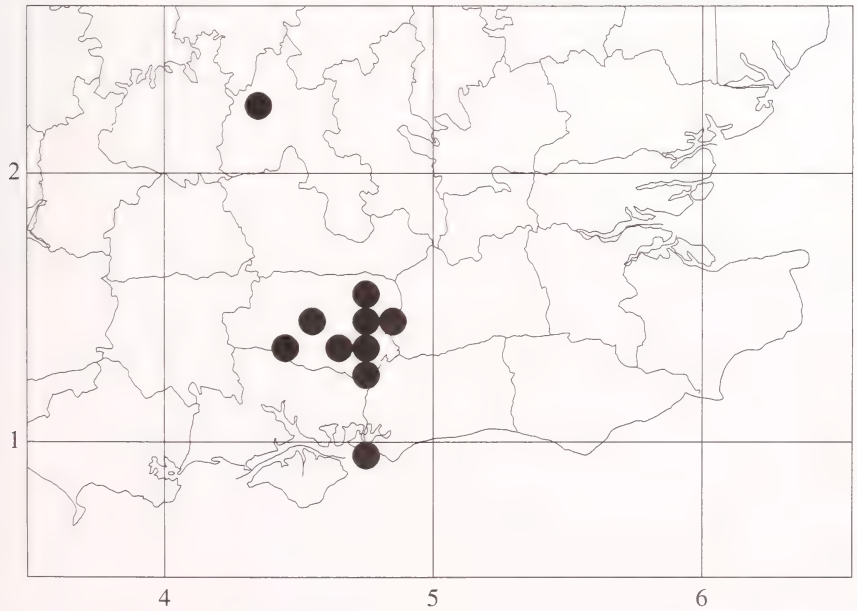


FIGURE 5b. Distribution of *Rubus vindomensis* D. E. Allen.

with Surrey, v.c. 17, into which it almost certainly continues in the neighbourhood of Farnham. Away from that core area the plant's North Hampshire occurrences are largely limited to a wide scatter of solitary, isolated clumps or patches, which peters out in the centre of the county north of Winchester. In addition, however, far to the south, nearly 40 km from the nearest other known locality, there is an unexpected large population on the coast at the south-east tip of Hayling Island (less than 2 km from West Sussex, v.c. 13). Even more anomalous, in this case far to the north and at a distance of nearly 100 km from the headquarters of the species, is a further population in the Oxfordshire Cotswolds sizeable enough to have yielded gatherings by Riddelsdell on five occasions in the course of eight years. This was in Heythrop Park, a large, well-wooded estate of long standing outside Chipping Norton. Numbers 2385, 2618, 3076, 3896 and 11537 of the former combined herbarium of Riddelsdell and W. C. Barton, now integrated with the general British collection in **BM**, the gatherings were successively determined by Riddelsdell as *R. saxicolus* P. J. Mueller, a species then erroneously thought to be British, and 'aff.' the East Anglian *R. lintonii* Focke ex Bab. All are unquestionably identical with the Hampshire plant. Whether this Oxfordshire outlier is part of a more extensive occurrence in the Cotswolds has yet to be investigated. Of possible relevance in that connection, as a part-way 'stepping-stone', is a further find – though of a mere solitary and perhaps transient clump – on the roadside margin of The Chase (SU438618), an ancient wood rich in rare *Rubus* species in the north-west corner of Hampshire just south of its border with Berkshire, v.c. 22, outside Newbury (Fig. 5b).

The species is named after Vindomi, a *mansio*, or posting station, mentioned in the Antonine Itinerary and credibly suggested (Rivet 1970, p. 61; Millett & Graham 1986, p. 158) as identical with a large Romano-British settlement recently found and excavated on the eastern outskirts of Alton.

ACKNOWLEDGMENTS

Alan Newton has examined on different occasions material of each species described in this paper and seen three of them in my company in the field. Len Margetts has similarly examined at my request material of *R. pydarensiformis*, and Herman Vannerom material of *R. clausentinus* and *R. milesianus*. I thank each of them for their assistance in these connections. I am also indebted to Philip Oswald for assistance with the Latin diagnosis and descriptions, to Arthur Chater and Philip Oswald for advice on a point of orthography, to Roy Vickery for arranging the taking of the photographs and especially to Martin Sanford for producing the maps.

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The current status of Military (*Orchis militaris*) and Monkey (*Orchis simia*) Orchids in the Chilterns

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ABSTRACT

The past and current status of the two populations of Military orchid (*Orchis militaris*) and one population of Monkey orchid (*O. simia*) in the Chilterns is discussed. All three of these extant populations reached nadirs twenty or more years ago, but have since increased substantially, especially in the last five years, and are now considered relatively healthy. Preliminary results from re-introduction attempts are given. The possible causes of the population increases are discussed.

KEYWORDS: Orchidaceae, conservation, re-introduction, artificial propagation.

INTRODUCTION

Both Military (*Orchis militaris* L.) and Monkey (*O. simia* Lamarck) orchids are considered to have once been relatively common in the Chilterns and surrounding area (Summerhayes 1951; Lang 1980; Farrell 1985), to the extent that advice on how to cultivate them (presumably after removal from the wild) was provided (Webster 1898). However, even 100 years ago, concern was expressed (Webster 1898) over the possible loss of some orchid species, including *O. militaris* (at that time *O. simia* was considered a sub-species, *O. militaris tephrosanthos*, of the Military or Soldier orchid), Webster writing that *O. militaris* had "suffered almost complete extermination at the hands of collectors and dealers". By 1925, the situation was worse. Tahourdin (1925) wrote that the *O. militaris* was "now so rare that only a few privileged persons know where, if at all, it can be found" and *O. simia* (now considered a distinct species) occurred "only in South-Eastern England, and probably near extinction even there". Around that time *O. militaris* was thought to have become extinct in the U.K. (Summerhayes 1951), and *O. simia* became confined to one site

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in Oxfordshire (Godfery 1933), leading Brooke (1950) to suggest that for both species "this excessive rarity appears to be due to the fact that the flowers are very seldom fertilized in this country". However, he also noted regarding *O. militaris*, that "the builder and the farmer have laid waste many of its former haunts, and probably it has suffered more than most orchids from those who should be its best friends – the botanists". Probably the same was true for *O. simia* (Summerhayes 1951)

This depressing situation took an unexpected twist when, in 1947, J. E. Lousley discovered, by chance, a colony of *O. militaris* growing at Homefield Wood in Buckinghamshire, a locality from which it had not previously been reported, although within its past distribution area (Summerhayes 1951; Farrell 1985). An even greater surprise was the discovery in 1954 of a large colony of *O. militaris* in Suffolk, well outside of the area normally considered its previous stronghold within the U.K. In contrast, *O. simia* was not considered to have become extinct (but see Preston *et al.* 2002, for a different opinion), although for many years it is thought to have existed on only one site (Hartslock) in the Chilterns, until the discovery of a single plant on a site in Kent in 1955, where the species thrived in subsequent years, possibly helped by hand pollination (Lang 1980).

The current situation is that both species remain very rare plants in the U.K. (Preston *et al.* 2002). *O. militaris* is confined primarily to the sizeable colony in Suffolk and two populations in the Chilterns, and *O. simia* is confined to two populations in Kent (one an introduction from the other) and one in Oxfordshire. It is recent changes in the numbers of these two species in Oxfordshire and Buckinghamshire (the Chilterns) which form the basis of this report. One of the populations of *O. militaris*, that at Homefield Wood, has been well studied for a long time, and earlier papers report on changes in the number of plants (Farrell 1985, 1991; Hutchings *et al.* 1998) and the population biology (Hutchings *et al.* 1998). These show that although the persistence of *O. militaris* at this site for the last 55 years suggests very considerable resilience, the population remained small (always less than 50 flowering plants), and hence very vulnerable. We are unaware of any reports in the open literature on the status of *O. militaris* at the other current site in the Chilterns, or of *O. simia* in the Chilterns.

THE SITES

There are presently two extant sites for native (not introduced) *O. militaris* in the Chilterns. One is Homefield Wood (SU814867), a mixed woodland with areas of open grassland. It has been owned by the Forestry Commission since 1955. A small portion of it, the area containing *O. militaris*, has been managed by the Berkshire, Buckinghamshire, and Oxfordshire Wildlife Trust (B.B.O.W.T.), under agreement, since 1969. In 1984 it was notified as a S.S.S.I. Further information about the site, since the discovery of *O. militaris* there in 1947, can be found in Farrell (1985 and 1991) and Hutchings *et al.* (1998). Recently, the area of habitat considered suitable for *O. militaris* has been increased by the removal of plantation trees planted in the early 1960s, and this has led to an expansion of the range of *O. militaris* at Homefield Wood. There are presently three distinct areas considered suitable for the species (see Fig. 1). When originally found (in 1947), the plants were located in the area here called 'The Enclosure', due to the fact that in 1968 a fence was erected around the remaining plants (Hutchings *et al.* 1998). In 1985, an adjacent grassland area was created by the clear felling of plantation trees: this area is referred to as the '1985 Clearing'. *O. militaris* have also appeared in 'The Meadow', which is separated from the other areas by trees and scrub (Fig. 1).

The other *O. militaris* site is privately owned, and there is no public access. It holds a relatively small population. For these reasons, we have chosen to refer to this site as Site X, rather than name and locate it. It is also managed by B.B.O.W.T. under an agreement with the owner.

Recent genetic fingerprinting studies (Qamaruz-Zaman *et al.* 2002) have suggested that the three extant native populations of this species (two in the Chilterns, one in Suffolk) are all distinct and probably represent independent colonisations from the continent (the U.K. populations are at the very north-west edge of the geographical range of *O. militaris* (Farrell 1985). The populations at the two Chiltern sites are probably the remnants of older, previously more extensive, populations (Qamaruz-Zaman *et al.* 2002).

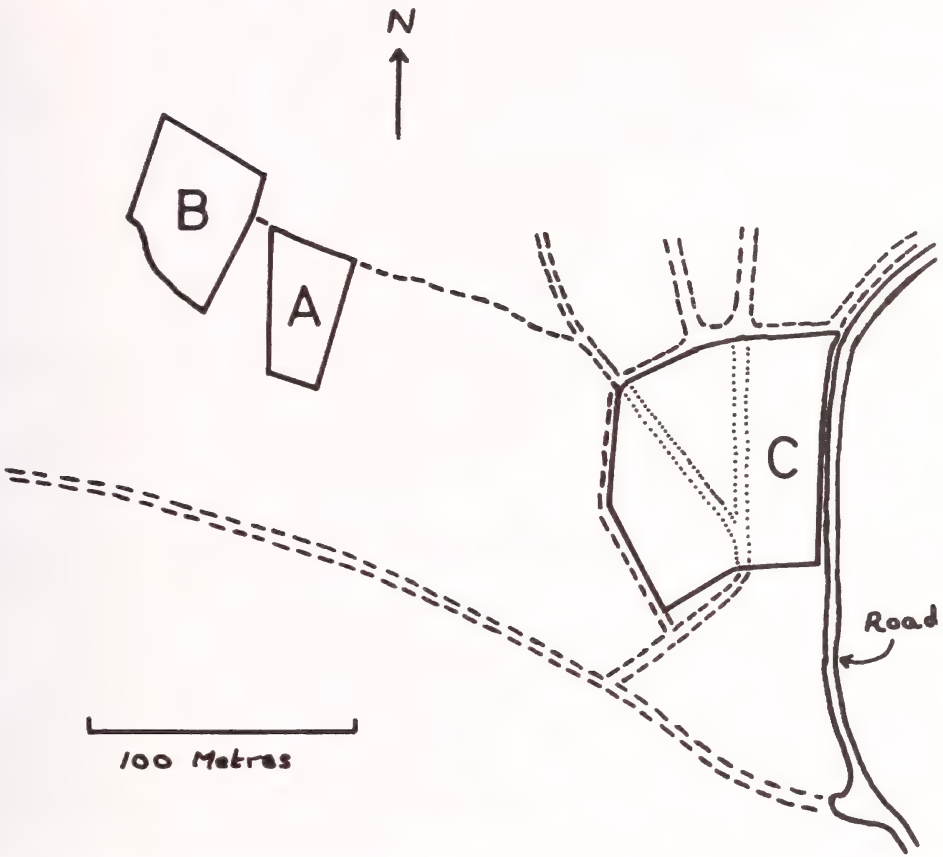


FIGURE 1. Simplified map of Homefield Wood S.S.S.I. in Buckinghamshire. *Orchis militaris* was originally found growing in the area now known as 'The Enclosure' (A). They now also grow in 'The 1985 Clearing' (B) and 'The Meadow' (C)

The only known extant site in the Chilterns for *O. simia* is Hartslock, Oxfordshire (SU616796). It is an area of 4·4 ha of species-rich chalk grassland, purchased by the B.B.O.W.T. in 1975. It is part of a larger S.S.S.I. The history of the existence of *O. simia* at this site can be found in Paul (1965) and Lang (1980). In brief, in the 1920s and 1930s there were more than one hundred *O. simia* plants at Hartslock. The whole slope on which the orchids grew was ploughed in 1950, after which the orchid led a very precarious existence at the site. Over the next 15 years, up until 1965, the number of flowering plants each year was very low, usually between one and five (Paul 1965).

DATA COLLECTION

All three sites have been managed for many years by volunteers (including the authors), under the direction of B.B.O.W.T. staff. Most of the data were collected by these volunteers. Additional data were obtained from records maintained by the B.B.O.W.T. In general, the data are considered very reliable. All three sites are relatively small, and the flowering spikes of both species are showy, and hence easily seen. Although various types of data (such as flowering dates, the frequency of flowering of individual plants, the size of each flower spike, the number of flowers per spike, number of seed pods per flower spike, etc) have been collected from all three sites, this paper concentrates only on the numbers of plants, although it includes data on both the numbers of

flowering plants and the total numbers of plants (vegetative plus flowering), hence conveying population trends. Accurate counts of vegetative plants are difficult, partly because these non-flowering plants are less obvious, and partly because small plants can be difficult to find. Thus, it is likely that the numbers given for all plants (vegetative and flowering) represent under-estimates of the true picture. Information on other aspects of the population biology of *O. militaris* at Homefield can be found in Farrell (1985, 1991) and Hutchings *et al.* (1998).

POPULATION CHANGES

ORCHIS MILITARIS

Homefield Wood

When Lousley discovered *O. militaris* at Homefield in 1947, there were 18 flowering plants (Lang 1980). From then until 1995, the number of flowering plants fluctuated considerably (Farrell 1985, 1991; Hutchings *et al.* 1998), but was always low, reaching 45 in 1995, a 7-fold increase over the number in 1977 (Hutchings *et al.* 1998). However, there has recently been a very marked increase in the number of flowering plants, the number passing 100 for the first time in 2002 (Fig. 2). This increase in number has occurred unevenly in the three areas of the site (Fig. 3). The number of plants in 'The Enclosure' has remained relatively constant for the last 15 years. *O. militaris* first flowered in 'The Meadow' in 1983, but the number remained very low (five or less) until 1996, after which there was a steady, sustained increase (Fig. 3). The first flowering plants in 'The 1985 Clearing' were observed in 1995, when two flowered. Since then, there has been a dramatic increase in the number of flowering plants in this part of the reserve (Fig. 3). Hence, most (over 80%) of the increase in the total number of flowering *O. militaris* that has occurred in the last 10 years has been due to the appearance of plants in 'The 1985 Clearing'.

Fig. 2 also presents data covering the total numbers (vegetative and flowering) of *O. militaris* at Homefield Wood, over the last 27 years. The number remained fairly stable, around 50 plants, until 1990, before increasing steadily, and then markedly, in the last 8 years. Presently there are over 200 *O. militaris* plants at Homefield Wood. As can be deduced from Fig. 2, although the proportion of plants flowering fluctuates, it has been fairly consistent recently. For example, in the last ten years (1994 to 2003 inclusive) the percent flowering has ranged from 31·7 to 58·6 (mean ± SEM: 47·6 ± 2·69%).

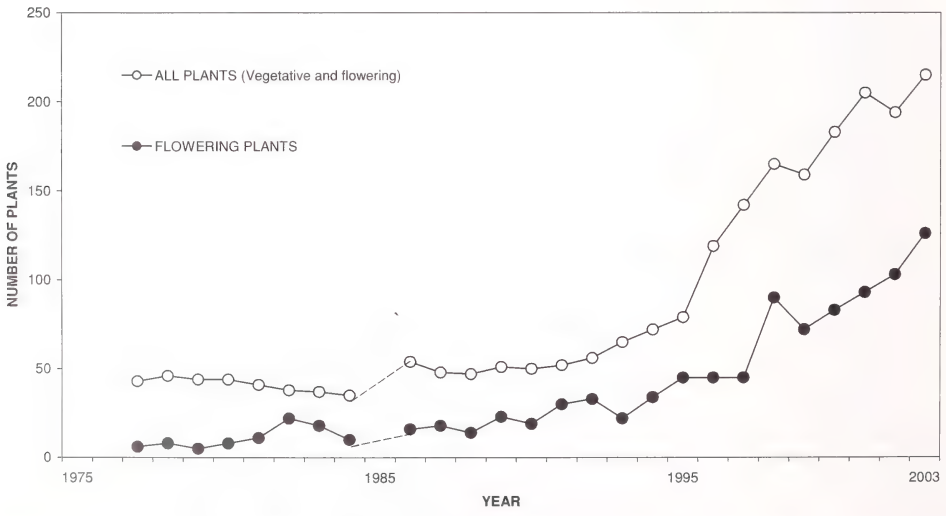


FIGURE 2. Changes in the number of flowering and total (vegetative and flowering) *Orchis militaris* at Homefield Wood, Buckinghamshire in the last 27 years.

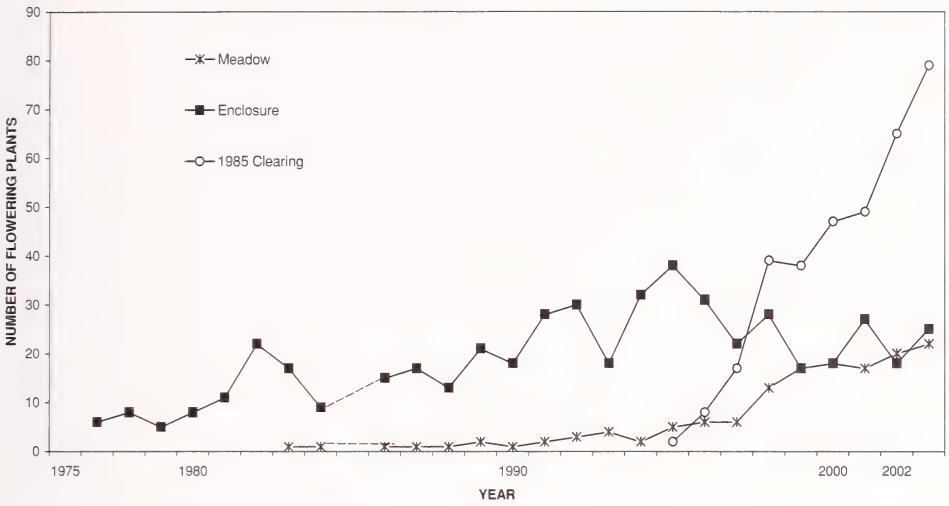


FIGURE 3. Changes in the number of flowering plants of *Orchis militaris* in the three different areas of Homefield Wood, Buckinghamshire in the last 27 years.

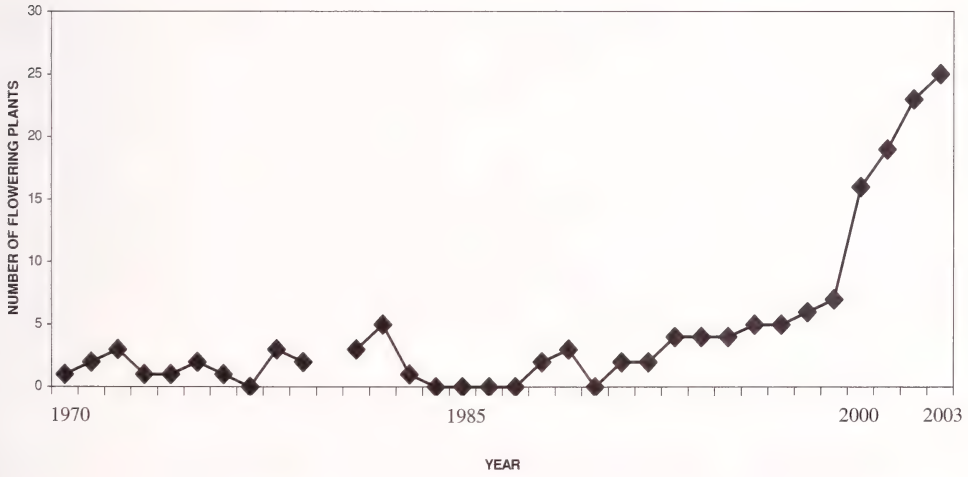


FIGURE 4. Change in the number of flowering plants of *Orchis militaris* plants at site x since its discovery in 1970.

Site X

O. militaris were first discovered at Site X, we believe by Lord Glendevon and Humphrey Bowen, in 1970. For the next 20 years, numbers remained very low, to the extent that in some years there were no flowering plants (Fig. 4), including for four consecutive years (1984 to 1987 inclusive). However, there has been a very pronounced increase in the number of flowering plants in the last 5 years, the total reaching 25 in 2003 (Fig. 4). Twenty five vegetative *O. militaris* plants were also present in 2003, making a total population of at least 50 plants. This was by far the highest number of plants that there has ever been at the site.

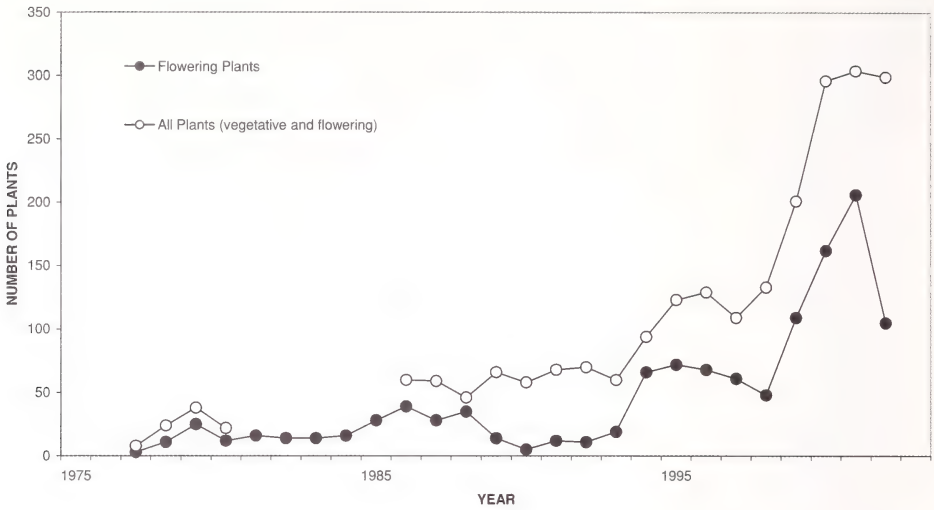


FIGURE 5. Changes in the numbers of flowering and total (vegetative and flowering) plants of *Orchis simia* at Hartslock, Oxfordshire since 1977.

ORCHIS SIMIA

Numbers of flowering plants every year for the last 26 years are shown in Fig. 5. The number fluctuated considerably for the first 15 years (from 1977 to 1992), being as low as five in one year. However, numbers have increased markedly since then, and reached over 200 flowering plants in 2001 (Fig. 5), before falling significantly in 2002, although still remaining very high in comparison to historical records.

Fig. 5 also shows the change in the total number (flowering and vegetative) of *O. simia* at Hartslock during the last 26 years (unfortunately, accurate data for 2003 are not available, but the situation appeared similar to that of the previous year). As occurred with *O. militaris* at Homefield Wood, after a slow but steady increase in the number of plants during the 1980s and early 1990s, thereafter there was a very marked increase, and since 2000 there have been around 300 identifiable *O. simia* plants at Hartslock. The proportion of plants flowering has, as with *O. militaris*, been reasonably consistent, especially recently. For example, in the ten years between 1993 and 2002, between 31·7 and 67·8 percent of plants flowered (mean ± SEM: 51·7 ± 4·0%).

ARTIFICIAL PROPAGATION OF *O. MILITARIS* AND TRANSPLANTATION OF THESE PLANTS INTO THE WILD

O. militaris seed collected over the years from Homefield Wood plants was supplied by The Royal Botanic Gardens, Kew, to Mr Svante Malgrem in Sweden, under a CITES licence. He raised plants asymbiotically (i.e. without any associated fungus). Two hundred and thirty one tubers, a mixture of one and two-year old plants, were planted at Homefield Wood (in 'The 1985 Clearing') and Warburg Nature Reserve (SU720879) in early July, 1996, and their subsequent progress monitored. In general, the plants did not fare well, at either location (Table 1). Even in the first year after transplantation, only a minority of plants showed above ground, and this proportion decreased steadily in the following years, such that very few plants now survive. However, a few plants have survived and grown enough to flower: the first artificially-propagated plants flowered at Homefield Wood in 2000, and five flowered in 2002, when the first plant (of the very few remaining) flowered at Warburg Nature Reserve (Table 1). In 2003, six plants, out of the ten that showed at Homefield Wood, flowered, but none flowered at Warburg.

Three other points of interest have emerged from this experiment. Firstly, that the tubers that were two years old when planted out into the wild survived better than those that were only one year old. This point is well illustrated by survival rates at Warburg Nature Reserve: in 1998, 23 out of 50 (46%) two year old plants showed above ground, whereas only 7 out of 70 (10%) one year

TABLE 1. NUMBERS OF VEGETATIVE PLANTS ARISING FROM MIXED ONE AND TWO YEAR-OLD MILITARY ORCHID TUBERS TRANSPLANTED IN 1996. THE NUMBERS OF FLOWERING PLANTS ARE SHOWN IN BRACKETS

SITE	YEAR							
	1996	1997	1998	1999	2000	2001	2002	2003
HOMEFIELD WOOD	111	31(0)	27 (0)	20 (0)	16 (2)	17 (7)	ND (5)	10 (6)
WARBURG RESERVE	120	18 (0)	30 (0)	16 (0)	11 (0)	8 (0)	4 (1)	4 (0)

ND = Not Determined
The data for Warburg in 1997 were not adequate, because we did not look early enough in the year, and hence the figure of 18 is a minimum.

old plants did. Secondly, that although survival was somewhat better at Homefield Wood (an established site for the species) than at Warburg Nature Reserve (where, as far as we are aware, *O. militaris* had never been common, although a herbarium specimen dating from 1862 was collected approximately 400 m from where the young tubers were planted), the difference in rate of survival was not great (Table 1). Thirdly, most of the plants which showed above ground for one or more years at Homefield Wood were ones placed in amongst existing plants. In contrast, tubers planted away from other, established plants fared much less well (data not shown).

REINTRODUCTION OF *ORCHIS MILITARIS*

As part of the Species Recovery Programme for *O. militaris*, twelve plants were removed (with the agreement of English Nature) from Homefield Wood in 2000 and introduced to a National Trust site considered suitable for the species. This site is approximately 25 km from Homefield Wood, and lies within the previous distribution range of *O. militaris* (Farrell 1985). The tubers were all of plants which flowered in the year they were relocated, or in the previous year. They were much larger than those used in the experiment (discussed above) based on the artificially propagated tubers.

In the following year, eight out of the twelve plants flowered. Five of these had flower spikes bearing seed pods when next observed in August, and it appeared that 33·5% of the flowers on these five flower spikes had set seed. In 2002, ten plants showed, eight of which were in bud when observed in early May. When observed next, in August, it appeared that six plants had flowered. These had between zero and sixteen seed pods per flower spike, suggesting relatively poor pollination. In 2003, nine plants showed, of which seven flowered, one aborted a flower spike, and one was vegetative.

DISCUSSION

The most obvious feature of the populations of both *O. militaris* and *O. simia* orchids in the Chilterns is the very pronounced increase in numbers of both flowering and vegetative plants at all sites in the last five years. These simultaneous increases might suggest a common cause, of which the most likely might be climate change. In England, both species are at the very north-western limit of their European distributions (Farrell 1985). They are considered to grow best where the spring and summer are warm (Farrell 1985), and therefore their U.K. populations might be expected to prosper with global warming. To date, there appears to be relatively little evidence that global warming has yet made a great difference to the distributions of most British plants (Preston *et al.* 2002). In contrast, there is good evidence that climate changes has led to the northward spread of some species of butterfly in Britain, Ireland, and mainland Europe (Parmesan *et al.* 2001). Hence, we cannot conclude presently whether or not climate change has had a significant positive effect on the *O. militaris* and *O. simia* in the Chilterns. However, results from a long-term study of another outlier population of *O. simia*, in the Netherlands, may be relevant to the situation in the U.K. In this population, there is evidence to suggest that both population size and the proportion of plants flowering can be strongly influenced by weather conditions (Willems & Bik

1991); low temperatures when plants appear above ground (January–February) resulting in death of a significant proportion of established plants. In contrast, mild winters led to higher numbers of plants flowering (Willems & Bik 1991). Hence, if climate change leads to warmer winters (as has occurred recently in the U.K.), over-winter survival of plants at the northern extremities of their ranges, such as *O. militaris* and *O. simia*, may be enhanced.

Another factor that is likely to have contributed to the increase in numbers of both species is appropriate management of the sites. However, definitively linking particular management strategies with changes in numbers of orchids is difficult because of the time lag between seeds setting and plants flowering. The precise length of this time interval is unknown for both species under consideration here, but may well be between 5 and 10 years (Summerhayes 1951; Farrell 1985; Hutchings *et al.* 1998). Hence, it is quite possible that management practices in the late 1980s and early 1990s were responsible for the increased numbers of plants that occurred in the last five years, but proving (or refuting) this link will be extremely difficult, if not impossible.

The general management strategy at all three sites was similar; it involved fencing the areas containing the orchids, grazing with sheep in autumn/winter, and scrub management. The deer and rabbit-proof fencing is designed to eliminate (or at least greatly reduce) the loss of plants and/or flower spikes to these grazers, which otherwise can do considerable damage. Fencing also allows controlled autumn/winter grazing with sheep, with the sheep preferably being removed before the orchids appear above ground, which can occur as early as November, although is usually January or February.

Besides these general management practices common to all three sites, site-specific actions may have contributed to the success of the orchids. In the case of Homefield Wood, the creation (by clear felling of plantation trees) of the '1985 Clearing' undoubtedly contributed very significantly to the overall increase in number of *O. militaris* at this site; in 2003, well over half of all flowering plants occurred in this clearing, despite the fact that the first plant flowered in this clearing only eight years earlier. Hence, the creation of more suitable habitat was indisputably a key factor. The fact that it took 10 years after creation of the clearing for the first *O. militaris* plant to flower there suggests that a considerable time needs to elapse before the success (or otherwise) of such a management practice can be gauged. This regular creation of additional areas suitable for orchids provides a dynamic environment into which new plants can colonise. Over time, established, but often relatively small, areas (such as 'The Enclosure' in the case of Homefield Wood) can become invaded by scrub, or change in character in other ways (perhaps imperceptibly), and become less suitable for orchids. Small, isolated populations may be more vulnerable than larger ones spread over larger areas. Therefore, a management strategy that regularly provides new areas ecologically suitable for the orchids, while maintaining established areas in appropriate condition, seems sensible.

Hand pollination is another management practice that might have played a significant role in the expansion of the populations of both orchids. According to the literature, natural pollination rates are very low; for example, Farrell (1985) summarizes the information available for *O. militaris* at that time by writing "it thus seems likely that poor seed set has been characteristic of British populations for at least 150 years". Various authors report that the proportion of flowers producing seed is around 5%, perhaps due to lack of suitable insect pollinators (e.g. Summerhayes 1951). Some degree of hand pollination of the orchids has occurred at all three sites, probably starting in the late 1980s or early 1990s. At Site X, after a number of years of no sign of the presence of *O. militaris*, two plants flowered regularly in the late 1980s. Given the precarious hold of this species at the site, the decision was taken to hand pollinate as many flowers as possible, to maximise seed production, even though there was concern that this might weaken the plants and shorten their lives. This achieved almost 100% successful pollination. The same two plants were heavily hand pollinated for the following 10 years, during which time seed production was (presumably) high. Thus, artificial pollination each year did not seem to have a deleterious effect on these two plants, a fact we have confirmed by hand pollination of other plants more recently.

At Homefield Wood, some hand pollination (up to 20% of available flowers) was carried out from 1986 to 1998, but none has occurred since. Overall, the percentage of flowers pollinated (some by hand, but the majority naturally), and which set seed, fluctuated between 21 and 59% (mean 38·7%) over this period, figures much higher than those reported earlier by other authors (e.g. Summerhayes 1951; Farrell 1985). No hand pollination was carried out in 1999 and 2000, when 40 and 24%, respectively, of flowers were pollinated and produced seed pods. We do not

know why the degree of pollination appears much higher now than it did to earlier authors. Similarly, hand pollination of *O. simia* has ceased, because natural pollination and seed production appears high.

The degree of success of the first stage of the re-introduction programme for *O. militaris* is difficult to gauge presently. Despite the success of raising *O. militaris* asymbiotically from seed, the young (1 and 2-year old) plants have not fared well, although a few have survived and flowered (and may continue to do so in subsequent years). The reason(s) why most plants failed is unknown. In contrast, the much larger (and presumably older) tubers transplanted from Homefield Wood to a new site have fared much better, and most have flowered, or at least attempted to flower, in the two years following their translocation. These plants must have produced a new tuber each year, suggesting that the conditions were favourable. Further, some natural pollination occurred, suggesting the presence at the site of at least one species of pollinating insect, although the overall degree of pollination has been quite poor. However, data for pollination success of the re-introduced plants are not very good presently, and hence we are cautious of drawing any firm conclusions as yet. It will probably be many years before it is known if this re-introduction has been successful; it will require the appearance locally of new plants, the offspring of the transplanted 'parents'. Using modern genetic techniques (Qamaruz-Saman *et al.* 2002) it would be possible to establish whether any new plants were indeed offspring of the transplanted plants, as opposed to natural spread from other plants at other sites.

ACKNOWLEDGMENTS

This paper is dedicated to the memory of Bill Havers, who died in 2002, after 16 years of successfully managing Homefield Wood nature reserve. His efforts, more than anyone else's, were responsible for the current very encouraging situation for *O. militaris* at Homefield Wood.

We are particularly appreciative of the efforts of Svante Malgrem, who raised the young *O. militaris* plants in Sweden, and to Margaret Ramsey of the Royal Botanical Gardens, Kew, who supervised the propagation and transplantation of these young plants. We also thank the many wardens, volunteers, and B.B.O.W.T. staff who have contributed to the management of the reserves, and the owners of the sites for allowing them to be managed for the rare orchids.

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The distribution and population sizes of the rare English endemic *Sorbus wilmottiana* E. F. Warburg, Wilmott's Whitebeam (Rosaceae)

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ABSTRACT

The distribution of the rare endemic *Sorbus wilmottiana* is given, based on field, literature and herbarium studies. 42 trees are currently known from seven sites in the Avon Gorge, and we have been unable to refind it in one site. Under the 1994 I.U.C.N. threat criteria it is categorised as 'Critically Endangered'.

KEYWORDS: Gloucestershire, Somerset, conservation.

INTRODUCTION

Sorbus wilmottiana E. F. Warburg, Wilmott's Whitebeam, is amongst the rarest and least known of the trees in Britain. It is an endemic species, confined to partially-wooded limestone rocks and slopes of the Avon Gorge, Bristol, on both the west (v.c. 6 North Somerset) and east (v.c. 34 West Gloucester) sides of the gorge. Nethercott (1998) described its population size as "X – where X is a very small number", and noted that its conservation record in recent years had been disastrous. Flanagan (1998) regarded it as one of the four species of *Sorbus* with the highest priority for conservation in Britain.

Sorbus wilmottiana was first noted in Warburg (1962); the name was legitimised posthumously with a Latin description and designation of a type specimen in Sell (1967). It appears that Warburg first found it on 14 September 1933 whilst investigating trees which had been erroneously called *S. hungarica* (Bornm.) Hedl., collected by J. W. White (cf. Salmon 1930). Warburg subsequently visited the gorge on many occasions and collected fruit (e.g. note on herbarium sheet at **BM** "seed no. 23") and determined that it was polyploid, but no records of his count survive (the only chromosome count traced is that of 2n=51 by H. McAllister in the B.S.B.I. Cytological Database). Warburg decided to give it a name once it had also been found on the Somerset side of the gorge (Nethercott 1998). During a tour of *Sorbus* in South-west England in autumn 1958, Warburg twice visited the Avon Gorge with R. A. Graham, R. M. Harley and D. H. Lewis, and *S. wilmottiana* was subsequently described from material collected from the edge of Clifton Down during the second visit (specimens **ex herb. R. M. Harley**, holotype in **OXF**, isotypes in **K** and **RNG**).

As part of work on the rare *Sorbus* species of the Avon Gorge, we have compiled records from herbaria (**BM**, **BRISTM**, **CGE**, **K**, **NMW**, **OXF**, **RNG**) and carried out field work between 1996 and 2003. A number of literature references and other botanical records have not been accepted, due to confusion with *S. aria* (L.) Crantz and another unnamed taxon (cf. Rich & Houston 1997). The records and details of population sizes we have traced are listed in the Appendix. Like Sell (1989), we consider that giving exact localities for rare trees is preferable to their being cut down without anyone being aware of their interest or location. Some fuller details have been lodged with the National Trust, English Nature, the Threatened Plants Database and the National Biological Records Centre, Monks Wood.

IDENTIFICATION

In many respects *S. wilmottiana* appears morphologically to be part of the complex variation within *S. aria* sensu lato in the Avon Gorge (Rich & Houston 1996 were able to recognise at least eight forms of *S. aria* in one part of the Avon Gorge alone), so it is surprising that Warburg picked it out as a distinct taxon at all; he may have placed emphasis on its ploidy level. Nonetheless, we accept it as a distinct, uniform taxon, which is supported by other studies. Investigations by Proctor & Groenhof (1992) showed it to have distinctive peroxidase phenotypes. Lemche (1999, excluding her '*wilmottiana* 23' which is now known to be *S. aria*), also found it distinct in RFLP and microsatellite DNA analyses.

Sorbus wilmottiana is distinguished by the leaves of the lateral rosettes being 1·6–2·1(–2·2) times as long as wide, rhomboidal with widest point (45–)46–58(–62)% along the leaf, with (7–) 7·5–10·5(–11) pairs of veins held at an angle of (20–)26–36(–37)° to the midrib, with 5–8 shallow lobes extending *c.* 1/9 way to the midrib and finer marginal teeth, with the upper surface green and the lower surface white-tomentose (Fig. 1). The largest fruit are (8–)12–13 × (9–)10·5–13 mm, subglobose or longer than wide (and usually looking longer than wide), red at maturity with a moderate number of moderate-sized lenticels scattered over the fruit.

Sorbus wilmottiana differs from forms of *S. aria* in the Avon Gorge in having narrower, shallowly lobed rhomboidal leaves with generally fewer veins. The local forms of *S. porrigentiformis* E. F. Warburg and *S. eminens* E. F. Warburg (*sensu* Proctor & Groenhof 1992) differ in having respectively obovate, unlobed leaves and fruits broader than long, and orbicular, unlobed leaves.

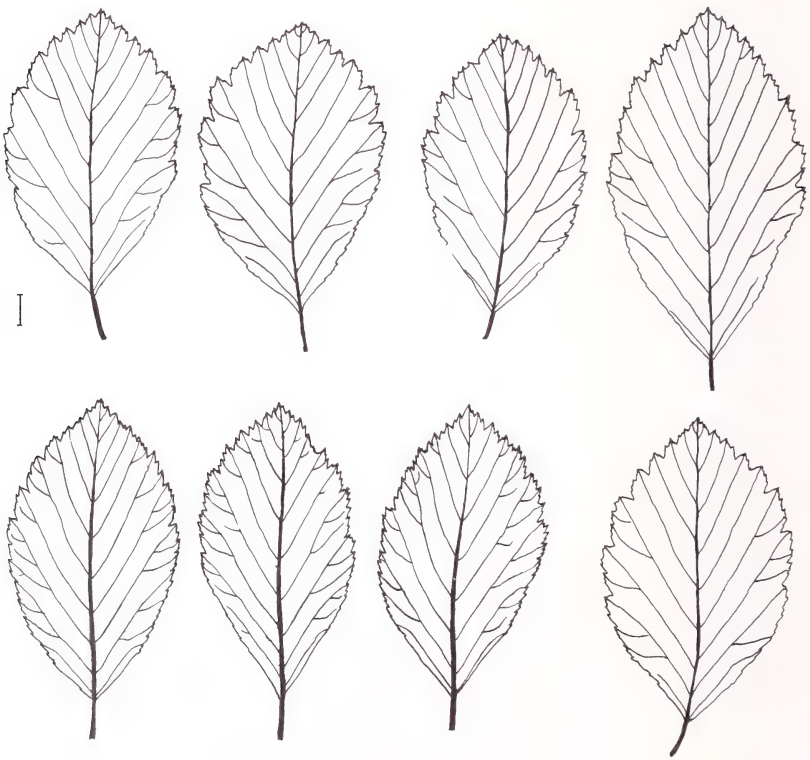


FIGURE 1. Typical lateral rosette leaves of *Sorbus wilmottiana* from sun-lit situations. Scale bar = 1 cm.

SITES AND POPULATION SIZES

V.C. 6. NORTH SOMERSET

Hendry & Pearson (1973) reported 'probably less than 10 all within the N.N.R. area' for the Somerset side of the Gorge, probably based on data supplied by P. J. M. Nethercott.

Site 1. Quarry 3, Leigh Woods (ST560743).
One tree was reported above Quarry 3 by Russell (1979). This quarry and the ridges and cliff tops above have been searched on several occasions in 2001–2003, but no *S. wilmottiana* has been refound, although six other *Sorbus* taxa occur. The quarry is used as a rifle range by the police, and some scrub clearance has taken place, at least in the bottom of the quarry.

Site 2. Quarry 4, Leigh Woods (ST561739).
Sorbus wilmottiana has been known in this quarry since 1958, and Russell (1979) reported eight fruiting trees and three saplings. This is perhaps the best known site of *S. wilmottiana,* and one tree in particular on the lower slopes of the quarry was often demonstrated to visiting botanists (e.g. during the Avon Gorge excursion associated with the B.S.B.I. A.G.M. in Bristol 8 May 1983). However, this tree was accidentally cut down during scrub clearance work in February 1995. Although it showed healthy regrowth two years later, it does not appear to have survived, possibly due to deer browsing the regrowth. In 2003, 17 trees of a range of sizes and several possible saplings were counted on the steep slopes, cliff edges and sheer faces around the top of the quarry.

Site 3. Cliff by railway line between quarries 4 and 5 (ST562738).
Eleven (possibly 12) trees were found on a sheer face above the railway in 1999. A further tree was recorded in 2001 during work in connection with the reopening of the Bristol to Portishead railway line. One tree was topped during preliminary line clearance work. Otherwise the colony remained undamaged and a safety fence has been erected between quarries 4 and 5 to protect it from wholesale removal of vegetation.

Site 4. Great Slab (ST561738).
Two trees and four possible saplings were first found here by L. Houston in 2002.

Site 5. Leigh Woods (ST558734).
One fruiting tree c. 7 m tall in woodland glade, first found by Bill Morris in 2001 during woodland management work.

V.C. 34. WEST GLOUCESTER

Site 6. Edge of Clifton Downs (ST563742).
This type tree appears to have been known since at least 1933 but was cut down to improve the view across the river in 1969 by the Corporation of Bristol (Willis 1969). Steps were taken to protect the stump which fortunately still showed signs of life, and by 1976 it had recovered and was fruiting abundantly (Willis 1976). The tree was subsequently lost, but was refound in 1997 by L. Houston, M. A. R. Kitchen & C. Kitchen using undated directions by Mark C. Smith, former Superintendent of Bristol University Botanic Garden (NB this location is incorrectly shown in Bailey *et al.* 1972). It fruited well in 2002.

Site 7. Walcombe Slade/The Gully, south side (ST562744).
An unspecified number of shrubs were known to P. M. J. Nethercott on north-west facing grassland towards the bottom of Walcombe Slade (also known as The Gully), prior to the records cited above (see area WN1 in Bailey *et al.* 1972). At least three trees were cut down during conservation work in the 1990s or earlier, including one well-known tree in 1995; they have subsequently regrown. Seven shrubs were counted on 20 May 2003 (**NMW**).

Site 8. Walcombe Slade/The Gully, north side (ST5674).
One tree in area cleared of scrub near the outcrop at the top north-west end of the Gully at ST563746, 20 May 2003, L. Houston & T. C. G. Rich. One tree in *Carex humilis* clearing cut down during conservation work but regrowing well, ST562745, 20 May 2003, L. Houston & T. C. G. Rich.

ERRONEOUS AND UNCONFIRMED RECORDS

A rare species population form 14 June 1975, L. Farrell, has a grid reference for Leigh Woods quarry 1, which has later been corrected with various grid references to Leigh Woods quarry 4. A small number of unverified trees were reported from Quarry 2, Leigh Woods (ST558744?) by Russell (1979); we have visited this quarry on a number of occasions but have been unable to find any *S. wilmottiana* though at least four other *Sorbus* species are present. Trees in, and on the edge of, The Great Quarry (sites T1 and T2 of Bailey *et al.* 1972) with unlobed leaves were once demonstrated as *S. wilmottiana*, but are now known to refer to another taxon (cf. Rich & Houston 1997). A single tree from Great Fault, Clifton Down (site BV4 of Bailey *et al.* 1972), 29 August 1957, P. J. M. Nethercott (**OXF**) has broader leaves; it is not currently accepted as *S. wilmottiana* and is probably referable to *S. aria*. Tree no. 8, The Gully, reported as close to *S. wilmottiana* by Rich & Houston (1996), is now known not to be *S. wilmottiana*.

In summary, 42 trees and six possible saplings are known from seven sites in the Avon Gorge, and we have been unable to refind it in one site. The distribution is shown in Fig. 2.

Anyone wishing to see *S. wilmottiana* is strongly advised to visit the planted tree on the edge of the grassland known as The Plain at Leigh Woods (ST557732) or those around Bristol University Botanic Garden at Bracken Hill before attempting to find it elsewhere in the Avon Gorge. No further leaf or fruit material should be collected from known sites. We will be happy to verify material from new sites.

BIOLOGY AND ECOLOGY

Relatively little is known about the biology and ecology of *S. wilmottiana*, most of which has been taken from Russell (1979). It grows to about 10 m tall, and will fruit before the trunk diameter at breast height reaches 4 cm. It occurs on calcareous rocks, screes and shallow soils, ranging from vertical rock faces to short open scrub and grassland. Soil pHs measured at the type tree were pH 6.9, on limestone soil around The Gully pH 6.6 and on the plateau clay soils in Leigh Woods pH 5.9. Like many others of the *S. aria* group, it is probably a light-demanding species, and is generally absent from tall, closed woodland.

It flowers in May and early June, but varies from year to year (e.g. 2002 was an excellent flowering year, but only one inflorescence was seen in 2003). Potential pollen inviability, assessed using Alexander's Stain (Alexander 1969), was 40% for the tree planted on The Plain (A. Karran, **NMW**). The fruits ripen between the end of August and early October, but fruit set appears variable from year to year. In 1976 Russell (1979) recorded an average of 23 fruits per inflorescence, and 125–145 viable seeds per 100 fruits (this reproductive output is lower than *S. anglica*, *S. aria* and *S. bristoliensis* which he also studied). Seed germination trials showed that no germination occurred in pots stored in sheltered conditions under trees (including coverage by leaf fall), but 10–20% germination was recorded in pots placed in exposed conditions. Further significant germination was noted three years after sowing. Berries were popular with a wide range of bird species and were freely eaten by small mammals. The saplings found during our surveys suggest that this species is regenerating, but the identifications need to be confirmed when they are mature; it certainly grows readily from seed.

CONSERVATION

Under the 1994 I.U.C.N. threat criteria (I.U.C.N. 1994) used for British plants (Wigginton 1999) *S. wilmottiana* can be categorised as 'Critically Endangered'. Its conservation record has indeed been unsatisfactory. At least five trees have been cut down during habitat management work (including one damaged during conservation work we were involved in). However, only one of these appears to have subsequently died. Once cut down, the trees usually respond by coppicing and regrow from the base, but it may take at least seven years for foliage to show its characteristic mature shape. Nethercott (1998) reported that one, possibly two, trees had also been stolen.

Material, possibly all originating from the type tree, is held in cultivation at Bristol University Botanic Garden, Cambridge University Botanic Garden, Ness Botanic Garden and National Botanic Garden of Wales, and seed has been deposited in the Millennium Seed Bank, Wakehurst Place.

All trees are currently within the Avon Gorge S.S.S.I. and S.A.C.

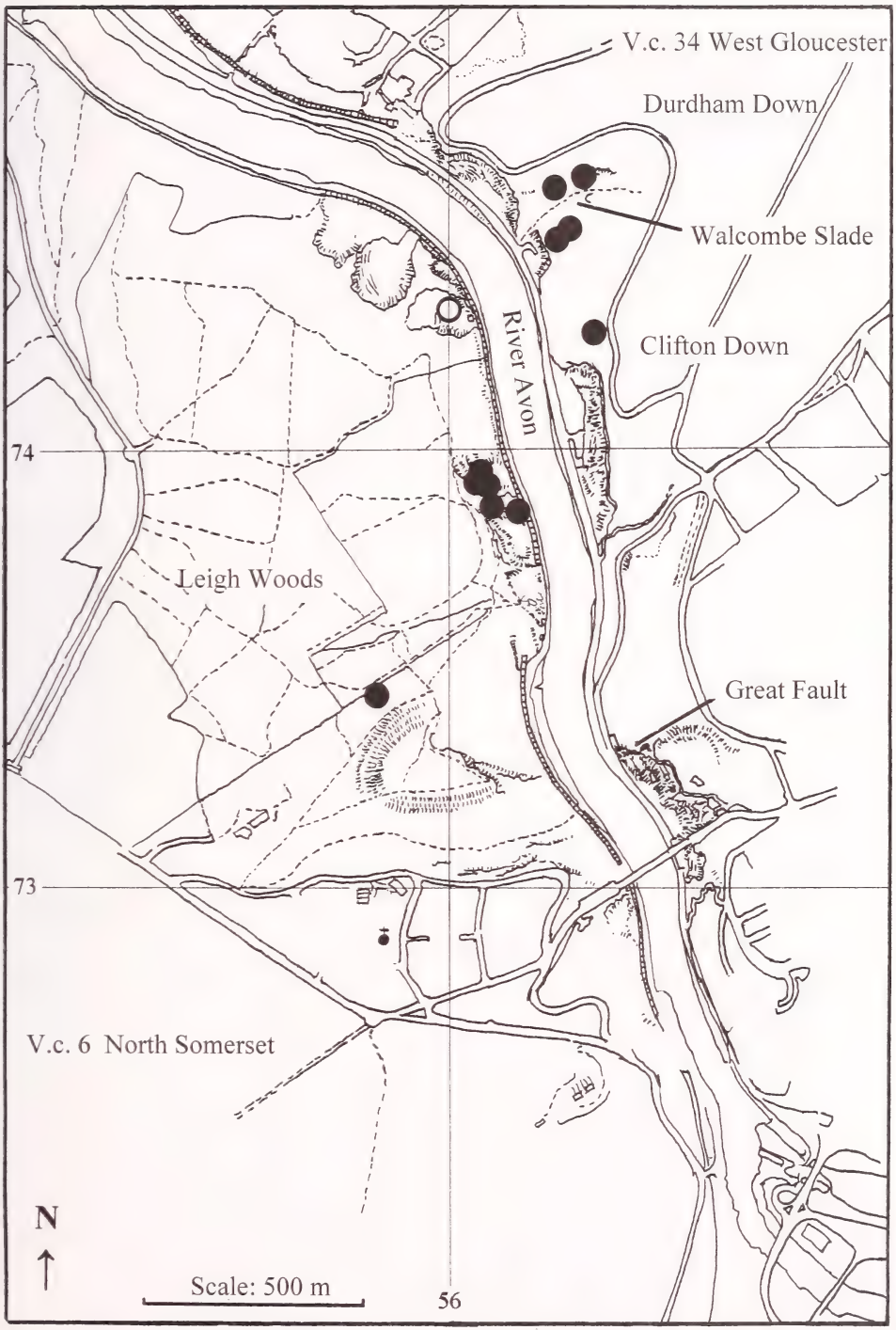


FIGURE 2. Detailed distribution of *Sorbus wilmottiana* in the Avon Gorge, Bristol. ● = 1996–2003, ○ = Not refound.

ACKNOWLEDGMENTS

We would like to thank the Keepers of **BM**, **BRISTM**, **CGE**, **LTR**, **NMW**, **OXF** and **RNG** for access to material, Tony Robinson and Bill Morris for information, Philip Nethercott for determining material, Andy Karran for assessing pollen viability, Brian Laney and Mark Jannick for help surveying, the Biological Records Centre, Monks Wood, and Alex Lockton and the Threatened Plants Database.

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APPENDIX 1

RECORDS OF *SORBUS WILMOTTIANA*

Site 1, Quarry 3. Leigh Woods, ST560743, 7 September 1977, P. D. Sell (**CGE**).

Site 2, Quarry 4. Leigh Woods, 10 July 1958, P. J. M. Nethercott (**OXF**). Rocky slope, ST561741, 6 June 1972, P. D. Sell (**CGE**). One plant, 14 June 1975, L. Farrell & P. J. M. Nethercott (rare species population form, English Nature; grid reference incorrect). Top of steep sloping limestone slab, 7 June 1976, R. J. Pankhurst & J. M. Mullin (**BM**). T. C. G. Rich, 8 May 1983 (**NMW**). 27 July 1989, P. J. M. Nethercott, A. Robinson & I. Taylor (rare species population form, English Nature; grid reference incorrect). ST/560.739, 2 October 1996, L. Houston (**NMW**). ST561739, 14 June 2001, T. C. G. Rich & L. Houston (**NMW**).

Site 4, Great Slab. Wooded rock face, L. Houston & T. C. G. Rich, 21 August 2002 (**NMW**).

Site 6, Edge of Clifton Downs. On limestone rock, 7 and 29 June 1922, J. W. White (**BM**, as '*S. aria* var. *incisa*', though other material he collected under this name is not *S. wilmottiana*; assumed to be this site). By cliff edge, 14 September 1933, E. F. Warburg (**BM**). 19 September 1935, E. F. Warburg (**BM**). 10 October 1956, E. F. Warburg (**LTR**, **OXF**). Edge of the greensward at top of Avon Gorge cliffs, ST563742, 27 September and 4 October 1958 (type), R. A. Graham, R. M. Harley, D. H. Lewis & E. F. Warburg (**K**, **OXF**, **RNG**). Type tree, 25 May and 7 September 1964, P. J. M. Nethercott (**BRISTM**). Type tree, single tree on edge of cliff, ST563742, 18 September 1966, S. M. Walters (**CGE**). Tree known to Dr Warburg, 29 September 1966 and 6 July 1967, P. J. M. Nethercott (**BM**). ST5674, 9 September 1997, T. C. G. Rich, M. Way, J. Carey *et al.* (**NMW**). Type tree, ST563742, 20 June and 10 October 2001, T. C. G. Rich & L. Houston (**NMW**).

Site 7, Walcombe Slade/The Gully, south side. Durdham Downs, scree, rare, ST563746[?], 7 October 1989, S. H. Bishop and R. J. Cooper (**BRISTM**). Grassland, ST562744, 20 June 2001, L. Houston (**NMW**). Group of four trees in grassland, ST562744–5, 21 August 2002 and 20 May 2003, L. Houston & T. C. G. Rich (**NMW**).

A summary of the past and present status of *Spiranthes aestivalis* (Poir.) Rich. (Orchidaceae) (Summer Lady's-tresses) in north-west Europe

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ABSTRACT

The past and present distribution of *Spiranthes aestivalis* (Poir.) Rich. in north-west Europe is described. A species at the edge of its geographical range, it has been readily susceptible to changes in its damp habitat. This is especially so where the latter has dried out, either directly due to drainage or by other means, so that the plant is now lost from many of its former sites. Gross over-collecting will also have contributed to the plant's demise, especially where populations were small. *S. aestivalis* appears to be extinct in the British Isles, Belgium and the Netherlands, whilst in north and north-west France, where it was formerly quite widespread, it is now very scarce and reduced to about eighteen populations.

KEYWORDS: Orchids, distribution, extinction, ecology, extant populations.

INTRODUCTION

Spiranthes aestivalis, which at one time occurred extremely locally in southern England, the Channel Islands, Belgium and the Netherlands is now considered to be extinct in these regions. It is a close relative of *S. spiralis* from which it is most readily distinguished by the fact that its flower spike arises directly from the centre of the current season's basal rosette rather than adjacent to the developing one of the following season as is the case in *S. spiralis*. Its habitat is also very different, *S. aestivalis* being a plant of damp, often rather acidic, ground whereas *S. spiralis* is largely restricted to dry, short-grazed calcareous turf.

Within the British Isles, all confirmed records of *Spiranthes aestivalis* were from the New Forest in Hampshire and from the Channel Islands, in both of which areas it is now thought to be extinct. In much of Europe it is rare and decreasing as its damp, boggy, or heathland habitat is threatened by drainage, coastal development, or by agricultural improvement. Populations on the Dutch-Belgian border and in northern Germany, all now also thought extinct, together with those in the New Forest, were at the northern limit of the plant's range. Even just across the Channel in north-west France, where formerly there were many populations, the majority have now been lost. There is concern for its survival throughout most of central Europe, although further south, especially in Mediterranean areas such as Spain, there are still good populations, so that its survival chances there should be better. It has been widely recorded across central and southern Europe as far east as the Balkans and also, doubtfully, in Turkey (Renz & Taubenheim 1984); it is also found in North Africa. In north-west Europe it is a lowland plant but in the Alps is recorded to altitudes of 1200 metres.

This account outlines the result of an investigation (carried out over a period of more than ten years) of the past and present occurrence of *S. aestivalis* in north-west Europe. This area is defined here as that lying to the north and west of the River Loire (France) upstream as far as Orleans, and then of a line running approximately east-north-east passing just south of Luxembourg, along the Nahe valley, until reaching an arbitrary limit at longitude 8° East at the Rhine just west of Mainz (Germany). Within this area there are records from Belgium, the Channel Islands, England, France

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and The Netherlands. Information relating to the plant's former and current status has been obtained from the literature, from herbarium specimens, from field observations, and through personal communication with local botanists who know their area well. Inevitably, small populations may have been overlooked and even some existing ones lost during the survey period. Nevertheless, a fairly accurate picture of the plant's current status should be apparent.

In north-west Europe *S. aestivalis* occupies at least three types of fairly closely related habitat: open moist heathland (as at one of its most important extant sites near Lessay, France); wetter, rather acidic, boggy, peaty ground with *Sphagnum* spp. (as formerly in the New Forest) and damp, perhaps rather more alkaline, depressions in dunes (as on the Atlantic coast of north-west France). In southern Europe it is also found in base-rich ground, which however is still usually moist. Like many orchids the number of flowering plants can fluctuate appreciably from year to year.

THE PAST AND PRESENT DISTRIBUTION OF *SPIRANTHES AESTIVALIS* WITHIN THE REGION

GERMANY (EXTREME WEST ONLY)

It is not recorded in the area under consideration but was present prior to 1945 just outside the eastern limit in the area to the south of the mouth of the River Weser, west of Bremen, and also further south in the Rhine valley near Mannheim (Haeupler & Schönfelder 1989).

THE NETHERLANDS

In the past, *S. aestivalis* was recorded from the Limburg area. Localities there were close to those on the Belgian side of the border (see below). According to Adema (1980) and Kreutz (1987), prior to 1950 the plant was known from twelve separate 5 × 5 km squares in the border region of Noord-Brabant. It was first recorded in 1873 on marshy heathland at Stramproij near Weert, this being the first of three localities on the Swartbroeker Peel (peatland); however these sites were later lost through land reclamation. It was also known at Geuven and Aalst-Geldrop and appears to have been last recorded with certainty there in 1936. A record for *S. aestivalis* from the Dutch province of Zeeland in the vicinity of the "Braakman" was an error for *S. spiralis* (L. Vanhecke pers. comm.; cf. Vander Meersch, 1874).

There have been claims of further records from the Netherlands during the period 1968–1981. Kreutz (1987) relates that there have been reports that in 1968 the plant was re-found in dry heathland in the Stamproij-Weert area and at the Groote Peel (nature reserve) and that in the early 1970s up to 150 plants were found near Budel in a damp area, growing with *Calluna vulgaris, Drosera* sp., *Gentiana pneumonanthe*, *Narthecium ossifragum* and other typical associates. In 1981 it was thought there were still seven plants present but these were dug up, although it was claimed to still occur at de Hoort near Budel post-1980. In more recent years these areas have been searched without success (C. A. J. Kreutz pers. comm., 1991). Although the habitat was still good and the typical associated species present in abundance, there have been no further records of *S. aestivalis*. Due to this, and to the lack of absolute confirmation from the Rijksherbarium, Leiden, all these records are best treated as doubtful; this is also the opinion of local botanists (e.g. J. Willems, C. A. J. Kreutz, pers. comm.).

Losses in the Netherlands have been mainly attributed to habitat change caused by drying out, agricultural upgrading, and encroaching industrial development. However, the later claimed sites are still apparently intact and so the plant may yet be re-found there. The typical habitat in The Netherlands is, or was, damp heathland, usually over calcareous substrates.

BELGIUM

S. aestivalis formerly occurred at several localities in the Limburg region close to the Dutch border but it is now considered to be extinct there. It was mentioned for the first time as occurring in Belgium by Lejeuene & Courtois (1828) "*in pratis paludosis* Prov. Limburg" but subsequently was not recorded for many years; this resulted in some botanists questioning the validity of the original record. However, new localities were found at Genk in 1870 by Ch. Baguet and A. de Prins (Baguet 1871), where it was stated to be fairly common in a complex of heathland and *étangs*, preferring compacted soils, but not too wet conditions. Other localities were recorded in 1889 by Th. Thurand, and in 1913 by H. Van den Broeck and J. J. Hardy (L. Vanhecke pers.

comm., 1991). Eventually, eight localities were known, all in the Campine (Kempenland) region near Genk. By 1940, though, only one locality remained (Lawalrée & Delvosalle 1969), with less than ten plants; drying out of its habitat was given as the cause of loss. Since 1955 it has not been found at this last surviving locality, at which date the Ford Motor Company built a factory on the site; nor has it been refound elsewhere. In Belgium its habitat was damp heathland similar to that which it occupied in the Netherlands.

LUXEMBOURG

Not recorded from Luxembourg (van Rompaey & Delvosalle 1972).

ENGLAND

NEW FOREST, HAMPSHIRE: The only locality in the British Isles, other than the Channel Islands, was in the New Forest, Hampshire, where it is now thought to be extinct and where the date of the last record is uncertain. It was stated to be formerly present here in three or four valley bogs amongst *Sphagnum* sp. (Brewis *et al.* 1996). Popular belief is that it was last seen in about 1959, but it may have gone before then, although Lang (1980) suggests a possible sighting near one of the old localities that year, whilst McClintock (1968) considered it to be present until 1961. J. E. Lousley knew the plant in its latter days, noting two plants north of New Forest Gate in 1937 and that it was just hanging on there "about 1940" when the habitat was drying out and so becoming unsuitable. Another relatively late sighting was by D. McClintock in the New Forest on July 31, 1937 (D. McClintock pers. comm., 1991) when he found just two plants – possibly the same as Lousley's.

Babington, writing in Sowerby's "English Botany" (Sowerby 1838) after his first discovery of the species in Jersey (see below) expressed the hope that it would soon be discovered in the south of England, and this was fulfilled when it was found by Joseph Janson near Lyndhurst in August 1840 (Watson 1847–59), (see also a collection of Janson, 1840, **BM**!).

There were probably at least five localities in the area immediately to the south-west of Lyndhurst. Firstly, there was the site mentioned above, just north of New Forest Gate and east of Highland Water, where extensive *Sphagnum* bog still occurs but where the bordering carr woodland has now probably encroached onto the original site and natural succession taken its effect. A second site was at Gritnam Bank, a small area of *Sphagnum* bog bordered by deciduous woodland. This area was partly drained in the 1960s. Another site was west of Brick Kiln Inclosure, about ¾ mile south of Lyndhurst. This was also known to J. E. Lousley, who was of the opinion that its *Sphagnum* bog habitat was destroyed by both drainage and tree planting a few years after its discovery. At one time he had seen as many as 55 plants at this site, but his last visit was about 1940 when it was becoming overgrown with trees and he never returned. A fourth site was "about one and a half miles to the west of the road between Lyndhurst and Brockenhurst" as given on a herbarium label for nine specimens collected by F. J. Hanbury in 1893 (**BM**!). Yet a further locality was near a pond at Brockenhurst as evidenced by a herbarium specimen from there in 1880 "pond at Brockenhurst, 7/1880 leg. E. H. Melvill" (**MANCH**!). There is also another specimen "E. H. Melvill 8.1879, Brockenhurst, in boggy ground (**MANCH**!)". As Brockenhurst is six kilometres south of Lyndhurst, it is unlikely that any of the former sites are being referred to. Other than referring to a small *Sphagnum* bog close to the Lyndhurst to Christchurch road, the Floras of the period (Townsend 1883, Rayner 1929) are not specific about localities, although Townsend (1904) mentions that it was known from three separate localities near Lyndhurst.

The number of plants occurring at these sites seems to have been variable. It was "in abundance at the old locality in 1879" according to Bolton King (Townsend 1904), but later Rayner (1929) stated that it had all but gone from the site indicated by Townsend (1883) (see above). However, he referred to another one discovered by J. Cross prior to 1900, where for some years 200 flowering plants occurred annually but had subsequently diminished, with only seven being seen in 1927; nevertheless he concluded with an optimistic observation of 20 plants in 1928 (Rayner 1929). There is also the record quoted by Lang (1980) for nearly 200 flowering plants at a New Forest site in 1900. Despite this, several herbarium labels comment on its scarcity at the New Forest sites, and very many collections from there are now held in most major British herbaria – some with more than ten plants on a sheet, many with their tubers attached. It would seem to be very probable that over-collecting, allied to drainage, afforestation and the effects of natural

succession, has led to its extinction. There is apparently still some suitable habitat surviving close to the classic sites so there is always the chance that it may yet be re-found. Its New Forest habitat was wet *Sphagnum* valley bog where the conditions were slightly less acidic than elsewhere within the immediate area. [Some of the above historical information has been provided by R. P. Bowman (pers. comms.)].

An interesting and significant comment in relation to its former abundance and variable flowering performance was made by Marquand (1901) when noting the plant's occurrence in the Channel Islands. He reported that in the New Forest he "once saw half an acre of bog perfectly white with these flowers, but the following year only a few spikes of bloom appeared".

Recently *S. aestivalis* has been illegally re-introduced to one of its old New Forest sites where plants are flowering and fruiting freely. However, any irresponsible undocumented introduction, made without the full approval of the appropriate conservation body, is most inappropriate.

CHANNEL ISLANDS

JERSEY: *S. aestivalis* appears to have become extinct here in about 1925 (although stated to be in 1926 by Attenborough (1934) and 1928 by McClintock (1968)). It was first recorded for the British Isles by C. C. Babington on the banks of St. Ouen's Pond on 24 July 1837. A specimen, collected the following day, was sent to J. Sowerby, who reproduced a drawing of it in his supplement to *English Botany* (Sowerby 1838). It was stated to be "far from plentiful" even then and was not discovered elsewhere on Jersey. In the ensuing years it was subject to gross over-collection, again evidenced by the large number of specimens in many herbaria, so that well before the turn of the century it had become very rare. In its last years T. W. Attenborough took a great interest in the plant after collecting it on an early visit to the island in 1906. He recorded it for several years up to 1917 but, due to its scarcity, he was not collecting it at this stage. From then onwards he found none until 1926 when he discovered a single plant, but did not make a record of it in his Société Jersiaise Botanical Report until 1934 – possibly as a conservation measure (F. Le Sueur pers. comm., 1991). This appears to be the last reasonably reliable sighting. There is in fact a specimen of Frère Louis-Arsène's in **BM** purporting to come from St Ouen's Pond in 1926, and four further plants from the same locality in 1928 in his own herbarium (now with the Société Jersiaise). Unfortunately, since appreciable doubts have been shown to exist as to the validity of many rarities in Louis-Arsène's collections (Le Sueur 1982), both these herbarium sheets are of doubtful provenance and are probably not genuine Jersey plants. However, it is just possible that the 1926 specimen might have been the plant recorded by Attenborough (Le Sueur 1984).

The precise spot where the plant grew was wet sandy ground at the margin of St Ouen's Pond. The site is still natural and undeveloped but a reed bed has developed around the pond with *Juncus communis, Lythrum salicaria, Carex riparia* and other Carices dominant. This vegetation was formerly cut back hard by the farmers, but now grows unchecked. However, it is unlikely that this, rather than over-collecting, has been the cause of loss (F. Le Sueur pers. comm., 1991).

GUERNSEY: Extinct, not recorded since 1914. The date of its first discovery is not clear. Haslam in 1855 has been suggested, although there is an older undated record from Newbould c.1841 (McClintock 1975). Other early records include those of Beevor in c. 1858, and Wolsey and Hanbury, and also H. Trimen, in 1862, as well as a series of herbarium specimens also collected about this time. Although fairly abundant in the early days (Marquand 1901) it was considered to be quite rare by 1906 (McClintock 1975), presumably due to over-collecting and, in part, to drainage. Its Grand Mare locality appears on labels in numerous herbaria although Marquand (1901) reported that it flowered very sparsely in some years. The original site, where it occurred in *Sphagnum* bog, is apparently now much reduced although a small suitable area remains which has frequently been searched, but without success.

FRANCE (NORTH/NORTH-WEST)

In the part of France under consideration in this paper (i.e. north of the Loire, etc), *S. aestivalis* was formerly widespread but is now extant in only a relatively few localities. These lie in two main areas: (i) western Brittany (Départements of Finistère, Morbihan and Loire-Atlantique) and (ii) the Cotentin peninsula south of Cherbourg (Dép. Manche); there is also an isolated site further south in Dép. Ille et Vilaine and one in Sarthe. An examination of the published literature (de Vicq & de Brutelette 1865; De Vicq 1883; Masclef 1886; Lloyd 1897; Bonnier & Layens 1921; Riomet

& Bournérias 1952–1961; Wattez 1967; des Abbayes *et al.* 1971) reveals how frequent it once was in much of northern France. Many of these localities are indicated below under the relevant Département or area. Although perhaps not an exhaustive list, this shows that *S. aestivalis* formerly had a wide distribution.

FINISTÈRE: Des Abbayes *et al.* (1971) considered it to have formerly been fairly common in coastal slacks and inland marshes in the Département whilst Lloyd (1897) listed localities at Herbot; Quimper; Brest; Kerloc'h; Plougastel; S-Renan; Plouarzel; Goulven; Plobannalec; Edern; Plomodiern; Menezc'hom; Clohars. Many of these are now lost but some still survive (see below). MORBIHAN: The same authors Des Abbayes *et al.* (1971) and Lloyd (1897) give localities near Guer; at St-Dolav; Auray; Quiberon; Lorient; Theix; Ploërmel. LOIRE-ATLANTIQUE: Localities recorded in the Departement include St Gildas-des-Bois; Grande-Briere; le Pont-Mahé; près de Assérac; between Pornichet and Pouliguen; les Renardieres; lac de Grand-Lieu; la Seilleraie près de Mauves; Mazerolles et la Popinière near Sucé; Herbignac. CÔTES DU NORD: grand étang de Jugon; marais de Languenan; Planguenoual; Brusvily; Trébédan; in a depression in the dunes at Plévenon; in the landes of Kervezo in Tréglamus. ILLE ET VILAINE: Rennes; Broons-s-Nilaine; étang de Bazouges-sous-Hédé; St-Rémi; St-Pierre-de-Plesguen; landes de l'Ouée near Gosné. MANCHE: Mesnil-au-Val; Donville; Doville; landes de Lessay; dunes de Surville and Bréville; marsh at Gorges, 10 km west of Carentan, recently lost through drying out; Cherbourg "*in arena maritima*", 1886, herb. L Corbière (M!). MAYENNE: localities recorded by Des Abbayes *et al.* (1971) or supplied by D. Landemaine (pers. comm.), include the Signal des Avaloirs; near the source of the stream of "Buisson de malheur"; Boulay and Pré-en-Pail; south of mont Souprat; étang du Frêne at Champéon; on the firing range at Glaintin in St-Fraimbault; marsh of Cerisiers and of Randonnières in Aron; la Berlinchetterie en St-Germain-le-Guillaume; les Caves-de-Gérennes en Deux-Evailles; les Epinais and chateau of Cumont in Laval and a second site also at Laval. MAINE ET LOIRE: Pouancé; Angrie; Combrée; la Chapelle-s-Oudon; la Chapelle Rousselin; Rablay (all Des Abbayes *et al.* (1971)). CALVADOS: Falaise. ORNE: Gandelain. SARTHE: stated to be only slightly frequent (Des Abbayes *et al.* 1971); at Savigne sous le Lude, 1983 in moist alkaline meadows at stream margin at Cartes (D. Landemaine pers. comm., 1991). SEINE INFÈRIEURE, EURE, and EURE ET LOIRE: no records traced; PARIS BASIN: Rambouillet; Compiegne; Morlefontaine; Anet; Nogent-le-Rotrou; le Marais Vernier. PAS DE CALAIS: marsh between Beuvry and Cuinchy; St-Omer; Merlimont; Villers sur Authine; Villers-Cucq, seen there in 1966 but apparently not since (Wattez 1967); Tourbière de Villers (E of Cucq) in a rich alkaline *Schoenus* fen with *Liparis*, an unusual habitat (F. Rose pers. comm.). SOMME: St-Quentin-en-Tourmont; Mautourt; Cambron; Quend. AISNE: Chivres; Lierval; Parfondru; La Férte-Milon; Silly-la-Poterie; Montrgu Saint-Hilaire; Maucreux; Montchevillon. BOURGOGNE: Semur; Vielverge. ARDENNES: Sedan. [NORD: not known (Wattez 1967)].

French populations variously occupy acidic peat, *Sphagnum* bog, damp heathland, depressions in coastal dunes, or sometimes the more alkaline marshy areas.

CONCLUSIONS

The past and present distribution of *S. aestivalis* is indicated on the accompanying map (Fig. 1) where records are plotted on a 50 × 50 km squares basis of the UTM grid. In addition, the location and a brief description of the extant populations within the geographical area under consideration is summarised in Tables 1 and 2. Only readily detectable when in flower and in itself of very variable flowering, it is possible that the plant may be re-found at some of the old sites or that new populations will be discovered – or even that existing small ones have been overlooked.

Formerly very rare, *S. aestivalis* is considered to be extinct in the British Isles, Belgium, and the Netherlands. Within the area of north and north-west France under consideration, it was at one time quite a frequent plant but now only eighteen populations have been found to survive there (Fig. 1; Tables 1 & 2). Of these, six are in dune depressions on the Atlantic coast, eight in rather acidic bogs, two in acidic heathland and two in alkaline marshes.

Here, at the very edge of its geographical range, it has been susceptible to slight changes in habitat, especially to drying out caused as a direct or indirect result of drainage or through

TABLE 1: STATUS OF *SPIRANTHES AESTIVALIS* WITHIN THE AREA OF NORTH-WEST EUROPE UNDER CONSIDERATION

Country	Status	Region/Département	No of extant populations
Belgium	Not recorded since 1955	Limburg (near to Dutch border)	Considered to be extinct
Channel Islands	Not recorded since 1914 (Guernsey), c. 1925 (Jersey)	Guernsey, Jersey	Considered to be extinct
England	Not recorded since 1959	Hampshire (New Forest)	Considered to be extinct
France (north & north-west only)	Extant (now in only 6 Départements)	Finistère Morbihan Ille et Vilaine Loire-Atlantique Sarthe Manche	6 populations 4 populations 1 population 1 population 1 population 5 populations
		[Cotes du Nord, Mayenne, Maine et Loire, Calvados, Paris Basin, Pas de Calais, Somme, Aisne, Bourgogne and Ardennes]	All considered to be extinct
The Netherlands	Not recorded since c.1981?	Limburg (near to Belgium border)	Considered to be extinct
Luxembourg	No records	-	-
Germany (extreme north-west)	No records	-	-

agricultural upgrading. Industrial development has also resulted in losses and anthropogenic activities in coastal areas has caused, and may further cause, a reduction in the number of extant populations. Encroachment of its habitat by scrub or other coarse vegetation in the course of natural succession, especially in the absence of grazing, will also have contributed to losses.

An examination of the contents of major herbaria show the plant to have been grossly over-collected, sometimes with ten or more plants on a single sheet, often with the tubers attached. Such depradation is to be deplored. Small isolated populations cannot withstand such avid collecting for very long and in consequence will have soon been lost. In some circumstances however, the plant may tolerate or even benefit from slight disturbance. At one population, robust plants of *S. aestivalis* flowered freely on the raised ruts of vehicular tracks! Nevertheless, the few remaining populations should be monitored and protected. The large colony to the south of Cherbourg is of international importance and is the largest in north-west Europe. At some extinct sites, well-documented introductions might be worthy of consideration.

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TABLE 2: EXTANT (FRENCH) POPULATIONS OF *SPIRANTHES AESTIVALIS* WITHIN THE AREA OF NORTH-WEST EUROPE UNDER CONSIDERATION

Département	Population	UTM 50 km square
Finistère	Plounéour-Menez; bog west of road from Morlaix to Playben, to the south of Plounéour-Menez.	VU1
	St Rivoal; source of l'Elorn, *Sphagnum* peat bog, altitude 300 m, less than 10 flowering plants.	VU2
	Penmarc'h-Guilvinec; Le Steir, coastal dune depression, more than 100 flowering plants.	VT1
	Penmarc'h-Guilvinec; Toull Gwin, coastal dune depression, more than 500 flowering plants.	VT1
	Penmarc'h-Guilvinec; Poulguen, coastal dune depression, more than 100 flowering plants.	VT1
	Plomodiern; Menez Hom, peat bog, altitude 225 m, less than 10 flowering plants.	VU2
Morbihan	Ploemeur; Fort Bloqué, alkaline marsh, altitude 5 m, more than 50 flowering plants.	VT3
	Plouhinec; Kerzine, coastal dune depression, more than 50 flowering plants.	VT3
	Plouhinec; Moténo, coastal dune depression, more than 10 flowering plants.	VT3
	Guiscriff; inland marsh, discovered in 1990, c.200 flowering plants.	VU4
Ille et Vilaine	St Jean; inland peat bog. Population size not known.	XU2
Loire-Atlantique	La Turballe; coastal dune depression, altitude 5 m, more than 10 flowering plants.	WT2
Sarthe	Savigne sous le Lude; moist alkaline meadow and stream margin. Population size not known.	YT1
Manche	Lessay; approx 5 km to the south, heathland where associates include *Gentiana pneumonanthe, Lobelia urens* and *Carum verticillatum*, growing amongst *Pinus*, 600+ flowering plants counted in 1990 (estimated at 1000+).	XV2
	Lessay, a second small scattered population in heathland c.500 m to the south, where there are more than 25 flowering plants.	XV2
	Lessay, Tourbière de Mathon nature reserve, valley bog to the east of the town, small population.	XV2
	Marais de Doville, between St Sauveur-de-Pierrepont and the route national N800, small population in a large area of peat bog dominated by *Cladium mariscus* and *Myrica gale*.	XV2/WV3
	St Michel-des-Loups, SSE of Granville, small peat bog with a few flowering plants.	XU1

FIGURE 1. Map showing the provisional distribution of *Spiranthes aestivalis* in north-west Europe when plotted as 50 × 50 km squares of the UTM grid; (a) all records, (b) extant localities

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A re-examination of *Rosa* × *perthensis* Rouy

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ABSTRACT

In 1892 W. Barclay discovered a strikingly unusual rose near Auchterarder, Mid Perthshire v.c. 88. Specimens were sent to H. J. Coste, who incorporated them in the *Herbarium Rosarum* of Pons & Coste (1899). Rouy (1900) described the plant as *R.* × *perthensis* ("× *R. perthensis*"). The plant still grows at the type locality and we conclude that it is an unusual variant of the hybrid *R. mollis* Sm. × *R. sherardii* Davies. As *R.* × *perthensis* predates *R.* × *shoolbredii* W.- Dod the former is the correct name for this hybrid.

KEYWORDS: *R.* × *perthensis*, persistence, cytological examination.

In 1892 W. Barclay found a strikingly unusual rose growing near Auchterarder Railway Station in Mid Perthshire, v.c 88. Barclay sent material of this to H. J. Coste, who incorporated it in the *Herbarium Rosarum* of Pons & Coste (1899) under the name of *Rosa pimpinellifolia* × *tomentosa*. G. C. C. Rouy had access to this collection, and described the plant in his *Flore de France* under the name × *R. perthensis* (Rouy 1900).

Since that time, as described below, everyone, with one notable exception, has considered this plant to be a hybrid, and there has been much speculation as to its parentage. It is obvious that the plant named by Rouy as *R.* × *perthensis*, whatever may be its parentage, is a unique variety. In 1919 J. R. Matthews planted seedlings raised from the Auchterarder plants near St. Andrews Cottage, Dunning, a few miles from the original site, and J. W. H. Harrison, who had seen the Auchterarder plants, reported having seen it at Forres, near Elgin, v.c. 95. Specimens in all the major British herbaria of this variety examined by us are all from Auchterarder, apart from a few from elsewhere which were wrongly named. In 1999 R. Maskew visited the site at the now defunct Auchterarder Railway Station, and found the plant still growing there. He did not find it at Dunning. As far as we know, apart from these records, this unique variety as described below has not been found in any other locality .In order to be sure that the plant at present growing at Auchterarder , which we name as *R.* × *perthensis* Rouy, is the same taxon as that so named by Rouy himself, a specimen was obtained from Lyon on loan to **LTR** stamped on the sheet with HERBIER ROUY. This specimen is selected here as the lectotype for *Rosa* × *perthensis*. The sheet has the printed label common to all the sheets of No. 378 of the *Herbarium Rosarum* of Pons & Coste. It reads:

Dr. Pons & Abbé Coste

Herbarium Rosarum

5e fascicule (années 1898 et 1899)

No. 378 *Rosa pimpinellifolia* × *tomentosa* (*R. involuta* Sm.var.)

Ecosse: Auchterarder , comté de Perth

3 juillet, 6 septembre, 1899

Barclay

In addition to the printed label, also written on the sheet is:–

R. perthensis = (*pimpin.* × *omissa*) Rouy Fl. Fr. V1, 430

There are two branches on the sheet, one in flower (3 July) and the other in fruit (6 September).

The following description refers both to the material from Lyon, and to that collected from Auchterarder by R. Maskew in 1999:

Erect suckering shrub; main stems straight in the lower part, slightly arching near the top, brown or green; young stems slightly zigzagging with wine red or purple pigmentation; stem prickles unequal, some small and almost straight, mixed with others larger and more curved with stouter bases, both mixed with scattered acicles; leaflets consistently seven, 1·8–3·5 × 1·2–1·9 cm, ovate or ovate-lanceolate, glandular-multiserrate; upper surface dull matt green, slightly pubescent; lower surface moderately pubescent on the midrib, less so on the remainder of the surface; both surfaces covered in dark red stipitate glands with a very strong resinous odour; petiole and leaf rachis densely glandular-hispid with numerous glandular and eglandular unequal acicles; stipules 10–13 × 3–6 mm, densely glandular; hips 1·8–3 × 1·4–1·8 cm, subglobose to pyriform, densely glandular-hispid with some acicles reaching 7 mm in length; pedicels 0·5–1·5 cm, densely glandular-hispid, with long eglandular acicles bearing short lateral gland-tipped branches mixed with shorter simple glandular ones; sepals 2–2·5 cm, spreading-erect, pinnate with long leafy tips, some tips reaching 10 mm in length, very densely glandular hispid, some acicles in the lower half with short lateral gland-tipped branches; styles slightly hispid; stigmas in a small flattish head partially concealing the disc; disc slightly concave; orifice 1/3 the diameter of the disc.

According to Matthews (1934), Barclay, and both Baker and Nicholson, at first named it *R.* × *involuta* Sm. var. *sabinii* Woods, and it is recorded under this name in Buchanan White's Flora of Perthshire (White 1898). This is unacceptable nowadays because *R.* × *involuta* is the name given to *R. pimpinellifolia* L. × *R. sherardii* Davies, and *R.* × *sabinii* to *R. mollis* Sm. × *R. pimpinellifolia* L. Later Barclay (1911) expressed as his final opinion that the plant was *R. spinosissima* × *R. omissa* (i.e. *R. pimpinellifolia* × *R. sherardii*) "with a leaning to the *omissa* side" – in other words he considered it to be *R sherardii* (female) × *R. pimpinellifolia*. A. H. Wolley-Dod (1911) first became involved in this matter when he stated that *R.* × *perthensis* was best referred to as *R. involuta* var. *nicholsonii* Crépin. He subsequently confused the issue by naming it as × *R. barclayi*, a name doubly illegitimate because (a) the name *R.* × *perthensis* had priority, and (b) × *R. barclayi* had already been applied to another taxon. Later (1930–31) he described *R.* × *perthensis* under his group *Spinosissimae* × *Villosae*, but this cannot be acceptable because it cannot be applied to any of the three British species of the Subsection Villosae. (a) *R.* × *involuta* has priority for *R. pimpinellifolia* × *R. sherardii*; (b) *R.* × *sabinii* has priority for *R. mollis* × *R. pimpinellifolia*; and (c) *R. tomentosa*, the third British species of this Subsection does not occur so far north, and hence is very unlikely to form part of this hybrid.

The plant was figured by Harrison (1921), and later Matthews (1934) stated that Harrison had informed him that he had cytologically examined the plant and had found no evidence of its being a *spinosissima* hybrid. Matthews (1934) gave a detailed discussion in which he rejected the idea of hybridity and stated that he considered *R.* × *perthensis* to be *R. omissa* Déséglise (= *R. sherardii* Davies var. *omissa* (Déséglise) W.-Dod). Matthews (1934), like Wolley-Dod, was convinced that all rose hybrids must show at least partial sterility, but he found that *R.* × *perthensis* was fully fertile, and had raised from seed an F2 generation which was identical in characters with its parent. He also claimed that *R. pimpinellifolia* did not appear to occur anywhere near Auchterarder .

Over forty years later Matthews (1976) revealed that he had long had proof that *R. pimpinellifolia* could not be involved. He had already (1934) stated that Harrison had examined the plant cytologically, and had found no evidence that *R. pimpinellifolia* was involved. This could only mean that Harrison must have studied the behaviour of the nucleus during meiosis, where the behaviour of the 28 chromosomes of *R. pimpinellifolia* if present would have been apparent.

Melville (1975) had evidently not taken this into account when he stated that *R.* × *perthensis* was the triple hybrid *Rosa pimpinellifolia* × *R. rubiginosa* × *R. sherardii*. In any case the characters he cites as evidence for *R. pimpinellifolia* influence are unconvincing. The presence of seven leaflets in the leaves is a common feature of the caninoid roses, and the slender nearly

straight prickles do not necessarily point to *R. pimpinellifolia*. The acicles cited as evidence by Melville do not resemble those of *Rosa rubiginosa*, and, with careful examination, we can find no sweet briar type subfoliar glands – all the glands on *R.* × *perthensis* are downy rose type with a very strong resinous odour .

That *Rosa sherardii* Davies is involved has been recognised by nearly everybody since the plant was first discovered (*Rosa tomentosa* of the earlier authors, e.g. Rouy, almost certainly referred to the aggregate name, which at that time covered all the downy roses), the zigzag habit of some of the branches, and a number of slightly curved prickles with comparatively broad bases, are indicators of this species.

The other species involved can only be *Rosa mollis* Sm. This is indicated by straight main stems with a tendency to sucker, and a number of slender, almost straight prickles. The long and numerous acicles on the hips are not indicative of any other species, but rather an exaggerated form of the normal character of *R. mollis*. Other characters such as the resin-scented glands typical of the downy roses are common to both species. In this hybrid it is unusual for the indumentum on the lower surface of the leaflets to be more or less confined to the midrib and veins. However, there is more regional variation in *R. sherardii* than in most British roses (Graham and Primavesi 1993). This is particularly noticeable in the degree of pubescence in the leaflets, where, in some districts, this is much reduced from normal. If the plant is examined in the light of modern taxonomic opinion and research, it can be seen that there is only one deviation from *R. mollis* × *R. sherardii*, namely the unusual profusion of stipitate glands and gland-tipped acicles, which tend to obscure and distract from the normal characters of the two species. The fact that this unique plant has persisted so long at the original site is probably due in part to its suckering habit, enabling it to perpetuate itself vegetatively, and that it grows in isolation on the bank of a quiet country lane, and has somehow managed to avoid destruction from mechanical hedge cutting.

The name *Rosa* × *perthensis* Rouy predates *R.* × *shoolbredii* W.-Dod, and is therefore the correct name for the hybrid *Rosa mollis* Sm. × *R. sherardii* Davies.

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Notes

TOFIELDIA PUSILLA (MICHX.) PERS. AT THE SCOTTISH BORDER

In 1671 John Ray found Scottish Asphodel, *Tofieldia pusilla*, new to science, about two miles from Berwick-upon-Tweed on the North Sea coast. Given the northern and montane distribution of this plant, as it is now known, this is a remarkable locality and this note presents evidence on its exact whereabouts and botanical character and considers whether the question of whether the record belongs to England or Scotland can be resolved.

John Ray (1677) records 'about two miles from Berwick, by the side of a rivulet, in boggy ground, not far from the road leading to Edinburgh, we found a sort of *Pseudo-asphodelus* which I had never before seen, much less than that common in England, having, as I guess, white flowers in a spike, to which succeed roundish seed-vessels. The stalk of the spike is naked, or not having above one leaf, the spike itself short, the root fibrous, as that of the common'. As the Scottish border lies a little under three miles from Scotch Gate, the northern exit from the walled town of Berwick, this record nominally falls in England (v.c. 68). Ray gave an abbreviated account of the same find in his 'Synopsis' (1724) as 'juxta rivulum non procul Bervico in Scotia'. There is an ambiguity as to whether Ray wrongly thought Berwick to be in Scotland or whether he sought to localise the record in Scotland. As this detail is not in the earlier account, which presumably was drawn from a field notebook, its authority is weakened. Ray may not have been clear just where the Scottish border lay as it may have been marked less well than by the later Lamberton Toll.

No subsequent botanist has refound the plant in this area, though many have looked for it, notably George Johnston and Charles C. Babington in 1834. Johnston (1829, 1853) quotes Ray but does not attempt to allocate the record to a country. George Swan in his recent 'Flora of Northumberland' (1993) follows Johnston (1829) who wrote 'Ray seems to have found *Tofieldia palustris* by the side of that stream which rises on this hill (Lamberton) and runs by the Shields', which would place it in Scotland (v.c. 81), despite Lamberton Shiels lying a full four miles from Berwick. This interpretation has been followed by Stace et al. in the 'Vice-county Census Catalogue' (2003). Inexplicably, Alfred Slack in 'Scarce Plants in Britain' (1994) speculates 'that it could have been in a flush by the River Tweed'.

THE LOCALITY AND ITS HISTORY

Berwick-upon-Tweed and its bounds or 'Liberties' north of the River Tweed comprise a roughly triangular area of land with sides about 5 km long that now falls to England, but only after a turbulent history. Indeed the Bounds of Berwick were granted to England in a treaty with Scotland in 1502 on the condition that they were 'to remain uncultivated, unbuilt and uninhabited'. They remained thus until the Union of 1603 when James VI of Scotland and I of England gave full 'liberties' for the freemen of Berwick to plant and build as they pleased. By 1724 Daniel Defoe was able to report agricultural improvement with fine barley and turnips and, around 1775, the remaining open land was enclosed and let out in small farms. That is not to say that wet meadows and other permanent pasture did not remain or that there were not stretches of coastal heath and heathery deans, but by 1800 almost all the wet areas had been drained and brought under the plough. The position just north of the Scottish Border seems to have been similar.

There were still exceptions: in particular one boggy field on the farm known as 'The Steps of Grace' on the main road north (then as now farmed with Conundrum), which seems to have been just across the A1 from Loughend Farm Cottages at NT982558. It is just two miles from Berwick. The name Loughend itself suggests at least a seasonal water body and the field does have a hollow suitable for a former mire and a burn that emerges from a mysterious 200 m underground channel runs alongside. The 1769 map marks a farm here as Sedgeburn and indeed the field is still known today as 'Sedgden'. Geologically this is just where Silurian rock abuts on Carboniferous calciferous sandstone. Here in the 1790s John V. Thompson, as a teenager, found a fine collection of wetland plants including *Selaginella selaginoides, Sagina nodosa* and *Schoenus nigricans*, but not the *Tofieldia*. Here or hereabouts in the 1820s Johnston was also to find *Epipactis palustris*.

This field was drained before 1853 and not a trace of its riches remains today, unless one counts *Parnassia palustris* at the foot of the sea cliffs nearby.

This was not the only mire in the area. Johnston (1829) wrote of the hill and moor of Lamberton that 'several small streams produce a variation in its surface, in some places forming narrow ravines, in others marshes'. He found *Schoenus nigricans* and *Epipactis palustris* in one such mire at Lamberton, apparently the first field into Scotland below the A1 at NT974572, but the habitat was also destroyed by 1853. Indeed, amazingly, a rather similar mire survives today on Lamberton Moor at NT955582 (v. c. 81), and such *Schoenus* flushes survived elsewhere on Lamberton Moor until the 1970s, particularly around the head of the Lamb's Burn, this being the burn by which Johnston thought the *Tofieldia* to have been found. There is evidence from the fragments that remain all along the coast that these mires were formerly set in extensive coastal heath and, indeed, a fine colony of *Scilla verna* survives just 10 km to the north near Eyemouth.

This evidence of relevant botanical riches set in an area of coastal heath near where Ray reported his *Tofieldia* seems sufficient to substantiate his find and the land use history is consistent with the failure by subsequent botanists to refind the plant, as the locality was probably lost before Johnston actively searched for it in the 1820s even though some associated habitats survived. Nevertheless, while there is a choice of suitable localities, it seems churlish to favour any other than that which falls just as he describes. This would localise his record for *Tofieldia* near Loughend in England (v. c. 68), but a Scottish location for the record cannot be ruled out.

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THE TAXONOMIC STATUS OF *RUBUS ORBIFOLIUS* SENSU W. C. R. WATSON (ROSACEAE)

In his eventual monograph on the Rubi of Britain and Ireland, Watson (1958) included a bramble belonging to series *Sylvatici* (P. J. Mueller) Focke which he identified with *R. orbifolius* Lef., a species described from, and at that time apparently otherwise known in, one district in dép. Saône-et-Loire in the far east of France. Like many other Watson identifications with *Rubus* taxa of mainland Europe, this seems to have been based solely on the description and drawing in Sudre (1909), for the species is not represented in the extensive series of exsiccatae distributed by Sudre

under the name *Batotheca Europaea*, nor do any British herbaria contain more than the odd specimen or two of the large number distributed through the Association rubologique française in which this species had its taxonomic origin. Although an authentic specimen of *R. orbifolius* is to be found in **MANCH**, that is not a herbarium that Watson appears ever to have consulted. The poor fit of the **MANCH** specimen with the taxon as defined by Watson and the relative unlikelihood that Britain could share a species with such a distant and floristically dissimilar part of France have been sufficient to bring Watson's identification into disrepute, and in their own subsequent monograph Edees & Newton (1988) relegated his taxon to its lengthy appendix listing species recorded as doubtfully British at best. It may also have been noticed that Sudre's description contains features that are sharply at variance with Watson's yet ignored by the latter, most notably a flat-sided primocane and ternate, finely biserrate leaves.

That the bramble discriminated by Watson is nevertheless a distinctive entity and (disregarding his erroneous determination of a Scottish specimen of *R. septentrionalis* W. C. R. Watson in **CGE** as the same) has a distribution that may well be regional rather than merely local has received general acknowledgement among British *Rubus* specialists informally. More recent work in the field and herbaria, indeed, has revealed its presence in at least 12 hectads and five vice-counties – and a sixth if a credible south Berkshire record cited by Watson (1958) is added to those. With such a distribution the plant amply qualifies for recognition taxonomically. The distinctiveness, however, may be illusory. Curiously, in his monograph Watson failed to draw attention to the similarity to another species restricted to the same region on which he had recently bestowed a name (Watson 1952: 97), *R. averyanus*. Seventeen pages separating the accounts of these two in his book strengthens the impression that he did not particularly connect them: it is *R. obesifolius*, rather, also recently described by him (from the Pennine foothills in Staffordshire, v.c. 39), that he mentions as most like '*R. orbifolius*' and accordingly places next to it. Yet, suspiciously, *R. averyanus* and '*R. orbifolius*' both have their possession of a dense armature of yellow, strongly curved prickles emphasised by means of italics in their respective descriptions and the localities cited for each are in much the same general area, The Weald of north Sussex in the one case and central Surrey in the other. Though Watson rarely includes habitats with his species accounts, he could have added that the two are also alike in favouring the "heaths and open wood margins" identified by Edees & Newton (1988) as that of *R. averyanus*. Furthermore, that the two are sufficiently similar in appearance to be mistaken for one another is shown by the fact that in two instances herbarium specimens labelled as *R. averyanus* by two of Watson's pupils, C. Avery and J. E. Woodhead, in **SLBI** and **CGE** respectively, were redetermined in subsequent years by B. A. Miles as '*R. orbifolius*'.

Close comparison of the distinguishing characters listed for the two taxa reveals that most are either mere size differences or characters that are particularly prone to variation in *Rubus* or to modification by habitat conditions. *R. averyanus* is typically a tall, slender plant with sharply serrate-dentate leaflets, features consonant with growth on the wood margins on which it occurs in one of its two *loci classici*, Broadwater Common in Surrey's Tillingbourne Valley, the climate of which is sufficiently mild and moist to support several populations of the strongly western *R. incurvatus* Bab., absent or nearly so from all of the surrounding vice-counties. '*R. orbifolius*', by contrast, is a plant of open heath margins at least in the main and its lower stature, shorter prickles and broader and more obtusely toothed leaflets with shorter tips reflect this. Though the sepals of *R. averyanus* are described in both monographs as long-pointed ("prolonged into linear leafy tips" in the words of Watson and those of '*R. orbifolius*' are in most cases short-pointed, exceptions to the latter can be found if a sufficient range of material is examined. The same goes for the pilosity or otherwise of the young carpels, a reliably unvarying character in many *Rubus* species: subglabrous in *R. averyanus*, these are well supplied with long hairs in most examples of '*R. orbifolius*' examined but devoid of them in specimens in **BM** from one Sussex locality (Shortgate) – and total glabrosity was Watson's experience with '*R. orbifolius*' as a whole. Digitate leaves and furrowed, red-purple primocanes, the residue of the claimed differences, hardly seem enough to enable '*R. orbifolius*' to be told apart consistently.

The matter can be resolved definitively only by DNA sequencing or, in default of that, by cultivation of the two under contrasting conditions. For the time being, however, it is suggested that the two are treated provisionally as facies of a single species. This has the consequence of extending the known range of *R. averyanus* very considerably, more particularly into the Weald.

For as well as many further stations in East Sussex, v.c. 14, most notably around Chailey and in Ashsdown Forest (Rich *et al.* 1996), and an extra one in West Kent, v.c. 16, bottom of Tunbridge Wells Common, TQ5738, 1902, E. G. Gilbert (**K**)), two additional vice-counties for the species result: v.c. 11, S. Hants.: south-west corner of Havant Thicket, SU7010, 1987, D.E.A. (**BM**) v.c. 13, W. Sussex: open heath north of Hawkin's Pond, St. Leonard's Forest, TQ223300; east side of Mannings Heath golf course, TQ220288, both 1964, B. A. Miles (**CGE**).

The broader interpretation of *R. averyanus* now proposed reopens the possibility that the French bramble may be conspecific after all, in which case the name *R. orbifolius* Lef. would have priority, That Sudre's description of Lefèvre's taxon includes a character, finely serrate leaflets, hitherto regarded as one of the distinguishing features of *R. averyanus*, is suggestive in this connection. It is further suggestive that in Herb. Déséglise in **NMW** (another herbarium unconsulted by Watson) there is a specimen of Ripart's from the Forêt d'Allogny in Cher, two *départementes* closer to England than Saône-et-Loire, that is intermediate between *R. averyanus* and the British '*R. orbifolius*', though nearer the latter. Misdetermined by Ripart as *R. rosaceus* Weihe, a strongly glandular species which resembles this eglandular plant only in having leaves of a similar shape and pink flowers, the specimen was misdetermined by Genevier in turn as *R. atrocaulis* P. J. Mueller, a mainly Central European species now known as *R. gracilis* J. & C. Presl subsp. *gracilis*. In order for the matter to be settled, however, a wider range of material of Lefèvre's taxon from the type locality in Saône-et-Loire needs to be obtained and examined.

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A NEW SITE IN CAITHNESS FOR *SAXIFRAGA HIRCULUS*

In August 2002 a new site for the marsh saxifrage *Saxifraga hirculus* was found on the Plantlife nature reserve at Munsary in Caithness. It was found by Dr Fiona Everingham, who was a member of a survey team led by Dr Richard Lindsay of the University of East London, conducting a baseline survey of the reserve for Plantlife.

At the time the ground was very wet, with footmarks impressing some 7 cm into the site. Consequently only superficial surveying of the site was prudent.

In August 2003 the ground was much drier after a prolonged period without rain and footfalls made no lasting impression. Dr R. E. C. Ferreira and the author were able to examine the site which is on a hillside facing north-west at an altitude of 170 metres and with a slope of 0·04. The hillside is Middle Old Red Sandstone covered in a layer of peat of variable thickness but probably averaging 0·5 m thick. At the site there is a substantial flush of groundwater to the surface, which evidently carries a rich supply of minerals into the surface layers. The flushing promotes a circle of 50 metres diameter of green vegetation that is in marked contrast to the majority of the heather moorland of the hillside. The site is a percolation mire, with a distinct spring head, a large zone of evenly flushed fen and a tail where the water flows into rills and becomes a small burn.

The *S. hirculus* occupies a roughly circular patch of about 22 m diameter within the bigger (50 m) circle. There were more than 1000 flowering shoots visible and around five times that number of non-flowering shoots prominent. About $^{2}/_{3}$ of the flowering shoots bore one flower, while the other $^{1}/_{3}$ had multiple flower heads. Within the 50 m green circle the areas that have the saxifrage are of a different plant community from the areas where it does not occur.

The species associated with the saxifrage were, roughly in order of frequency: *Holcus lanatus* (dominant), *Juncus articulatus* (dominant), *Eriophorum angustifolium, Carex dioica, Festuca rubra, Epilobium palustre, Agrostis canina, Triglochin palustre, Ranunculus flammula, Menyanthes trifoliata, Carex nigra, Anthoxanthum odoratum, Rumex acetosa, Lychnis flos-cuculi, Cerastium fontanum, Cardamine pratensis, Sagina nodosa, Calliergon cuspidatum.* Mosses were very scarce in this congested medium-height community.

Saxifraga hirculus did *not* occur in:

- the bryophyte-rich spring head community, which includes *Philonotis fontana,*
- the *Juncus effusus* - *Filipendula ulmaria* rush pasture that covers much of the rest of the green circle,
- the tail of the site, which consists of rills and an inundation community.

The site showed no signs of grazing, which is as expected since there has been no agricultural grazing for around 7 years and the number of wild deer is low. However the site would have been heavily grazed previously and may be in a state of transition. There was no known previous survey of the site so it is not known whether the saxifrage has become prominent after the cessation of grazing, or was always waiting to be found.

S. hirculus is a Red Data Book species and the account (Wigginton 1999) by D. Welch indicates that this Caithness site is the biggest in Scotland and around the size – 1000+ flowering stems - of the largest sites in Britain.

The vegetation of the area where the saxifrage occurs does not correspond closely with a category in the N.V.C. (Rodwell 1991), nor is it closely similar to the sites described by Welch in N.E. Scotland (Welch 1996). Rodwell (1991) considers the saxifrage to belong to the M38 community, which is a spring-head community. Welch (1996) found the plant in several forms of the M9 mire and in one case in an M9 / M32 mire. These fen sites are notably variable in floral composition (Rodwell 1991) and the grazing history may be an important factor. It nevertheless seems likely that the vegetation bearing the saxifrage in the Caithness site could be classified as a form of M9 percolation mire. The saxifrage did not extend into the spring-head community - which was not examined in enough detail to classify it.

There was a different site for *S. hirculus* in Caithness found by the Rev. D. Lillie in 1912 but not re-found in recent times despite careful searching.

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RUBUS CROMERENSIS A. L. BULL (ROSACEAE) MUST GIVE WAY TO *R. NEUMANNIANUS* WEBER & VANNEROM WHICH HAS PRIORITY

Whilst preparing the paper 'Four new species of *Rubus* L. (Rosaceae) in Eastern England' (Bull 1998) during 1996, specimens of each of which had previously been sent to Prof. H. E. Weber in Germany, questioning whether he knew of any of them growing on the Continent. In his reply, he stated that he did not recognise any of the sheets sent. At about the same time, a sheet of *R. neumannianus* Weber and Vannerom, was received from the latter, from Belgium, which appeared very similar to *R. cromerensis*. At the same time it appeared to differ in a number of important points. The Norfolk plants usually had many more prickles on the stem, some even occurring on the faces as well as the angles, and whereas *R. neumannianus* was usually pink flowered, *Rubus cromerensis* is only occasionally pale pink at first, or more usually white flowered. A specimen of *R. cromerensis* was sent of Mr Vannerom who responded by saying that he felt sure that *R. cromerensis* and *R. neumannianus* were one and the same and urging that a further specimen be sent to Prof. Weber. This time the latter replied that, whilst the two were very similar, he still felt that *R. cromerensis*, in addition to being white flowered, was also a much more heavily armed plant than *R. neumannianus*.

So the matter rested until Dr D. E. Allen questioned the status of *R. cromerensis* as being very narrowly distributed along the coastal fringe of north east Norfolk. After some correspondence, Dr. Allen kindly arranged with **BM** that the author should have a series of sheets of *R. neumannianus* on loan so that they could be compared with the whole folder of *R. cromerensis*. Study and comparison of the two sets revealed that there was a good deal of variation in the plants on both sides of the North Sea. As a result of this, it was decided to send a parcel of specimens to Prof. Weber. With several sheets from Norfolk, and including Mr. Vannerom's sheet of *R. neumannianus* from Belgium. Having had the opportunity to study several Norfolk specimens simultaneously, Prof. Weber was able to determine them all as being *R. neumannianus*, pointing out in several cases how they differed from the holotype collected by himself from the Eifel district of Germany in 1985. Differences in armature have been ascribed to the fact that the Norfolk plants grow on the acid moraines of the Cromer ridge, and at most sites are exposed to the harsh conditions along that coast of biting 'nor'easters' from Scandinavia in winter. It is also now felt in Batalogical circles that ecological factors can affect flower colour in *Rubus*, not just with *R. neumannianus*, but in a number of other species found in Britain. For example,. *R. londinensis* is pink flowered in Surrey, but has been found to be usually white flowered north of the Thames.

Bearing in mind that *R. neumannianus* only grows in Norfolk, along a narrow coastal fringe for a distance of about 25 km, it is almost without doubt that the plant must have arrived as defecated seed from migrating members of the Thrush family in autumn. On the Continent, *R. neumannianus* occurs in Belgium, Luxembourg, the Rhineland-Palatinate, North Rhine-Westphalia, Lower Saxony, Hessen and Baden-Wurttemburg.

ACKNOWLEDGMENTS

My thanks due to Prof. Weber for his patience in identifying specimens, to Mr Vannerom for sending me a specimen from Belgium in the first place, to Dr D. E. Allen for providing the impetus to get this matter solved, and to **BM** for the loan of specimens.

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Book Reviews

Wild flowers of Britain & Ireland. M. Blamey, R. Fitter & A. Fitter. Pp. 482. A. & C. Black, London. 2003. Softback. £16.99. ISBN 0-7136-5944-0.

Most British botanists will be familiar with the work of Marjorie Blamey, Richard Fitter and Alastair Fitter. This book continues their tradition in admirable fashion. It is intended as a field guide, with illustrations of almost all vascular plant species found in the wild in Britain or Ireland, identification notes and maps. There are 482 pages, so it is slightly bulkier than many field guides, but could still be slipped into a rucksack with relative ease.

I initially learnt my botany using *Wild Flowers of Britain and Northern Europe* by the same authors, so I was interested to see how their new book compared to that classic text. An initial glance shows the familiar painting style of Marjorie Blamey, with excellent colour reproduction; however, the facing page immediately appears different, with the inclusion of thumbnail maps for the first time. The maps are based on the *New Atlas* data, with various other symbols intended to indicate how dominant or otherwise species are.

This is one of the few field guides to cover only Britain and Ireland. This decision particularly pleased me, as I have always felt that the average user will only use a book within the British Isles. By restricting the geographic coverage there is more room available to feature the British flora, and only some apomictic groups and the rarer non-natives have been missed. The authors have even attempted some of the complex groups such as *Salicornia*, *Sorbus* and *Euphrasia* with suitable warnings to the reader.

The authors have made an interesting use of keys. Large parts of the book are entirely without keys, forcing the beginner to turn the pages looking through the pictures. Far from being tiresome, I would advocate this as an excellent way to familiarise oneself with the various families. This is also less off-putting to the beginner than being faced by a dichotomous key. Many genera and some families have excellent summary tables, dividing the different species using a few very simply observed characters, such as flower colour or petal shape. These tables immediately restrict the number of pictures and descriptions that require consideration. A few larger families such as Apiaceae, Fabaceae and Asteraceae also have short keys, which direct you to a particular section of the family. I thought the keys provided were extremely helpful without being overpowering for beginners. The descriptions themselves have important characters for identification italicised.

An unusual feature of the book is the grouping at the end of various 'types' of plant. First, there are 'Aquatic plants with all leaves submerged'. This section is not dissimilar to that given in *Wild Flowers of Britain and Northern Europe*, although now the illustrations are in full colour. The title of the section is not entirely helpful, as not all of the species have all their leaves submerged, and neither are all such aquatic plants included here. For instance, *Ranunculus fluitans* is not included here, but is within the Ranunculaceae, whilst *Callitriche stagnalis* is included. Another section that I found somewhat awkward was 'Grasses, Sedges and Rushes'. A key at the start divides all three families up according to the form of the flowering head; the following illustrations are not divided by family but according to this key. I found this confusing, and would have preferred an opening section explaining how to tell the families apart, and then for each family to be covered separately. Further sections are: 'Trees and Tall Shrubs', 'Ferns, Horsetails and Clubmosses', 'Specialities of the Isles of Scilly and West Cornwall' and 'Irish specialities'.

My only real gripe in an otherwise excellent publication for aspiring botanists is the glossary. Most terms are illustrated, but using thumbnail illustrations which only show the part in question. I was not sure that beginners would find it easy to locate a stigma, having seen an illustration which does not show its relationship to the rest of the flower. Equally, I felt that illustrations of bracts and bracteoles would have been more helpful if the flowers were shown.

Overall, this is a very useful new field guide that I am sure will be used and enjoyed by both beginners and those who prefer pictorial guides. It is a worthy successor to the authors' earlier works.

C. CHEFFINGS

Compendium of Symbolic and Ritual Plants in Europe. Marcel de Cleene & M. C. Lejeune. 2 vols in boxed set, pp. 885 & 695. Mens & cultur uitigevers, Ghent. Hardback. 2003. £115.00. ISBN 90-77135-04-9.

This attractively produced work seeks to cover plants 'which play or have played a part in man's religious experience.' Thus species such as *Achillea millefolium* and *Plantago lanceolata*, which feature extensively in folklore but not in ritual, are not included.

The authors have made little, if any, effort to collect current material but have relied on previously published work, including websites. This is excusable given the area they are trying to cover, but for many regions the previously published work is of a poor quality. Inevitably the authors' linguistic abilities have a great deal of influence on what they have used. I also suspect that they failed to make any systematic attempt to find out what is available. For the British Isles the authors rely mainly on Margaret Baker's *Discovering the Folklore of Plants* (ed. 3, 1996) and Vickery's *Dictionary of Plant-lore* (1995). The latter attempted to gather unpublished material, but the former is a popular introduction to its subject which relies mainly on material published late in the 19th Century, which in turn used material derived from a variety of 'old authors'. Thus by the time it is used by de Cleene & Lejeune it is already third-hand.

The authors tend to regard all customs and beliefs as survivals from earlier cultures, and works such as James Frazer's *Golden Bough* loom in the background. Most present-day folklorists reject such speculations. For example, we are told that 'in the late 1950s there was *still* a belief in Thorncombe, Dorset, that alder was good against gout'. This statement is derived from Vickery (1995) where he records his grandfather's (unsuccessful) attempt to treat gout, but does not claim that this was a long accepted remedy. De Cleene & Lejeune's inclusion of 'still' implies that the cure was of ancient origin.

The *Compendium* is divided into two volumes, the first dealing with trees and shrubs and the second with herbs. Rather confusingly, *Thymus* is included in the first volume. Each volume starts with a series of essays, one of which, on 'early herbalists and herbalist writings', is included in both, followed by alphabetical entries on the plants which the authors consider to be ritual or symbolic. These consist of a description of the plant, common names (apparently a very incomplete selection for some parts of the continent), and extensive notes on the folklore, etc., associated with the plant. The authors tend to be 'lumpers'. Both *Malus sylvestris* and *M. domestica* are included under 'Apple tree', with the description referring primarily to the former but most of the consideration of apples in ritual, myth and symbolism referring to the latter. *Leucanthemum vulgare* and *Dendranthema* × *grandiflorum* are both included under the heading 'Crown daisy'. *Aesculus hippocastanum* is mentioned under 'Sweet chestnut' 'because people often confuse its fruits ... with those of sweet chestnut'. In some cases it is difficult to work out to which species the text refers. However, the work is meticulously provided with references, so it should be possible to sort out any confusion. In addition to providing standard footnotes stating where information was published, the authors also provide information on people mentioned in the text – something which is valuable when one realises one nation's hero may be unknown to citizens of other countries. Unfortunately, at least as far as the British monarchy goes, these notes tend to be inaccurate.

The authors have assembled a vast quantity of plant-lore and include over 550 useful illustrations. Folklorists will regret that they have followed outdated ideas concerning survivals; botanists will regret that they have excessively 'lumped.'

A. R. VICKERY

Flora of North America north of Mexico. Volume 25 Magnoliophyta: Commelinidae (in part): Poaceae part 2. Flora of North America Editorial Committee. Pp. xxv + 783. Oxford University Press, Oxford. 2003. Hardback. £70.00. ISBN 0 19 516748 1.

In the purest sense a Flora serves the dual purpose of a catalogue of biodiversity and a manual for identification. Ideally it should contain diagnostic keys as well as suitable descriptions and illustrations that enable the users to be confident of their identifications. It is, therefore, the ultimate practical expression of the skills of the taxonomist. I begin to get nervous of Floras that are used for other purposes, particularly as a platform for presenting the latest theories on plant

phylogeny. The present volume of the Flora of North America (FNA) opens with a discussion of the PACCAD clade of grasses. If anything were ever a theoretical concept of no practical value, it is that of the BEPP & PACCAD clades. However much this concept may appear to be a logical explanation of the findings of molecular phylogenists, the Flora-writer can make no use of it. The clades are not taxonomic ranks in any sense; they have no morphological reality and they are unpredictable from a plant's morphology. Discussion of these clades, in my view, is best left for a more appropriate forum than a regional Flora.

Volume 25 is the second part of the account of *Poaceae* and it is regrettable that it must be reviewed in the absence of volume 24, which has not yet been published. There may have been sound practical reasons for leaving volume 24 until volume 25 had been completed, but nevertheless it is difficult to assess the latter's contents in isolation. Volume 24 will contain the key to tribes as well as an artificial key to genera. I have some misgivings about that second key; if the taxonomy is sound and the key to tribes is well constructed, there should not be a need for an artificial key to genera.

Mysteriously, this volume presents a key to the tribes it contains, but for the life of me I cannot understand why. With or without volume 24 to hand, who would know – simply by looking at it – whether or not a grass belonged in the PACCAD clade and could therefore be keyed out in this volume? Inclusion of this key is an error of judgment and a waste of space. The key itself is very curious. It has only 14 couplets and yet it manages to key out Danthonieae three times. This suggests either a poor tribal concept or poor key-writing. Couplet 7 seems to be entirely redundant. Its first lead takes the user to Danthonieae and its second lead to couplet 8. The first lead of couplet 8 takes the user, again, to Danthonieae. The account of grass genera to be found in Clayton & Renvoize *Genera Graminum* (1986) may be getting a little out of date by now, but it was an eminently practical account. The authors knew that Danthonieae and Arundineae could not be separated morphologically with any degree of conviction and chose to amalgamate them. Molecular phylogenists claim that not only are they different at tribal level but at subfamily level as well. The account in FNA has failed to convince me of this.

I was also disappointed to see that the amalgamation of Cynodonteae and Eragrostideae is maintained. The change from multi-flowered spikelets, with separately disarticulating florets, in panicles or racemes found in Eragrostideae, to spikelets with one fertile floret, with all florets falling together, in racemes (these sometimes much reduced or modified) found in Cynodonteae is fundamental enough to demonstrate the practical value of grass tribes. If these two elements are not tribes, molecular data notwithstanding, it is difficult to know what are. The characters used in FNA to demarcate Orcuttiae and Pappophoreae are far less significant than those that at one time demarcated Cynodonteae from Eragrostideae. With the amalgamation of these two tribes we have a situation of taxonomic inflation wherein the tribe is now scarcely distinguishable from the subfamily.

The nomenclature of the grass 'inflorescence' has been a problem from the very beginning, but agrostologists have long since learnt to come to terms with it and have settled into a number of conventions. Attempts at a more rigid nomenclature have generally been ignored. When I tried the key to genera of Paniceae I had to go back and start afresh because I thought I had missed something. The option presented at couplet 2, lead 2, was 'inflorescence panicles, sometimes spike-like.' In my experience a spike-like panicle belongs to such genera as *Alopecurus* and *Phleum*, and in the present context *Pennisetum*, where the panicle looks like a spike. After going back over the text I found that a new term, unfamiliar to many of us, had been introduced. There are, it seems, no multiple racemes any more, be they digitate or scattered along an elongated axis. The elements of the inflorescence of *Digitaria*, for example, are called 'rames', and a panicle composed of discrete rames is, apparently, a spike-like panicle. The term 'spike-like' now embraces two entirely different concepts and its use in the present context will confuse rather than clarify. The conventional terms describing the grass inflorescence have been with us for so long that they have become indispensible even if they are, from time to time, rather strained; we all know what the terms mean and if something isn't broken why try to fix it?

This is a huge account of a very difficult family and it is easy to pick holes in it and find fault with it. There are no absolutes in taxonomy and for this reason no-one has yet written a perfect Flora; it is doubtful if anyone ever will. Whatever, in my view, may be wrong with this volume, it is nevertheless a magnificent achievement and is written to a consistently high standard. All the

elements of a traditional Flora are there: descriptions are complete but not over-long; the keys in general work well; the ecological notes are brief but informative; and the illustrations are first-class (many are familiar from the earlier work of Hitchcock). I would, however, have liked to have seen at least the major synonyms in the text. All synonyms are to be found in an index, but it can only be used in one direction: it tells the user the accepted name of a synonym, but not the synonyms of an accepted name. Fortunately the grass synonym database at Kew and the Tropicos database in Washington take care of this.

All contributing authors are to be congratulated on this monumental achievement and I look forward (with some trepidation I have to admit) to volume 24. The volume is priced at £70 which seems reasonable enough for a book of this size, but multiply that by the number of volumes proposed and it is evident that the complete Flora will make a very serious hole in the budget of any library. There is, on the other hand, a value-for-money criterion which this particular volume seems adequately to fulfil.

T. A. COPE

The Isle of Wight Flora. C. Pope, L. Snow & D. Allen. Pp. 255. The Dovecote Press, Dorset. 2003. Hardback. £35.00. ISBN 1-904349-28-5.

Islands are often especially attractive places to botanise and Wight, with its diversity of habitats, is no exception. Drawing on a long history of recording by distinguished botanists (including Bromfield, Townsend and Lousley), this scholarly and thorough book, the first detailed flora since 1978, fills a definite gap in the recent floras produced in southern England and sits very nicely alongside the excellent *Flora of Hampshire* (1996). The introduction by Richard Smout sets the scene beautifully, discussing the concept of Wight as the Garden Isle and indicating how early man had a horticultural influence on the flora (as early as 1798 Gilpin stated that the island "...is, in fact, a large garden..."). A detailed chapter on geology and physical features (Allan Insole) follows, although I was a little disappointed that more space was not given to the flooding of the Solent and the creation of the island itself. After a short chapter on climate (Denis Simmons), a very detailed and informative account of the island's palaeoecological record is given by Rob Scaife. This describes vegetational changes over the last 12,000 years, drawing on a wealth of evidence from famous sites such as Bohemia Bog, and is one of the clearest and most readable of such accounts I've seen. Again, the huge effect man has had on the island's flora is brought sharply into focus, and events like the clearing of the Small-leaved Lime woodland in the late Bronze Age make a lasting impression on the reader. A short comparison of the island's flora with that of neighbouring counties by Francis Rose is followed by David Allen's chapter on the history of recording. Being full of anecdotes and observations, this is one of the most enjoyable chapters in the book. It illustrates wonderfully how luck and chance have played vital roles in the history of botanical recording, and how the island has depended on social and economic tides to bring botanists to its shore from the mainland, only subsequently to remove them. In the final introductory chapter, Colin Pope describes the island's vegetation in detail. Not only are particular species and habitats described, again often with enlightening anecdotes, but management issues are also discussed and the chapter has a strong ecological background. My only complaint would be the lack of Latin names for vascular plants.

The main species accounts follow a typical format. For vascular plants, records stretch from the 16th Century to 2002, with the "most recent" records dated from 1987 (in line with the *New Atlas*, recording for which was the stimulus behind producing this flora). Recording in this period was, admirably, site- or 1 km square based. From these data, tetrad maps have been produced for some taxa but, again admirably, only where this adds additional information to the species accounts. The accounts themselves are concise but informative and are not restricted to a maximum number of words. This allows nice discussions of, for example, the increase in *Asplenium trichomanes* subsp. *quadrivalens* since the 19th Century and the decline of *Cirsium dissectum*, as well as the longer discussions of rarer species you would expect in a flora. Coverage is good; hybrids and subspecies are treated tolerably well and there is good recording of aliens, which are given with the *New Atlas* categories of archaeophyte or neophyte, the latter either established, surviving, planted or casual. Colin Pope pointed out to me the accidental omission of *Aster tripolium*, although a Dines &

Preston record of *Convallaria majalis* also seems to have been omitted. My only other criticisms would be the lack of any analysis of the data (such as numbers of native, archaeophyte and neophyte taxa, maps showing numbers of records and species per tetrad) and the poor quality of the tetrad maps, perhaps because they were reproduced from poor resolution computer image files ('bitmaps'). The chapters covering bryophytes (Lorna Snow), lichens (Colin Pope) and stoneworts (Nick Stewart) follow the same format and are similarly detailed and informative, with plenty of discussion and historical context. They add substantially to the value of the book and it's nice to see selected bryophytes mapped as well. Finally, it's worth mentioning the excellent photographs and reproductions of colour paintings that illustrate the Flora. A good mix of vascular and non-flowering plants are included, and those of bryophytes are particularly fine.

This is a lovely flora that will appeal to all that know the Isle of Wight, residents and visitors alike. It will particularly appeal to those with a serious interest in the flora, as the level of detail is sufficient to keep enquiring minds satisfied. It is a credit to the authors and the efforts of all those that have contributed records, especially given the short time in which it has been produced. A lesson to some other vice-counties perhaps!

T. D. DINES

Botaniska strövtåg. Svenska och engelska. M Rydén. Pp. 182. Acta Academiae Regiae Gustavi Adolphi LXXXII. 2003. Softback. 190 kr. ISSN 0065-0897. ISBN 91-85352-51-9.

Consider the cornflower. Once a troublesome weed – though one whose receptacle could be eaten like an artichoke – today it is a "fair and futile flower". Its English name reflects its habitat, where the Swedish designation, *blåklint*, describes the colour and shape of its budding flowers. Local names such as *hurt-sickle* or *båtsmansmössa*, "bosun's cap", reflect the fertility of popular imagination as well as the effects of its hard stem on reapers' tools.

The cornflower is just one of a series of "plant portraits" by Mats Rydén, emeritus professor of English at Umeå and Uppsala universities. Originally written for Swedish newspapers and for the journal of the Swedish Botanical Society, they now appear together with brief essays on themes from the history of Swedish and English botany, under the title *Botaniska strövtåg*, "botanical rambles". They range from the groves of his own home parish – echoing still with the Romantic poetry as well as the prosaic plant descriptions of Krok-Almquist, the flora used by generations of Swedish school-children – to the herbals of English 16th Century naturalists William Turner and John Gerard. Whether Swedish or English, most of Rydén's botanical rambles take him through the borderland between language and botany. In the plant life of Shakespeare's plays as well as in the diversity of vernacular plant names, Rydén explores past and present conceptions and uses of plants.

Rydén's portraits are impressions rather than full-length, tantalisingly and sometimes frustratingly brief. Recommendations in the text to further reading (to the linguistic studies of Rydén and others as well to as the growing field of ethnobotany) are helpful, but also draw attention to the limitations of the form. Despite the brief English summary, *Botaniska strövtåg* is largely inaccessible to a non-Swedish-speaking audience. English readers may refer to Rydén's investigations of plant names, some of which have been published in English – but they would miss the musings of Swedish poets on wild strawberries, and the joy of a glimpse of *Creeping Lady's tresses* in the forest.

J. BECKMAN

The vice-county census catalogue of the vascular plants of Great Britain. Edited by C. A. Stace, R. G. Ellis, D. H. Kent and D. J. McCosh. Pp. xxii + 405. Botanical Society of the British Isles, London. 2003. Paperback. Price £11.00. ISBN 0–901158–30–5.

It is now more than 70 years since Druce's *Comital Flora of the British Isles* made its posthumous appearance. In the intervening period, the B.S.B.I. has made extensive use of the vice-county system, appointing Recorders for each of the 111 British vice-counties, as well as for the 40 Irish vice-counties and for the Isle of Man and Channel Islands. New vice-county records are regularly published in *Watsonia*, but it has been almost impossible for the ordinary botanist to know whether

or not a record is indeed new. This curious state of affairs could well lead the sceptic to ask whether vice-counties have had their day. Perhaps they ought to be banished into the past along with those divisions of counties based on parishes and river catchments, used by our Victorian ancestors in local floras.

If vice-counties are indeed an archaic remnant, then the new *Census Catalogue* is not timely. A modern botanist ought to use the National Grid and stick to the information in the *New Atlas*. The alternative view is that the B.S.B.I. has been deplorably remiss in not keeping the system up to date, and that this new volume fills a major gap and is sorely needed. Surely this must be the majority opinion. Indeed, the new *Census Catalogue* will be seen by many as a major achievement, to be greeted with relief and joy because local loyalties are strong. Vice-counties 'are the units ... to which most field botanists demonstrate some chauvinistic allegiance; a species discovered new to Leicestershire will always be greeted with more interest than one discovered new to hectad 42/58, or to 100 × 100 km square 42'.

So what is presented here? The basic catalogue occupies 380 pages, about the same as Druce's 398. At first sight, the catalogue is pretty bleak. Ireland has been banished to the Irish. Unlike the British they have published several excellent recent vice-county catalogues, most recently *A Catalogue of Alien Plants in Ireland* (2002), which is almost exactly the same size as the catalogue under review. The *Census Catalogue*, by contrast, is brutally numeric. It is simply the numerical expression of a database. Plants are not described as 'viatical', 'sylvestral' or 'ericetal' in the style of Druce. There is no information on when they were first discovered in Britain. On the other hand, we are offered numerical data on the occurrence in vice-counties of an astonishing 4880 taxa. For *Cypripedium calceolus* L. the distribution reads **57** *60* **62** **64** **65** **66** **69** **70**. This tells us that it formerly occurred in Derbyshire, North-east Yorkshire, North-west Yorkshire, County Durham, Westmorland and Cumberland (57, 62, 65, 66, 69, 70), and that since 1969 it has been found in West Lancashire (60) as an introduction and in Mid-west Yorkshire (64) as a native. For *Bellis perennis* the distribution reads **C** **1** **2** **3** ... **110** **111** **112**, signifying that the common daisy has since 1970 been found as a native in all vice-counties.

The key to this code is the footer to each page: **Bold = native**; Roman = archaeophyte; *Italic* = *neophyte*; *Small italic* = *casual*; Underline = post-1970. This symbolism is not easy to read. Nor is it as simple as might appear. For example, the distinction between archaeophyte and neophyte was introduced only at a late stage. Almost all vice-comital occurrences of species that are archaeophytes in Britain are treated as archaeophytic, even though the date of introduction to some counties must have been post-1500. It is just too hard to know when species were in fact introduced. Vice-county Recorders did not know; neither did the editors.

With neophytes, the ascription of casual status is almost equally arbitrary, because consistent standards have not been applied. We read that *Picea sitchensis* is casual in Dumfriesshire – i.e. that it cannot maintain itself there by seeding. Any visitor to the Forest of Ae can see it coming up like grass (so to speak). On the other hand, *Larix kaempferi*, less prolifically self-seeding, is signified as a non-casual neophyte there. *Avena sativa* is apparently a persistent neophyte in South Somerset and Caithness, and was formerly persistent in Easterness and Easter Ross; elsewhere it is merely a casual. Here, the views of Vice-county Recorders were presumably taken into account, but one may doubt whether the plant ever forms persistent populations.

The treatment of hybrids is initially confusing. Most are technically natives. Thus the highly sterile *Papaver rhoeas* × *dubium* is treated as a former native in eight vice-counties, where its parents were mere archaeophytes. Yet anything more casual than a sterile hybrid of annuals is hard to imagine. Likewise, casual occurrences of native species cannot be distinguished from persistent populations unless the species was introduced. *Himantoglossum hircinum* was formerly native in North-east Yorkshire but it arrived in 1940 and never persisted.

Even the native status of possibly native species can be difficult to ascertain. As the editors ruefully observe, 'many of the status decisions made and represented in the census text are arguable to say the least'. Some explanation would have helped. For example, the ascription of native status to *Tanacetum vulgare* in some counties but not others seems completely arbitrary. The text of the *New Atlas* tells us why its status is often unknowable, but *Census Catalogue* data are presented without comment.

The *Census Catalogue* is weakened by these inconsistencies. In particular, it cannot be used as a reliable guide to whether or where a species is persistent. On the other hand, we have here a good

foundation on which to build. Those of us who know the highly efficient vice-county recording scheme run by the British Bryological Society (as Recording Secretary of the B.B.S., this reviewer ought not to be *too* smug), are often amazed by the apparent laxity and inefficiency of that run by the B.S.B.I. Of course recording is easier with bryophytes, because they are fewer, smaller and easily sent through the post. The bryophyte system runs with just two national Recorders, who, together with referees, check specimens of all putative vice-county records. In addition, vice-county recorders (an incomplete set for Britain and only one for Ireland) are listed with their e-mail addresses on the B.B.S. website. By contrast, nowhere on the B.S.B.I. website is recording at the vice-county scale given any prominence. This is because the B.S.B.I. does not have a formal, official vice-county recording scheme. Now is the time to start one. Otherwise, the present volume will suffer the same fate as its predecessor, and become an interesting historical document that is largely ignored.

Let us hope, on the contrary, that we see a genuinely new beginning. The *Census Catalogue* is not perfect. There are even few minor errors, e.g. *Quercus* wrongly indexed, *Pseudofumaria lutea* indicated as native in v.c. 7 and *Larix kaempferi* as native in v.c. 1. But any difficulties arising from these imperfections are trivial in comparison with those that would exist if the authors had not courageously and painstakingly collated this splendid database.

M. O. HILL

The Flora of Huntingdonshire and the Soke of Peterborough. T. C. E. Wells. Pp. xxxiii + 203. Huntingdonshire Flora and Fauna Society and the author, Upwood, Huntingdon. 2003. Hardback. £17.00. ISBN 0-9514427-2-4.

Huntingdonshire has been fortunate in the past in having received a considerable amount of botanical attention but, until now, this low-lying area of Britain has been one of the few counties without a recent flora.

In the 17th Century, John Ray first recorded *Auricula leporis minima (Bupleurum tenuissimum* Slender Hare's-ear) near Ellesley and throughout the 1800s botanists such as the Rev. W. W. Newbould and the Rev. W. R. Linton noted and collected plants. Alfred Fryer, best known for his *Potamogeton* studies, also published a list of Huntingdonshire plants and had even contemplated writing a Flora. In 1926, George Claridge Druce used many of these previous lists of plants and published them in the Botany section of the Victoria County History. In more recent times, John Gilbert, a founder member of the Huntingdonshire Fauna and Flora Society, provided most of the records for the 1962 *Atlas of the British Flora* and published a check-list of plants found in the county but without detail. It was not until Terry Wells succeeded John Gilbert as Vice-county Recorder, in 1967, that plans were made to write a county Flora.

The author of the present Flora was soon to discover that there were many obstacles to overcome. The county may be one of the flattest in Britain but Terry was to have an uphill struggle! The original boundaries of the Watsonian vice-county 31 coincided very closely with the administrative county boundaries and it seemed sensible to base the Flora on this area. However, changes in the administrative boundary of Huntingdonshire took place in 1965, and the county now included the Soke of Peterborough. After discussion with Dr John Dony, the author also decided to include this area, thus enlarging the scope for botanical recording by just over a third but, unfortunately, gaining no new recorders in this area to help with the extra work. In recompense, a glance at the Species Richness map on page xiii shows that this north westerly area of the county increases the floral interest of the county as it contains a limestone area including Barnack Hills and Holes and Castor Hanglands National Nature Reserves. Species such as *Pulsatilla vulgaris* and *Antennaria dioica* would not, otherwise, have been in this Flora!

Systematic recording began in 1967 and was on a tetrad, 2 km × 2 km, basis. Each of the 382 tetrads was visited in spring, summer and autumn, which, although the effort involved was huge, has added greatly to the value of the flora. This was particularly important in the Soke, as previous coverage, published in *The Flora of Northamptonshire and the Soke of Peterborough* by Gill Gent, Rob Wilson *et al.* in 1995, was based on records made by the Kettering and District Natural History Society only on a 5 km square basis. Distribution maps were prepared for 837 species, the Flora being intended for publication by 1991. For various reasons, not least the bankruptcy of the

chosen publisher, the author was unfortunately obliged to postpone this. Recording continued during meetings of the Huntingdonshire Flora and Fauna Society, other records being added during the B.S.B.I. Monitoring Scheme, 1987–8, the Arable Weed Survey, 1989, and again during data gathering for *Scarce Plants in Britain*, 1994, and the *New Atlas*, 2002. The inclusion of these additional, recent records has certainly enhanced the present volume although the map symbols do not differentiate between older and more recent records. Over 600 maps are included but taxonomically difficult genera such as *Taraxacum* are, understandably, not mapped and in the case of *Rubus* the author candidly says 'I have been unable to take an interest in the *Rubi*...'.

The 1250 species accounts include the date of the first record in the county where this is known, the status, and excellent habitat descriptions, which reflect the author's intimate knowledge of Huntingdonshire, followed by the number of tetrads in which it occurs. Rare and 'interesting' species are given site names and grid references. Perhaps it would have been helpful to include a gazetteer of other localities mentioned in the text? There is, however, a table showing the Nature Reserves (with grid references, details of ownership and acreage), which is particularly important as many of the rare and special plants of Huntingdonshire occur in these reserves. For example, *Viola persicifolia* occurs at Woodwalton Fen, *Lythrum portula* at Monks Wood, *Aceras anthropophorum* at Barnack Hills and Holes and *Primula elatior* reaches one of its most westerly sites in Europe in Waresley Wood.

Melampyrum cristatum, another of the county's 'special' plants, is most attractively portrayed on the front cover and the colour photographs inside show superb views of four Nature Reserves and 23 excellent portraits of some of Huntingdonshire's beautiful plants.

This Flora has been long awaited. In spite of numerous setbacks and more recent severe health problems, Terry Wells, together with his wife Sheila, has produced a magnificent book Not only will it be invaluable to all of us who live and work in Huntingdonshire but it will join the ranks of those recently published Floras used widely by botanists throughout Britain.

J. M. CROFT

PROFILES OF THE REVIEWERS

DR JENNY BECKMAN works at the Department for History of Science and Ideas at Uppsala University. Her interests include 19th and 20th Century Swedish vernacular plant names.

DR CHRIS CHEFFINGS was until recently involved in the teaching and promotion of plant biology to primary school and university students and to the general public. She is currently the Plant and Fungal Conservation Advisor at the Joint Nature Conservation Committee.

DR TOM COPE is a taxonomist at the Herbarium, Royal Botanic Gardens, Kew. He is a grass specialist who is currently preparing an account of the British species for the *BSBI handbook* series.

MRS JANE CROFT has lived in Huntingdonshire since 1966. She worked at the Biological Records Centre, Monks Wood, until her recent retirement, using county floras as a source of plant records on an almost daily basis.

DR TREVOR DINES was born and bred in Hampshire. He was a co-editor of the *New Atlas of the British and Irish flora* (2002) and is currently Plantlife Wales Officer. He is undertaking fieldwork, with Ian Bonner, for a new Flora of Anglesey.

DR MARK HILL was co-author of the 1981 edition of the British Bryological Society's census catalogue, *Distribution of bryophytes in the British Isles*. He is currently head of the Biological Records Centre, Monks Wood.

ROY VICKERY is the Senior Curator in the Department of Botany, Natural History Museum, London. He has written extensively on the folklore of plants.

Obituaries

R. H. ROBERTS
(1910–2003)

Richard Henry (Dick) Roberts, who has died aged 92, was one of the country's leading amateur botanists and a nature conservationist of the highest integrity. His recognition of the botanical interest of the Anglesey fens during the 1950s led directly to their designation as nature reserves and to the establishment of the North Wales Naturalists' Trust (now the North Wales Wildlife Trust) of which he was a proud co-founder and the first General Secretary. In addition he had an international reputation for his taxonomic expertise in *Polypodium, Dactylorhiza* and *Mimulus.*

Born at Llanllechid, near Bangor, North Wales, in a strongly Welsh speaking community, Dick took an early interest in botany, encouraged no doubt by his mother's knowledge of herbal plants and his upbringing on the family hill farm. However, he received no formal instruction in botany at school or university and, after graduation from University College of North Wales, Bangor he began a lifetime's career as a primary school teacher. His first teaching post was in Sussex, followed by a spell in Evesham where he met and married Bet, who was his loving and supportive wife for 58 years. In 1947 he was appointed to teach in Penmachno which allowed him to study the mountain flora of Snowdonia, especially the area's ferns. Here he relished the opportunities to study the fine grained distribution patterns of plant species against the wide range of rock types, eagerly seeking out outcrops of Bala Limestone and the Bedded Pyroclastic Series. Finally, in 1955 and now with family, he moved to Bangor where he was a much respected head teacher until his retirement in 1974.

Despite a heavy work load, Dick was an active member of both the British Pteridological Society and the Botanical Society of the British Isles (B.S.B.I.) for almost 50 years. He was appointed B.S.B.I. Vice County Recorder for Anglesey in 1955, a position he carried forward with undiminished enthusiasm and expertise until 1995. During his stewardship he made a number of significant additions to the island's flora, including *Ophioglossum azoricum*, *Equisetum* × *fontqueri*, *Pyrola maritima* subsp. *rotundifolia*, and the marsh orchids, *Dactylorhiza traunsteineri* and *D. majalis* subsp. *cambrensis.* As his interest in marsh orchids grew he undertook detailed morphometric studies which, together with his keen appreciation of ecological factors, gave him a unique field-based insight into this complex. It was the same with the Polypody ferns which he came to understand with great authority; ably distinguishing the cytotypes both in the field and after careful examination at home, regularly preparing sporangia or root tips to view under a microscope on the family's lounge table and thereby to make accurate chromosome counts and cell measurements. He wrote a series of papers for the *Fern Gazette* and *Watsonia* clearly describing his findings in these fields, and frequently accompanied by his own skilled botanical drawings.

After extensive fieldwork Dick published *The Flowering Plants and Ferns of Anglesey* in 1982, an invaluable guide to the island's plant life. An *Atlas of the Flowering Plants and Ferns of Anglesey*, which he published privately in 2002, reveals the detailed extent of his knowledge of the distribution of species, both native and alien. Even in his late 80s and 90th year Dick was presiding over regular sessions giving valuable advice as to the treatment of Anglesey data for the *New Atlas of the British and Irish Flora.*

Despite his commitments to Anglesey, Dick retained a keen and discerning interest in mainland botany, partly as a result of his long friendship with a fellow Caernarfonshire botanist Evan Roberts of Capel Curig, and made notable contributions to our understanding of *Dryopteris* in Snowdonia. He also contributed in a wider field by collaborating with specialists in plant genera such as *Mimulus*, *Equisetum* and *Asplenium.* As well as publishing almost 50 scientific articles and papers of his own Dick has been formally acknowledged in 20 more. He has been given due recognition in the naming of two taxa – *Mimulus* × *robertsii* and *Equisetum* × *robertsii*, the latter a hybrid horsetail discovered on Anglesey in 2002, a fitting tribute to a botanist with a keen eye for hybrids and a deep attachment to the flora of his natal area.

Dick was always happy to share his knowledge and experience, regularly advising university staff and students, professional conservationists and taxonomists, as well as fellow amateur botanists. He acted as a referee for the Botanical Society of the British Isles (B.S.B.I.) for *Polypodium*, *Dactylorhiza* and *Mimulus* with a worthy reputation for his prompt, informative and courteous responses. For a time he was editor of the B.S.B.I. *Welsh Bulletin*.

During the 1950s and 1960s Dick became increasingly involved with conservation as he witnessed first hand the changes to the landscape and wildlife of North Wales wrought by farming, forestry and tourism. He teamed up with Bill Lacey, a Senior Lecturer in the Botany Department in the University at Bangor, to save a fine wetland in the east of Anglesey known as Cors Goch from becoming a rubbish dump, and this action led the two botanists to form the North Wales Naturalists' Trust and a long friendship which was to serve nature conservation well.

Indeed Dick Robert's association with the University at Bangor developed strongly, and in recognition of his botanical scholarship and services to plant conservation he was awarded an Honorary M.Sc by the University of Wales in 1979. He became an Honorary Member of the B.S.B.I. and was awarded the Linnean Society's prestigious H. H. Bloomer Medal for services to botany and conservation in 1999.

Despite such accolades, Dick was an intensely modest man who was content to work quietly without acknowledgement. He had wide interests, which included archaeology, Welsh history and poetry, and even Welsh Mountain sheep breeding. Above all he loved his family and to his wife, Bet and their two daughters Pat and Anne and the wider family we extend our condolences.

There is no doubt that in his combined knowledge of the flora, history and environment of North Wales Dick Roberts was unsurpassed in his lifetime and has continued the fine tradition of Welsh natural historians.

My thanks to Bet Roberts and Ian Bonner for information and comments on this obituary.

NIGEL BROWN

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PETER JOHN SELBY
1946–2003

A member of B.S.B.I. since 1987, Pete Selby was appointed as B.S.B.I. Recorder for v.c. 11 (South Hampshire) in 1999, having organised the recording for the 'new Atlas' in v.c. 11 since 1996. In 2002 Pete was appointed as Hon. Volunteers Officer for the B.S.B.I. National Local Change Project; he set this up, a considerable task, and he had with efficiency made excellent progress with the organisation in the short time then left in his life.

Pete Selby was born on 1 August 1946. His parents were shop owners in Wickham Square near Fareham. He attended Portsmouth Grammar School until 1963, when he joined the army in the Royal Signals, initially attending the Army Apprentices College at Harrogate. His family always had an interest in natural history, and Pete developed his angling skills on the Thames in Oxfordshire while stationed there in the army. Waiting quietly for a fish to bite led first to an interest in ornithology and then to plants because, as he put it, "the birds kept flying away and the plants didn't". He married Janet (Jan) in 1968 and they had a daughter Sara in 1972. Whilst in the army Pete took the opportunity to seek out plants whilst also serving in Yorkshire, Liège (Belgium), Dorset, Herford (W. Germany) and Shropshire, before leaving in 1980 with the rank of Staff Sergeant (Foreman of Signals). He then became a computer engineer and taught himself computer programming, initially using BASIC. He rapidly developed IT skills and learnt to love computers – perhaps somewhat unusually for a botanist of his generation. In conjunction with the technical director of Permabond he wrote a computer program to select the optimum adhesive for a wide range of situations. Pete's natural ability as an organiser and this early experience with database methods was later to prove useful background for his contribution to B.S.B.I. In 1984 he became a Technical Author, writing instruction manuals for all sorts of things from parts of army tanks to railroad signalling systems for the USA. I remember how one day, as we chatted in a pub, he pointed to a microwave oven and said he had written the instruction book for it. I asked him to tell me more and found that he had even written an instruction manual for a light aircraft.

The story then switches to 2 October 1996 when a meeting was held in Winchester to discuss arrangements for recording the plants of Hampshire for the planned Atlas 2000. Trevor Dines and Catherine Chatters had called the meeting. It had the blessing of the then B.S.B.I. Recorders for Hampshire - Paul Bowman and Lady Anne Brewis - neither of whom felt able to take on the responsibility for the checking and computerisation of thousands of plant records, let alone organising the survey teams. Mike Wildish had agreed to take on v.c. 12 (North Hampshire) but who could, or would, consider the task for v.c. 11 (South Hampshire)? There was an embarrassing silence – many that were there remember it well. Then suddenly in the dimly-lit steeply-tiered auditorium a voice from high up at the back said, "I would be prepared to try if the v.c. 11 people are ready to help". Everyone clapped spontaneously even though most did not know him. So it was that Pete Selby introduced himself. It transpired that he had been a B.S.B.I. member since 1987 and his IT and organisational skills made him ideal for the task. Pete lost no time in arranging training/recording meetings: he came to them all and encouraged the old hands to team up with, and help, the less experienced botanists. If the weather was clement these meetings might end in a pub garden. Pint in hand, plant identification became less daunting for the diffident. The team got to know Pete better and many new friendships were made. In the summer of 1999, when Paul Bowman died, Hampshire was left with no Recorder for v.c. 11 - who could ever replace Paul? Who would have the time? Fortune smiled on us: Pete had coped with the Atlas for three years and had got into the habit of supplying his helpers with computer printouts of the plants found in their allotted hectads together with helpful hints on plants to search for. He accepted the B.S.B.I.'s invitation to become Recorder for v.c. 11. Pete wrote his own database program and set about transferring Paul Bowman's vast set of paper records into electronic form. Subsequently he found out about another database program called Mapmate, which at the time was primarily for recording moths. Pete could see that the huge advantage of Mapmate was its ability to pool data by 'synchronisation'. He had been developing such a system for his own database program (and had already tested exchanging data on zip-drive discs). However, Pete saw the potential of Mapmate and joined forces with its developers to help add the full list of plant species and other features

desired by botanists. In 2002 Pete also became the B.S.B.I. Volunteers Officer, with many extra responsibilities, including the organisation of the national Local Change survey. By this time Pete had built up an army of volunteers to help with plant recording in v.c. 11. As many are of the fairer sex, Pete's wife, Jan, would often jovially refer to them as his harem.

Pete always enjoyed and appreciated the value of the annual B.S.B.I. Exhibition Meetings. He was thus prompted to arrange his own exhibition meetings in Bishopstoke Community Centre, where interesting specimens were brought and examined, and identification problems solved. Pete brought the Hampshire records on his lap-top for all to use, which proved highly popular. Jan provided tea and cakes and conversation flowed.

Pete died at the Chelsea & Westminster Hospital on 10 September 2003, after collapsing at the Natural History Museum on 3 September. In spite of his military background he was very much a quiet, gentle person, with a passion for plants and great love for his family. Sadly, he was just beginning to enjoy the pleasures of being a grandfather as his grand-daughter, Laura, was born to his daughter Sara in 2002.

Jan made a brave decision and asked the Hampshire Flora Group members back to Bishopstoke again on 15 November. She brought books from Pete's library and invited those present to choose one or two volumes as gifts in his memory. Sara and enchanting 20 month old Laura joined the group for those final poignant moments. It is to be hoped that Laura will, one day, learn of the esteem in which Pete was held.

Our thanks to Jan Selby for providing much of the material in this account.

(Much of the information in this obituary was published in *Flora News*, Newsletter of Hampshire & Isle of Wight Wildlife Trusts Flora Group, Spring 2004.)

TONY MUNDELL & ELIZABETH YOUNG

PHILIP MORGANS SMITH
(1941–2004)

Dr Philip Morgans Smith was Senior Lecturer in Plant Sciences at the University of Edinburgh, and with his death from pneumonia on January 14 2004, at the age of 62, the University of Edinburgh has lost a botanist of international stature, an inspirational teacher, a sympathetic counsellor and Director of Studies, an effective administrator and a real team-player.

Philip Smith was born in Halesowen, West Midlands, in 1941 and sadly his father died shortly afterwards. He was brought up by his mother and her parents and his early interests in Natural History were initiated by his grandfather who was a keen fisherman. In his boyhood years he explored the countryside with a young friend, collecting all manner of natural objects – stones, rabbit skulls, birds, fish, worms, eggs, leeches, lizards, frogs, molluscs, insects, animal droppings but above all plants – which were set out, labelled and exhibited in the garden shed that was founded as their 'Naturlist Club' (sic). He attended Halesowen grammar school from 1953–1959 and although an intending scientist from his early teens he continued with English and Latin throughout his schooling. The latter subject became invaluable to him as a taxonomic botanist. In his last two years at school he was taught biology by Eira Morgans. At school and later at Birmingham University he was a member of the Birmingham Natural History Society when Professor Hawkes was amassing the data for the first computer based flora of a British county. He graduated in 1962 from Birmingham University with a 1st class Honours B.Sc in Botany and proceeded to his Ph.D on *Bromus* under Professor J. Hawkes, which he obtained in 1965. The previous year, he and Eira Morgans were married, Philip adopting Eira's surname as his middle name, and together they went to California on a Harkness Fellowship to study under Professor Ledyard Stebbins in the Genetics Department at University of California, Davis. He was appointed assistant lecturer in the Botany department at the University of Edinburgh in 1967, and became a senior lecturer in 1981.



Philip did his utmost to stimulate and nurture a wider interest in plants at a time when the organism-based approach in biology had become unfashionable. He taught in all 4 years of the courses in Biological Sciences at University of Edinburgh, and also in the Diploma in Taxonomy and later the M.Sc course in Biodiversity and Taxonomy of Plants based at The Royal Botanic Garden. The M.Sc course was his creation, and has become the European, probably the world, market leader. So also was the Honours course in Plant Science of which he was Convener. He served for a time as convener of the Biological Board of Studies and introduced many innovations such as modularisation, designed to increase student choice among a burgeoning range of biological course options. Philip lectured with flair and style and on occasion was applauded by the first year students. His success in lecturing was the result of a complete synthesis of his wide interest in botany and his love of literature, together with his good baritone voice and perceptive wit. He had a remarkable ability to quote extensively from his favourite authors such as Dylan Thomas and A. E. Housman, and with speeches of Churchill he was a great mimic. Despite an enormous work load with teaching and committees he was never ruffled or spoke a sharp word.

Philip's outstanding contribution and dedication to teaching was acknowledged by the School of Biological Sciences when he was nominated in 2003 for the Chancellor's award for excellence in teaching. He was described by his Head of School as "the most outstanding teacher we have. He has the highest teaching loads in the School and consistently gets ratings from students which the rest of us can only aspire to achieve."

He also made important external contributions to biological education, notably as a member of The Scottish Schools Exam Board. He was at times convenor and moderator for CSYS Biology; a member of The Scottish Central Committee on Science; Scrutineer for 10 years from 1990. In 1996 he was Consultant Principal Examiner in Sciences, Jordan Examination Reform Project. He was External Examiner, M.Sc. course in Taxonomy, University of Reading 1992–1996. He served on the Council of The Botanical Society of Scotland for many years, and as its President from 1989–91.

Philip supervised 16 research students and these, together with his M.Sc. students have contributed to the spread of broad taxonomic principles around the world. His own research, from which he was distracted by a frequently oppressive workload, was mainly concerned with the grass genus *Bromus,* on which he wrote about 20 papers and was the world authority. He was particularly interested in *Bromus interruptus*, now a rare, possibly extinct endemic weed species of sainfoin and hay-fields in south-east England. By 1973 seed held at Cambridge was no longer viable and it appeared that the species was finally extinct. It gave Philip much pleasure, at a B.S.B.I. conference in Manchester in 1979, to produce living plants grown from seed he had collected in Pampisford in 1963. In the 1960s he was one of the first to use serological techniques to distinguish between species in the study of their relationships, and used the method to demonstrate almost complete homology between the proteins of *Bromus interruptus* and *Bromus hordeaceus*. His book Chemotaxonomy of Plants (1976) proved valuable in advanced taxonomic courses. As a student he had collected data for the first computerised local flora – A Flora of Warwickshire, and over the last 20 years he galvanized members of the Botanical Society of Edinburgh (now Botanical Society of Scotland) into collecting data for a flora of the Lothians. Philip wrote several chapters of the resulting book "Plant Life of Edinburgh and the Lothians", edited in collaboration with Dr R. O. D. Dixon and Dr P. Cochrane, which was published in 2002 by Edinburgh University Press, establishing a new datum point in local plant recording. It stands as a testament to his vision, energy and powers of persuasion.

In recent years Philip spent much of his free time on his narrow boat cruising along the canals of the English Midlands, the part of the world from which he hailed and forever had affection. He was very sociable and liked to discuss a wide range of topics over a pint or two at any local hostelry. On field courses it was not long before he was leading the singing after a hard day in the field. Everyone, students, colleagues and acquaintances alike, will remember him as a good and convivial friend, never happier than, over a glass of beer, discussing any subject under the sun, with perhaps forthright views but never a hint of rancour and always with much humour, frequently at his own expense. Many who knew him well will see his light in the following: "Here is the story of my name, which is Greek in origin (I predate the Duke of Edinburgh's fame), meaning 'lover of horses'. I do not like horses, very dangerous, though I am familiar with riding a camel. When I was born I was very ill, and expected to die. For very many weeks they didn't bother to name me, therefore. But against the odds the wretched child survived, so they had to do something. No one could agree on anything. Eventually my father got fed up and decided the decision had to be made within a few minutes. His desperate eye fell upon the light bulb. 'Philips' it said. So here I am."

There will be many times when we will be reminded of our encounters with Philip. It is sad that he has been cheated out of his well-earned retirement. He will be sorely missed but also remembered fondly and with gratitude by hundreds of students all over the world and by many others in the wider botanical community. He is survived by Eira and his sons Mansel and Llewellyn, to whom we extend our deepest sympathies.

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C. E. JEFFREE

FRANCIS WILLIAM SIMPSON
(1912–2003)

Francis Simpson was born in Asyut, Egypt on 15 September 1912; he died at a nursing home in Felixstowe on 10 November 2003. For more than sixty years he was the chronicler of the countryside and wild flowers of his native county of Suffolk.

Although he was born in Egypt, where his father was employed as an instructor in a training school, teaching leatherwork, the family returned to England whilst Francis was still a baby. They settled in the east of Ipswich and Francis lived in the same house for the rest of his life. Suffolk was his father's home county and grandfather Simpson's bakery business existed in Framlingham until fairly recent times. His father had also been a soldier in the Boer War and a Court Official in Colchester, but on his return from Egypt he decided to make a success of a market garden in Ipswich. However, the Great War intervened and he was called into service with the army again.

From his own accounts, it is clear that from childhood Francis had an insatiable appetite to go out and explore the countryside at every opportunity. His grandfather was also a naturalist and Francis recalled that his mother, a well educated lady, had a good knowledge of wild flowers. When the weather was fine she would take her two children on long walks out of town. He



Francis Simpson at his home in Ipswich

remembered often setting off with his mother and older sister at 4 a.m. to walk to places as far away as the coast at Butley or Shingle Street, returning home at 10 or 11 p.m. Father preferred to stay at home and sister sometimes experienced sore feet, but Francis had no such problems, he would walk a good deal more than the 30 odd miles that the ladies covered, for he would always race ahead to explore an interesting looking wood or pit.

His teachers at Ipswich School may have recognised his potential, for it was a Flora given to him by a schoolmaster that provided him with his first significant understanding about the plants of Suffolk. He matriculated in 1930, but did not go on to university. His competence as a botanist must surely have helped him gain a place on the staff of Ipswich Museum in 1930 and his skills as a photographer were also put to good use in documenting the collections. Through the Museum he soon came into contact with the Suffolk Naturalists' Society who recruited him as 'Phanerogamic Recorder' – a role he continued for the rest of his life. His early writings for the Society's journal show an elegant, poetic style (probably influenced by the S.N.S. Secretary and editor, Claude Morley) and although still in his twenties he was already complaining about the despoiling of the countryside when most contemporary naturalists were more interested in collecting. In 1938 he writes "*HEU, HEU, HEU! – What a glorious Easter-tide we had this year! Every prospect pleased but everywhere I go I find that Man is vile; everywhere our Suffolk is made more hideous to live in all the winter through; nowhere is Beauty maintained. ...Nor do I alone have eyes that see. Stanstead was my bourn yesterday; and some changes en route are too appalling to describe. Here, where Beauty companioned me all along the way but a dozen years ago, is sheer havoc.*" That same year, while recording flowers in the parish of Mickfield, Francis discovered that a small meadow famous for its Snakeshead Fritillaries was in the process of being drained and ploughed. He dashed off a characteristic letter to the East Anglian Daily Times, warning that "*the countryside is rapidly becoming less floriferous in this mechanical and destructive age, and naturalists must defend the heritage of beautiful wild flowers, unless our future flora is to comprise only aliens and weeds.*" An appeal raised £75, enough to purchase the field for the Society for the Promotion of Nature Reserves. Mickfield Meadow, one of the oldest nature reserves in the country, is now managed by Suffolk Wildlife Trust – an oasis of meadow flowers in the midst of a vast arable desert.

In 1951 he joined the Botanical Society of the British Isles, taking on the role of Vice-County Recorder for both East and West Suffolk. His 52 years in this role are the longest service of any Recorder for the Society to date.

He despised the '*unnecessary use of the internal combustion engine*' and travelled the length and breadth of the county by train and bicycle. Never a great respecter of private property, he later bemoaned the lack of hedges and ditches along which he could creep without being seen. In 1989, when he was given a Rivis Vice-presidency by the S.N.S., Lord Cranbrook, President of the Society presenting the award, remarked that any landowner in Suffolk who considered that his estate was private hadn't reckoned with Simpson. In 1997 I was out walking in Tuddenham by the little bridge over the River Fynn when Francis (now aged 85) suddenly appeared with his old bike from behind some bushes clasping a specimen of Green Figwort *Scrophularia umbrosa*. I asked him how he would negotiate the stile with his heavy bike, whereupon he showed me where he had cut a small piece from the fence with a saw, just large enough for him to slip his bike through!

His lifestyle was frugal and he was garnering food from the countryside in the form of wild fruit, berries and fungi long before *Food for Free* had made these pursuits popular. After he retired from the Museum in 1977, he took full advantage of the extra time to get out into the field almost every day and continued to explore the county and make new records well into his eighties. Dressed in his woolly hat, thick tweeds and plastic mac (even in the heat of mid-summer) he was sometimes taken for a tramp. He was arrested and kept under armed guard on several occasions while investigating botanical habitats behind MOD fences. After one such incident he was amused to have his confiscated camera returned to his door complete with the film which had been nicely developed by courtesy of the Armed Services!

He strongly disliked field sports, and dismantled snares whenever he found them. He had a decidedly sweet tooth, an exceptional memory for plants and places, and was by turns opinionated, stubborn, cantankerous and loveable. Long before the end of his life he had become a treasured Suffolk institution.

By the time his flora was published in 1982, Francis knew his county and its plants as few have ever done before or since. The work of half a century of patient recording, it drew on other surveys, but was mainly his own work, a fact recognized by the Suffolk Naturalists' Society who published the work and insisted it be called *Simpson's Flora of Suffolk*. The book had a very long and difficult gestation. Francis was a self-taught botanist and greatly resented 'interference' from academics such as John Trist who chaired a committee S.N.S. had set up to try and bring the work to completion. As I mentioned last year in Enid Hyde's obituary, the final publication was in large part due to her patience and organisational skills in getting all Francis' materials sorted and the records up-to-date. The Flora, a classic of its kind, includes 285 of the author's own splendid photographs of plants in their natural surroundings and an elegant text in which the drastic changes seen in the countryside during his lifetime are described. John Dony's review in this journal includes a paragraph praising the 80 pages of colour plates which are such an important feature of the book:–

'The outstanding feature of *Simpson's Flora* is the inclusion of colour illustrations of the plants, 285 in all, making it without doubt the best illustrated Local Flora we have yet seen, or are likely to see, for many years to come. They reveal the author to be an even more superb plant photographer than we had already known him to be. I appreciated most the illustrations of plants shown in their natural surroundings, giving the reader a clear impression of the varied habitats in which wild flowers grow in Suffolk. Let no would-be compiler of a Local Flora be deterred by realising that inclusions of this nature are beyond his means!'

This last line is somewhat ironic – It cost £27,000 to produce in 1982 and, although S.N.S. co-ordinated the publishing, most of the money was raised through public subscription and 'pre-pub' offers. This did not raise enough to include much colour and Francis insisted on including the extra colour section and put in several thousand pounds of his own money.

Although he did not collect much herbarium material, he did amass a superb collection of several thousand photographs. He started in the 1930s using glass plates and continued to develop his own pictures throughout his life. The collection, mostly unlabelled, is now housed at Ipswich Museum; it includes many pictures of historic importance and will be an important resource for those studying habitat change. Francis was very careful about his records and rarely revealed the precise locations of rare plants. His notes usually only list the parish and the year of the record with the exact details only stored in his memory. He did not trust computers and was convinced that secrecy was the best protection. Whenever I tackled him on this issue, pointing out that managers and landowners could not protect sites if they did not know where they were he would always counter with examples of plants that had been destroyed by collectors or 'vandals'. I have great respect for the strength of his convictions and the trouble he was prepared to take to ensure precious sites were not revealed. In 1996 he was honoured with an M.B.E. for services to nature conservation.

Having grown up in the agricultural depression of the 1920s when much of the Suffolk farmland was left unploughed, his memories were of a countryside filled with flowers and bird song. Much of his adult life was spent decrying the destruction of that temporary paradise. He was a conservationist long before the word was invented. What drove his passion was the retention of a childlike pleasure in the beauty of the natural world. Populations of rare plants became like old friends whom he would revisit from time to time; he could always remember when and where he had first met them and mourned their losses as if they were family.

I can remember when I first met him, as a teenager taking my first plant (*Amsinckia micrantha*) for identification at the Museum shortly before he retired. His love of plants and dedication to their conservation have been an inspiration to me and many others working in the field.

MARTIN SANFORD

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The cover illustration of *Primula scotica Hook.* (Scottish Primrose) was drawn by Rosemary Wise.

The changing flora of the Lancaster Canal in West Lancaster (v.c. 60)*

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10 Gayton Parkway, Wirral, CH60 3SS

ABSTRACT

An account is provided of the history of the Lancaster Canal in West Lancaster (v.c. 60). During its 200 year history the changing flora is described showing it has provided a habitat for a characteristic flora. However, the changes are consistent with general eutrophication, which more recent detailed studies suggest is accelerating. In addition changes and especially losses appear to confirm a correlation with increasing boat traffic.

KEYWORDS: aquatic flora, eutrophication, boat traffic.

INTRODUCTION

The second half of the 18th century was a time of change across much of England. Despite the American Wars of Independence and the Napoleonic wars it was a time of gradually rising wealth as industrial development accelerated. It was a period of entrepreneurship and innovation with new manufacturing processes and a developing factory system. However, transport was a problem facing the new industrialists. Packhorse trails and even the new toll roads were inadequate. The solution was to build canals, which in England were pioneered in the Mersey basin with the opening of the St Helens Canal (1757) and the Bridgewater Canal (1765), which were used primarily for transporting coal (Hadfield & Biddle 1970).

Changes were also taking place in rural areas with the enclosure of common lands, drainage of wetlands and general agricultural improvement requiring marl (calcareous clay) and lime (Holt 1795).

As a consequence of these changes there was a rapid growth in the size of towns, particularly in Lancashire south of the River Ribble, whilst in the rural areas in the north and west of the county agricultural improvements took place providing food for the growing and increasingly urban population (Crosby 1998). These changes had a dramatic impact on the landscape; many habitats, especially wetlands and heaths, were reclaimed for farming. Yet at the same time new habitats were created. Amongst these were ponds derived from marl pits and canals (Day *et al.* 1982). They provided refugia for aquatic and marsh species at a time when the more natural wetland habitats were lost.

THE LANCASTER CANAL

The idea of a canal linking Kendal in Cumbria with the Leeds–Liverpool Canal via Lancaster and Preston was proposed at a meeting held in Lancaster on 8 June 1791 and work commenced on building the canal in January 1793. However, financial difficulties prevented the original scheme being implemented. Instead a tramway linked the northern end that terminated in Preston with a

* This is an expanded version of a paper read at an international conference organised by the Linnean Society of London 'Looking back for the future. The use of long-term data for predicting ecological change' on 24 October 2003. Abstracts and PowerPoint presentations were published on a CD-ROM compiled by Pisces Conservation Ltd, 2004.

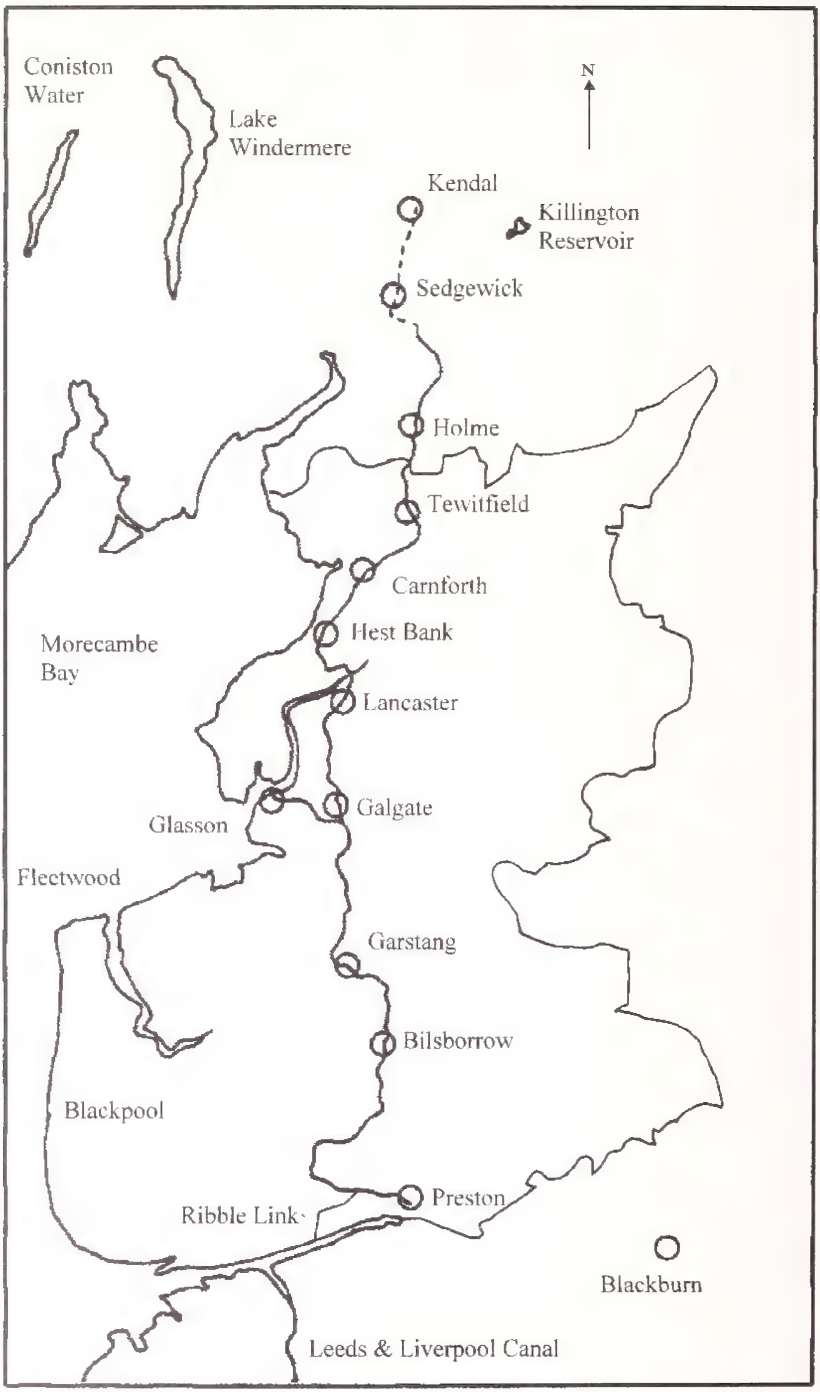


FIGURE 1. Location of the Lancaster Canal. The v.c. 60 boundary is shown by a solid line. The canal north of Tewitfield in Cumbria is un-navigable and the final section (shown by a dotted line) to Kendal is de-watered. The sketch map is based on images used by the Lancaster Canal Trust.

bridge over the R. Ribble to the south end at Walton-le-Dale, c. 5 km southeast of Preston. The northern end was built in three stages. The first section from Preston to Borwick was opened on 22 November 1797 and the second, from Borwick to Kendal via a flight of eight locks at Tewitfield, was opened in 1819. Finally a connection from Galgate to the sea at Glasson Dock, via another flight of six locks, was opened in 1826. Although there was a link to the sea the Lancaster Canal was effectively isolated from the rest of the canal system until 2002. Then, a short section near Preston was built to the River Ribble enabling leisure craft to cross the tidal estuary and join the rest of the canal system via the Rufford branch of the Leeds–Liverpool Canal (Fig. 1).

The main line of the canal from Preston to the locks at Tewitfield is c. 68 km long and has no locks. It was built as a 'contour' canal and therefore takes a meandering route at a constant level (25 m above mean sea level). Between 1797 and 1819, when the northern reaches (Tewitfield to Kendal) were built there were no outflows or water movement in the canal except by leakage or planned overflows into streams or rivers. The only water supply was from streams, natural drainage into the canal and by pumping water from the River Ribble at Preston (Anon no date) and from the River Keer at Capernwray near Carnforth (Hadfield & Biddle 1970). It was essentially a large ditch or elongated pond. However, the construction of the northern reaches also involved the building of Killington Reservoir on Killington Common in the Howgill Fells (close to the present day Tebay south services on the M6) to provide a water supply.

THE CANAL'S STRUCTURE

The total width of the canal is c. 13.7 m with a waterway width of c. 6·5 m. It is a broad gauge canal, in contrast to the narrow gauge of many other English canals, with embayments at many bridges to allow barges to pass and turn. The barges were 24 m long and 4·75 m wide with a draught of 1·25 m when fully laden with 50 tons of cargo. The canal was dug with sloping sides and a flat bottom to leave an operating depth of water of 1·96 m. It was built by hand using pick, shovel and wheelbarrow. Most of the canal south of Tewitfield was dug in clay and only occasionally was it necessary to cut through rock. The excavated clay was used to build embankments. To make the canal watertight the bottom and sides of the canal were lined with a layer of puddled clay 0·3–1 m thick. To puddle the clay navvies (diggers) stamped up and down on the clay with their bare feet until all the air bubbles were driven out. Sometimes cattle were used to assist the process. Today with the accumulation of organic matter and reduced maintenance the navigable depth is often no more than 0·82 m. The boundary fence on the towpath side was to be of 'Quicks and pricked', presumably *Crataegus monogyna* (RAIL 1795; Anon no date; Philpotts 1993; D. Slater pers. comm.).

The towpath was surfaced with small stones and grit. It is believed that the bare earth on the banks etc. was sown with grass seed (possibly a mixture of grasses and herbs found locally in pastures and meadows). In a few places trees, usually *Fagus sylvatica* (Philpotts 1993), were planted. In general the canal passes through a pastoral landscape with fields sloping gently to the canal on the eastern side whilst on the western, or towpath side, the canal was bounded by a hedge with *Crataegus monogyna*, as originally specified but now with other species and the fields often slope away from the canal. Thus the canal receives water from springs and general run-off on the eastern side and is therefore part of the general drainage system for the area through which it passes.

In building the canal stone was only used for bridges, aqueducts and quays etc. so that the completed canal, with its sloping, puddled clay sides and bottom, provided an ideal habitat for plant colonisation (Fig. 2).

It is difficult today to imagine the impact constructing the canal had on the environment and people of this rural part of Lancashire at that time. A temporary work force was required to build what was the 18th century equivalent of a 21st century motorway.

THE CANAL AS A MEANS OF TRANSPORT

Traffic gradually built up after opening and during its busiest period in the early 1840s a twice-daily passenger service (the special barges averaged 10 mph) operated between Preston and Kendal, although the main cargoes were coal going north and limestone going south. In 1804 c.

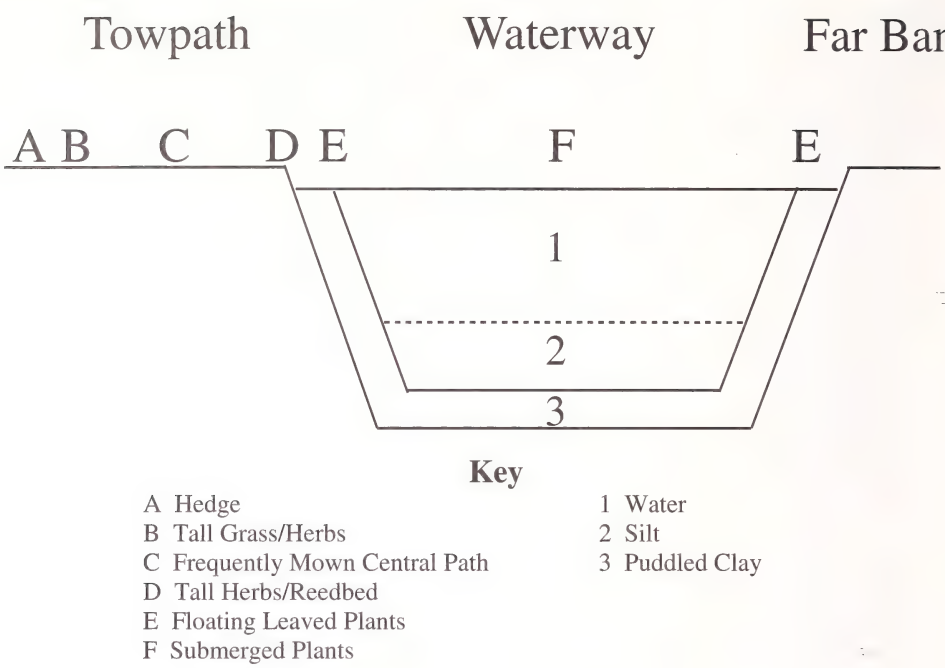


FIGURE 2. Cross-section of the Lancaster Canal.

102,000 tons of cargo was carried rising to 193,000 tons in 1840 (Anon no date). However, once the railways became competitive, traffic gradually declined until the canal was finally closed for commercial use in 1947. Before then, increasing difficulties in maintaining the canal north of Tewitfield led to the abandonment of that section in 1944. Although commercial boat traffic no longer used the canal it was being increasingly used as an aqueduct to supply industrial users along its length, and through a pipeline from Garstang to chemical works at Fleetwood. This probably saved the canal from total abandonment, and with increasing leisure use, especially by anglers and later small boats, the canal gradually became an important part of the leisure industry.

Nevertheless traditional canal maintenance continued with mechanical dredging and weed clearance, although at a reduced standard. However, in the late 1960s experimental weed control using herbicides was carried out and in the early 1970s an iron revetment was fixed to protect the towpath from erosion boat wash.

MACROPHYTES OF THE LANCASTER CANAL

PLANT COMMUNITIES

Today a transverse section of the canal reveals the following zones (Fig. 2, Plate 2.)

A. Hedge. Consists mostly of *Crataegus monogyna* but occasionally abuts on to plantation woodland or consists of another species, e.g. at Capernwray, north of Carnforth the main shrub species is *Prunus padus*. In places the hedge is replaced by a stone wall.

B. Tall grass/herb zone. *Arrhenatherum elatius* is usually abundant making this an *Arrhenatherum elatius* grassland (MG1 – see Rodwell 1991–2000 for a description and terminology of plant communities). In places this gives way to stands of other species, e.g. *Eupatorium cannabinum*, *Filipendula ulmaria*, *Carex acutiformis* or *Phragmites australis*.

C. A frequently mown central pathway. This is often dominated by *Lolium perenne* (possibly a *Lolium perenne–Cynosurus cristatus* grassland (MG 6) with occasional open areas where ruderals, e.g. *Poa annua, Matricaria discoidea* or *Juncus bufonius* may be found. *Juncus tenuis* has also been found in open areas in this zone. Formerly this area was a bare gravel path (Plate 1).

D. Tall herb/reed-bed zone between the frequently cut area of the towpath and the open water of the canal. The vegetation here gradually changes from a tall grassland through marshy areas to an emergent reed bed zone. Typical species in the marshy areas include *Lycopus europaeus, Lythrum salicaria, Iris pseudacorus, Stachys palustris, Stachys* × *ambigua, Mentha aquatica* and *Mentha* × *verticillata.* Emergent vegetation adjacent to the open water is often dominated by *Acorus calamus.* Rodwell (1991–2000) refers this community to S15 *Acorus calamus* swamp and notes the particular concentration of this community in Lancashire. Occasionally *Phalaris arundinacea* (S28) or *Phragmites australis* (S25) may dominate this zone. In places it is missing.
E. Floating leaved communities. The open water of the canal may have floating leaved aquatics (more usually on the far side and in embayments) often dominated by *Nuphar lutea* (A8), *Persicaria amphibia* (A10) or *Sparganium emersum.*
F. Submerged aquatics. A variety of free-floating and rooted submerged aquatics are found in the canal. These include fine-leaved pondweeds (*Potamogeton* spp.), *Potamogeton perfoliatus* and *Elodea nuttallii* (A11, variation of A15).
G. The far side of the canal. This may be bordered by a reed bed zone but more frequently grazed grassland with low marsh vegetation bordering the canal.

THE CHANGING VASCULAR FLORA

For the first 50 years after the canal was built there were few records of plants growing in the canal or along its banks, although *Dryopteris submontana* was recorded near Tewitfield in 1843 (Wheldon & Wilson 1907). There were, however, a number of active botanists living in the Lancaster area, including George Crossfield, father and son (1754–1820 and 1785–1847 respectively), Samuel Simpson (1802–1881) and his sister and brother in law Maria and Henry Borron Fielding (1804–1895 and 1805–1851 respectively). The latter lived within a few metres of the canal in the 1830s and 1840s.

From the 1850s until 1907 a number of observations of the canal's flora were made (Ashfield 1858, 1860, 1862, 1864; Wheldon & Wilson 1900, 1907) but apart from the report of a field meeting (Anon 1925) there were no further observations until the 1960s. Even then, apart from observations at Garstang (Greenwood 1974), no systematic survey of the canal's flora was undertaken until the 1980s when Livermore & Livermore (1989) undertook a survey in Lancaster District. In 2000 five of the richest sections were re-surveyed using the Livermores' methodology (see below). In addition other studies of the canal's flora have been undertaken since 1980 (e.g. Environmental Management Consultants 1993; Murphy & Eaton 1983).

Despite the absence of systematic surveys until recently it is possible, using the data that are available, to make some observations on the canal's changing flora. Table 1 draws together the data for observations of the noteworthy taxa that were observed growing in or on the banks of the canal since 1800.

Prior to 1850 few species were noted. From the canal itself the only aquatic recorded was *Groenlandia densa* from Lancaster whilst the other species noted were grassland or ruderal plants. *Groenlandia densa* persisted until the 1980s. In the early years of this period there would have been many open grassland habitats on the banks. It was also a time when commercial traffic (cargo and passenger) reached its peak. No doubt wash limited or prevented much colonization of the waterway and the horse traffic on the towpath kept the gravel walkway of the towpath free of plants. Assuming that all barges were fully laden and traversed the full length of the canal and with one passenger boat in each direction daily then at any one point on the canal there were 4590 boat movements per annum. Bearing in mind that the Fieldings lived close to the canal it is inconceivable that had interesting species grown in or by the canal they would not have noted them. The absence of records therefore probably represents a genuine absence.

By the middle of the 19th century the canal's habitats would have become more mature and, with increasing competition from the railways, boat traffic gradually declined in the second half of the century. The declining boat traffic may have allowed plants that could have colonized the waterway earlier but unnoticed to flourish. Between 1858 and 1864 C. J. Ashfield wrote a series of papers on the 'Flora of Preston' and included several noteworthy species from the canal. Further



PLATE 1. The Lancaster Canal believed to have been taken at Garstang in about 1900. The photograph shows an absence of trees, almost no marginal growth of emergent aquatics and an absence of vegetation on the towpath. It is thought that the bridge carried the Garstang–Knott End railway over the canal. Photo reproduced from a post card from the collection of B. J .N. Edwards and embossed E. Hoole Preston.



PLATE 2. The Glasson Branch of the Lancaster Canal looking west in 2000 showing a 1 m wide tall herb/reedbed zone on both sides of the canal, a central mown part of the towpath with less frequently cut grassland on either side. Photo: E. F. Greenwood.



PLATE 3. The Lancaster Canal at Garstang looking north in 2001. The bridge seen from the north in Plate 1 is removed leaving the bridge abutments now overgrown with shrubs and trees. Beech (*Fagus sylvatica*) trees line the canal on the right. Shade from the trees and boat traffic from the nearby Garstang Marina limit the growth of emergent aquatics but the towpath is mostly vegetated. Photo: E. F. Greenwood.



PLATE 4. The Lancaster Canal in about 1900 looking north to the Garstang basin from the aqueduct over the R. Calder. The photograph shows mechanical weed clearance taking place and floating/submerged aquatics are just discernible in the water. However there is no marginal tall herb/reed-bed zone. The flora of this area was recorded and illustrated by Greenwood (1974) when there was well developed marginal vegetation similar to that illustrated in Plate 2. Photo from a post card in the collection of B. J. N. Edwards.

TABLE 1. FIRST AND SUBSEQUENT RECORDS OF SELECTED SPECIES FOUND IN THE LANCASTER CANAL

Species	Prior to 1850	1851–1910	1911–1960	1961–1997	Post 1998
Acorus calamus		1907 (1)	1925 (2)	Present	Present
Angelica sylvestris			1925 (2)	Present	Present
Azolla filiculoides				1988 (3)	Present
Baldellia ranunculoides		1860 (4)	Not recorded	Not recorded	Not recorded
Butomus umbellatus		1858 (5)	1925 (2)	Present	Present
Callitriche hermaphroditica		1883 ((6)		Present	Present
Calystegia sepium	1830s (8)				
Carex nigra		1862 (7)		Present	Not recorded
Carex otrubae			1925 (2)	Present	Present
Ceratophyllum demersum				Present	Not recorded
Ceratophyllum submersum				Present	Present
Dryopteris submontana	1843 (1)	Not recorded	Not recorded	Not recorded	Not recorded
Elodea canadensis		1864 (9)		Present	Present
Elodea nuttallii				1979	Present
Epilobium palustre			1925 (2)	Present	Present
Gentianella amarella				1965	Not recorded
Groenlandia densa	1816 (10)	1858 (5)	1930s (11)	Present	Not recorded
Hippuris vulgaris		1907 (1)		Present	Present
Impatiens capensis					Present
Lemna gibba		1907 (1)	1930s (11)	Present	Present
Littorella uniflora		1891 (1)		Not recorded	Not recorded
Lycopus europaeus			1925 (2)	Present	Present
Mentha aquatica			1925 (2)	Present	Present
Menyanthes trifoliata			1925 (2)	Present	Present
Myriophyllum spicatum		1862 (7)		Present	Present
Nuphar lutea				Present	Present
Nymphaea alba		1907 (1)		Present	Present
Nymphoides peltata				1988 (3)	Present
Ornithopus perpusillus		1862 (12)		Not recorded	Not recorded
Peucedanum ostruthium			1925 (2)	Not recorded	Not recorded
Polygala vulgaris	1830s (8)				
Potamogeton alpinus		1907 (1)	1921 (10), 1959 (14)	Present	Not recorded
Potamogeton berchtoldii		1891 (13)	1946 (14)		Not recorded
Potamogeton crispus		1858 (5)	1946 (15)	Present	Present
Potamogeton natans			1925 (2), 1946 (15)	Present	Not recorded
Potamogeton obtusifolius		1900 (6)	1946 (14)	Present	Present
Potamogeton pectinatus			1939 (15)	Present	Present
Potamogeton perfoliatus		1858 (5)	1923 (12)	Present	Present
Potamogeton pusillus		1865 (14)	1939 (14)	Present	Present
Potamogeton trichoides			1946 (14)	Present	Present
Potamogeton x *lintonii*				1971 (12)	Not recorded
Pulicaria dysenterica			1925 (2)	Present	Present
Ranunculus circinatus		1899 (1)	Not recorded	Not recorded	Not recorded
Ranunculus peltatus			1930s (11)	Not recorded	Not recorded
Sagittaria sagittifolia		1875 (1)	Present	Present	Present
Scutellaria galericulata		1860 (4)	1925 (2)	Present	Present
Spirodela polyrhiza		1862 (7)	1930s (11)	Present	Present
Stratiotes aloides				1960s (16)	Not recorded
Trifolium campestre	1830s (8)				
Typha angustifolia		1907 (1)	1925 (2)	?	Present
Utricularia vulgaris		1858 (5)		Not recorded	Not recorded
Zannichellia palustris		1892 (1)	1923 (12)	Present	Not recorded

Notes: 1 = Wheldon and Wilson, 1907; 2 = Anon, 1925; 3 = Livermore and Livermore, 1988; 4 = Ashfield, 1860; 5 = Ashfield, 1858; 6 = **NMW**; 7 = Ashfield, 1862; 8 = Fielding, no date; 9 = Ashfield. 1864; 10 = **OXF**: 11 = France, no date; 12 = **LIV**; 13 = **YRK**; 14 = **BM**; 15 = correspondence between J. E. Dandy and E. F. Greenwood; 16 = Greenwood, 1974.

north at Lancaster, W. Hall (probably 1817–1891) also made a few records at this time (**LIV**) but interestingly there is little overlap in their observations. The end of this recording period is marked by the publication of the *Flora of Preston & Neighbourhood* (Preston Scientific Society 1903) with observations made between 1897 and 1902 and the *Flora of West Lancashire* (Wheldon & Wilson 1907).

Ashfield noted a number of the more interesting species for the first time. These included *Butomus umbellatus*, *Elodea canadensis* (also recorded by Hall), *Myriophyllum spicatum, Potamogeton crispus, P. perfoliatus, Spirodela polyrhiza* and *Utricularia vulgaris*, which was not seen again. The remaining species are still present. There were, however, a number of notable absentees including *Acorus calamus* that was not recorded until 1897–1902 at the Preston end (Preston Scientific Society 1903); *Hippuris vulgaris* from Galgate to Glasson (Wheldon & Wilson 1907), *Littorella uniflora* at Garstang in 1891 but not seen again; *Nymphaea alba* at Cabus and Garstang; *Potamogeton alpinus* at Lancaster that persisted until the late 1990s; *Ranunculus circinatus* first recorded at Lancaster in 1899 (Wheldon & Wilson 1907) and subsequently at several places but not since 1907; *Sagittaria sagittifolia* first recorded in 1875 but with still only two localities in 1907 (Wheldon & Wilson 1907; *Callitriche hermaphroditica* first recorded from near Preston in 1883 but Wheldon & Wilson (1907) found it throughout the canal; *Catabrosa aquatica* recorded in various places from 1888 in West Lancaster but Wheldon & Wilson (1907) had only one record from the canal at Garstang; *Baldellia ranunculoides* recorded by a Mr Pearson (Ashfield 1860) from Preston where it persisted until 1897–1902 and *Zannichellia palustris* first recorded in 1897 and recorded by Wheldon & Wilson (1907) from a few localities from Carnforth to Stodday south of Lancaster and last seen sometime between 1987 and 1997. Many of the species became well established, at least for a time, and many remain an important part of the canal's flora today.

For many pondweeds identification difficulties meant that reliance was made on herbarium specimens. Amongst these were *Potamogeton berchtoldii* seen at Garstang in 1891 and again from the same area in 1946 as well as at Preston but with no further reliable records after that; *P. pusillus* at Lancaster in 1865 and still present throughout the canal and *P. obtusifolius* first seen at Winmarleigh in 1900 and still present.

Between 1911 and 1960 there were few observations and most were attributed to the Blackburn Field Club excursion (Anon 1925) that explored the canal between Preston and Garstang as it passed through the Fylde. They found *Peucedanum ostruthium* but otherwise they made few notable records although they saw a number of the more common species for the first time, e.g. *Bidens cernua, Carex otrubae, Pulicaria dysenterica, Lycopus europaeus* and *Mentha aquatica.* More noteworthy was *Menyanthes trifoliata*, which Wheldon & Wilson (1907) described as frequent in the vice-county. Between 1964 and 1987 nearly 50% of all sites for this species were from the canal but by 2000 it had almost disappeared from the waterway.

Amongst the pondweeds *Potamogeton natans* was recorded for the first time in 1925 but it must surely have been present before then. Also recorded for the first time were *P. pectinatus* in 1939 from Myerscough but now frequent in many places and *P. trichoides* seen at Preston in 1946 and still found occasionally in various places.

Between 1964 and 1997 detailed recording at the tetrad level took place in West Lancaster and included the section-by-section survey of the canal in Lancaster District. New species were added to the list of records for the canal in this period. Perhaps the most surprising was *Nuphar lutea*. Today it is a common canal species but it is not known when it first appeared. Nevertheless it is clear it was a late arrival as Wheldon & Wilson (1907) did not record it, nor did Blackburn Field Club yet Wheldon & Wilson did record specific localities elsewhere. Other species that were recorded for the first time in this period were *Azolla filiculoides* at Tewitfield in 1985; *Elodea nuttallii* in 1979 from Halton; *Nymphoides peltata* at Carnforth in 1988 and at Newton-with-Clifton in 1998 and *Potamogeton* × *lintonii* at Lea near Preston in 1974 and in the Glasson branch in 1971–73 but not since. More remarkable was the appearance of *Stratiotes aloides*, first recorded in the Garstang area possibly in the 1950s but by 1963 was present between Garstang and Barton and became so abundant that it was a threat to navigation. Then, as suddenly as it appeared, it disappeared sometime in the mid-1970s. Other species to appear for the first time in this period include *Ceratophyllum demersum* first recorded in v.c. 60 by Perring & Walters (1962), possibly from the canal, where it became frequent before disappearing sometime in the 1990s and

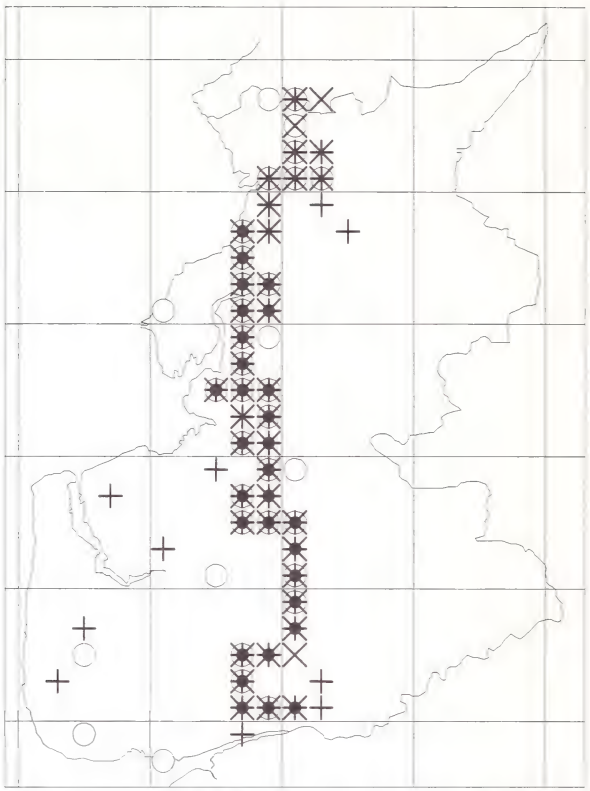


FIGURE 3. Coincidence map showing the 2 × 2 km square distribution of the Lancaster Canal (×), *Acorus calamus* (+), *Butomus umbellatus* (●) and *Sagittaria sagittifolia* (○) in v.c. 60. Map prepared using DMAP, a computer program supplied by Dr A. Morton.

Ceratophyllum submersum first seen at Borwick in 1966. Few noteworthy plants were found on the canal's banks but in 1965 *Gentianella amarella* was seen in mown grassland at Tewitfield Locks but was not seen there again.

Clearly the floral composition of the canal has changed over the years and continues to change. No doubt *Lemna minuta* seen on the canal at Crooklands in Cumbria (v.c. 69) in 2003 will soon appear in v.c. 60. Although the absence of records proves little there seems little doubt that in the first 50 years after the canal was built there were few noteworthy plants to be found in or on its banks. The few that that were recorded were mostly ruderal or grassland species. Most notably *Acorus calamus, Butomus umbellatus* and *Sagittaria sagittifolia* that later became characteristic species and found in few other places in v.c. 60 were absent (Fig. 3). If they had been present, at least in the Lancaster area, the Fieldings, Samuel Simpson and William Hall would surely have noted them, yet at **OXF** Simpson's specimens of *Butomus umbellatus* and *Sagittaria sagittifolia* came from the Leeds–Liverpool Canal with another specimen of *Butomus umbellatus* from Lytham. Despite living by the canal Mrs Fielding found her marsh plants for her 'English Flora' (Fielding no date) from other localities. These included characteristic plants of the canal's present flora, e.g. *Caltha palustris, Scutellaria galericulata, Iris pseudacorus* and *Lycopus europaeus*, all painted from specimens collected in ditches and streamside near her home at Stodday. For *Hippuris vulgaris* she travelled to Poulton (now Morecambe) and Southport whilst she found plants of *Nuphar lutea* and *Nymphaea alba* in Cumbria.

With the paucity of recording it is difficult to know how colonization of the canal proceeded or where the colonizing species came from. It is possible that pumping water from the River Keer at Capernwray, north of Carnforth introduced some species, e.g. *Groenlandia densa* described by Wheldon & Wilson (1907) as frequent in the area. For some, e.g. *Butomus umbellatus* and

Sagittaria sagittifolia the first records were at the Preston end of the canal and colonization appears to have proceeded northwards against the north–south flow of water in the canal. It is tempting to suggest that they were introduced from the Leeds–Liverpool Canal. *Acorus calamus* did not appear until late in the 19th century but by that time it was already common. However, it may too have been introduced from canals further south, although Shaw (1963) does not mention it as a South Lancaster canal species. Nevertheless Perring & Walters (1962) indicate the southern Lancashire and Manchester areas as two of its main centres of distribution in England and from which it seems to have spread (Preston, Pearman & Dines 2002).

For most species it is impossible to deduce how they colonized the canal or where they came from. For many species natural colonization from local populations must have taken place. Other species may have colonized the canal from garden throw outs or were introduced by anglers or boaters. It is also likely that different species colonized the canal from different or multiple starting points, e.g. *Callitriche hermaphroditica*, seems to have colonized from the north whilst *Stratiotes aloides* and *Potamogeton alpinus* appear to have colonized the canal from the Cabus and Garstang area in the middle whilst Livermore & Livermore (1988) suggest *Azolla filiculoides* colonized the canal at two places in Lancaster District almost simultaneously.

RECENT RECORDING

With the work of Livermore & Livermore (1989) more detailed and critical recording took place. However, they and others were confronted by plant identification problems not experienced by earlier workers who confined their observations to more noteworthy species. It is therefore important to describe these problems by analysing the detailed data derived from post-1985 observations.

It is clear that a number of species were misidentified. These include *Callitriche hamulata* which, whilst it might occur, was probably recorded in error for *C. hermaphroditica* and records for *C. hamulata* are therefore assumed to be *C. hermaphroditica.* This latter was never recorded if *C. hamulata* was noted and there are no voucher specimens for *C. hamulata.* The fine-leaved *Potamogeton* species, *P. berchtoldii* and *P. pusillus*, are often confused. Consequently only material named by referees was accepted and, as no post-1964 voucher specimens for *P. berchtoldii* were seen, all records after this date were assumed to be *P. pusillus*, which is frequent in, but largely confined to, the canal in v.c. 60. *Potamogeton praelongus* was also recorded but this is certainly an error for *P. alpinus.* Inexplicably, there were several records by one observer for *Glyceria maxima,* but this is a rare v.c. 60 plant and most known populations are probably of garden origin. It is, however, a common canal species elsewhere in Lancashire. Nevertheless it is difficult to know with what it was confused.

Some recorders (e.g. Environmental Management Consultants 1993) correctly observed that hybrids form an important component of the flora but not sufficiently rigorously to provide comparable data. *Mentha aquatica* and its hybrid *M.* × *verticillata* are common throughout the canal but they have only rarely been distinguished. Much more problematically *Stachys palustris* and its hybrid *S.* × *ambigua* were recorded but as plants showed varying degrees of sterility gatherings were made and checked using Rich & Jermy (1998) and Wilcock & Jones (1974). Morphologically most material agreed with *Stachys palustris* but plants varied from almost completely sterile to almost fully fertile and were slightly to moderately foetid (not as foetid as *S. sylvatica*). These plants could be a mixture of *S. palustris,* male sterile *S. palustris* or *S.* × *ambigua*. In addition a few plants were found that also agreed morphologically with *S.* × *ambigua*. Until more detailed work is carried out the identity of individual plants will often be unclear.

A number of other hybrids were also recorded and it is likely that more will be found, as their characteristics are better understood. Two nationally rare hybrids could be significant components of the vegetation although they have only been recognised recently.

Equisetum telmateia × *E. fluviatile* (*E.* × *willmotii*) was originally identified as *E.* × *litorale* (Livermore & Livermore, 1989) but it was later determined as this. It was abundant in a passing bay at Yealand Redmayne in a disused part of the canal.

Equisetum arvense × *E. telmateia* (*E.* × *robertsii*) was found shortly after the type specimen was described from a population in Anglesey (Dines & Bonner 2002). However, although typical it

grows with luxuriant *E. arvense* in the marsh vegetation at Cabus and is very difficult to spot in the field. It could well be frequent but recorded as *E. arvense*. A second colony was found a few kilometres further south at Catterall in 2003.

RECENT PLANT SURVEYS

In 1989 Livermore & Livermore published an account of the Canal's flora. This was based on species lists compiled from observations made along sections of the canal in the Lancaster District. This embraced the northern 32 kilometres of the canal to the Cumbrian border north of Tewitfield and included the Glasson Branch. A section was defined as the distance between two bridges and thus the sections were of uneven length. Although most observations were made from the towpath, occasional observations were made from bridges and the other side of the canal where access was possible. Lists were compiled at three different times of the year: spring, summer and autumn and on each visit the species observed were recorded on one traverse of each section in each direction. Species were recorded from the boundary hedge or wall bordering the towpath to the marsh vegetation on the far side of the canal.

In 2000 the survey was repeated for five sections of the canal chosen to provide geographical spread of sample points and that represented maximum species diversity.

ANALYSIS OF SURVEY DATA

In a preliminary analysis of floristic change on the Lancaster Canal (Greenwood 2003) it was shown that changes could be correlated with possible eutrophication of the waters. However, it was also pointed out that boat traffic affected macrophyte growth and species diversity. In this account the data have been revised and re-assessed.

HISTORICAL DATA

Table 2 shows that 15 aquatic species (Ellenberg value of F >10; for an explanation of Ellenberg values see Hill *et al.* 1999) were identified as having colonized the canal before 1907 and were known to be present in 2000. However, prior to 1974 (Greenwood 1974) only the more noteworthy species were recorded so that other species regarded by Wheldon & Wilson (1907) as too common to list were probably present but unrecorded. A good example might be *Persicaria amphibia*, plentiful in 2000. Table 2 also shows that the average Ellenberg N value for these species is 5·9 denoting moderately nutrient-rich waters.

Few observations were made between 1907 and 1940 and it is believed that there were few changes in this period. In Table 3 species present prior to 1940 but apparently absent in 2000 are shown alongside species that have colonized the canal since 1940 together with a few species that have been gained and lost since 1940.

Eleven species were lost with an average Ellenberg N value of 4·8 whereas five species were gained with an average N value of 6·6 suggesting that eutrophication had occurred. On the other hand several of the lost species were ones that could be easily damaged by boat traffic.

However, they were mostly found in the mid-19th century when, although past its peak, there was plenty of commercial traffic. Similarly the recent immigrants are interesting. Today *Nuphar lutea* is a common plant yet it was not recorded until sometime after 1964. Preston & Croft (1997) discuss the autecology of *Elodea canadensis* and *E. nuttallii*. Both are North American introductions represented by female plants so that spread is by vegetative means only. The explosive spread of *E. canadensis* is a classic example after its first observations in the English canal system in 1847. By 1864 it was abundant and widespread in the Lancaster Canal (Ashfield, 1864) and it remained so until the 1980s.

Elodea nuttallii was at first confused with *E. canadensis* so that its spread is less well documented. It was first recorded in 1966 from a ditch at Stanton Harcourt, Oxfordshire (Simpson 1984; Killick *et al.* 1998) but from the early 1970s it was recorded at an increasing number of localities in England. In v.c. 60 the first records were from a reservoir and the River Lune near Lancaster (1976 and 1978 respectively) and it first appeared in the Lancaster Canal near Lancaster in 1979. By 2000 it was apparent that *E. nuttallii* had replaced *E. canadensis*.

These two species are both able to withstand heavy boat traffic and both favour eutrophic waters. They can grow together but *E. nuttallii* favours slightly more eutrophic conditions than *E. canadensis* and often out competes it (Simpson 1989). This appears to be the situation on the Lancaster Canal.

TABLE 2. AQUATIC SPECIES COLONIZING THE LANCASTER CANAL BEFORE 1907 AND PRESENT IN 2000

Name	N Value
Acorus calamus	7
Butomus umbellatus	7
Callitriche hermaphroditica	5
Hippuris vulgaris	4
Lemna gibba	8
Lemna trisulca	5
Myriophyllum spicatum	7
Nymphaea alba	4
Potamogeton crispus	6
Potamogeton obtusifolius	5
Potamogeton pectinatus	7
Potamogeton perfoliatus	5
Potamogeton pusillus	6
Sagittaria sagittifolia	6
Spirodela polyrhiza	7
No. of species 15	Average 5·9

Status of some species uncertain, e.g. *Potamogeton natans* (not seen 2000) and *Persicaria amphibia* (plentiful 2000)

TABLE 3. LOSSES/GAINS OF SELECTED AQUATIC SPECIES IN THE LANCASTER CANAL

Species lost by 2000 Present pre 1940		Species gained since 1940 Present 2000	
Name	N Value	Name	N Value
Baldellia ranunculoides	2	*Azolla filiculoides*	8
Elodea canadensis	6	*Elodea nuttallii*	7
Groenlandia densa	5	*Nuphar lutea*	6
Littorella uniflora	3	*Nymphoides peltata*	6
Menyanthes trifoliata	3	*Potamogeton trichoides*	6
Potamogeton alpinus	5		
Potamogeton berchtoldii	5		
Ranunculus circinatus	7		
Ranunculus peltatus	6		
Utricularia vulgaris	4		
Zannichellia palustris	7		
No. of species 11	Average 4·8	No. of species 5	Average 6·6

SPECIES GAINED AND LOST POST 1940

Name	N Value
Ceratophyllum demersum	7
Stratiotes aloides	6
Potamogeton × *lintonii*	5·5
No. of species 3	Average 6·2

A small group of three species were both gained and lost after 1940. One, the hybrid *Potamogeton* × *lintonii*, may still be present as it is difficult to identify. However, a thorough search of the Glasson Branch was unsuccessful and with an Ellenberg N value of between 5 and 6 it is probably susceptible to eutrophication. Boat traffic is low in the Glasson Branch and unlikely to be a factor. *Ceratophyllum demersum* and *Stratiotes aloides* are known to have critical nutrient tolerances and disappear rapidly when nutrient levels become too high. Although there was an erroneous record for *Ceratophyllum demersum* from the River Hodder (Anon 1891) the first confirmed but unlocalised records for v.c. 60 were in Perring & Walters (1962) probably from the canal. It then spread throughout the Lancaster Canal and into ponds in the Fylde. However, by 1998 it seemed to have gone from the Canal.

Stratiotes aloides was known from a few ponds since at least 1868 but it was not known from the Lancaster Canal until the 1950s with records from Garstang. It subsequently colonized most of the canal southwards to Preston. Its growth was explosive and was a major impediment to boat traffic and anglers and led to the experimental use of herbicides (Greenwood 1974). These were largely unsuccessful yet at some stage during the mid-1970s *S. aloides* disappeared.

THE SURVEYS OF 1989 AND 2000

The surveys of five sections of the Canal in 1989 and 2000 enabled a closer examination of changes over a much shorter time scale and involved both the dry land habitats associated with the towpath as well as the wetland habitats of the waterway.

Table 4 shows that in this period for the five survey lengths 25 species with an average Ellenberg N value of 4·6 were lost whilst 35 species with an average Ellenberg N value of 5·1 were newly recorded. The newly recorded species were all grassland and marginal plants associated with the towpath.

However, if the species involved are analysed for their Ellenberg N values according to their moisture (F) preferences a more complex picture emerges. In species with an Ellenberg F value of <8 (more or less dry land species) the difference between lost (N = 4·7) and gained (N = 5·1) is less marked. This is consistent with the view that the only significant source of nutrient enrichment is atmospheric. When the aquatic and marginal plants (i.e. Ellenberg F values 8–12) are analysed a marked preference for more eutrophic waters is noted with lost species having an average Ellenberg N value of 4·2 whilst new species have an average Ellenberg N value of 5·2.

Although only a few species are involved if aquatics with Ellenberg F values of 10–12 are examined, the lost species have an average Ellenberg N value of 4·8 whilst new species have an average value of 6·6. This apparent gradient can be accounted for by the eutrophication taking place in the waters of the canal from atmospheric nitrogen deposition as well as run-off from adjacent fields. However, perhaps more significant is the black-headed gull (*Larus ridibundus* L.) colony that started to colonize the island and some of the banks around Killington Reservoir in 1985. Their numbers increased rapidly, stabilizing at around 3000 pairs in 1990. In addition about 20 pairs of Canada geese nested on the banks of the reservoir in the 1970s; these increased to over 40 pairs by 1988 and have remained at this level since then (Fig. 4; F. Gould, pers. comm.). It is not clear where the gulls came from or why Killington Reservoir was chosen but it is suggested that there may be a link to a former colony at Sunbiggin Tarn some 17 km to the north east. (J. Wilson pers. comm.; Halliday 1997; Ratcliffe 2002; Stott *et al.* 2002). Their faeces have killed much of the vegetation in the nesting area and must provide a major source of eutrophication for the canal. Furthermore, treated effluent from the nearby motorway service station may also enter the Peasey Beck, into which the reservoir empties, before reaching the canal at Crooklands, north of Holme. Clearly these sources of pollution will raise the levels of phosphates and nitrogen in the canal's waters. Lateral movement into the towpath will be at least hindered by the iron revetment separating the two zones. Furthermore at least some of the emergent plants (Ellenberg F values 8 & 9) grow on the towpath side of the revetment. Interestingly in this analysis there are more new species than lost ones.

The changes in floristic composition of the five survey lengths were also analysed to see if there were any differences in the Ellenberg Reaction Values (R) for lost and gained species (Table 4). Overall there was little difference but this hid a difference between the changes for aquatic species (F = 10–12) and marginal and dry land species. Aquatic species showed that lost species had a mean value of 5·8 whilst new species had a mean value of 6·8.

TABLE 4. LOSS/GAIN OF ALL SPECIES IN THE LANCASTER CANAL 1989–2000 OVER THE FIVE SURVEY LENGTHS

Species lost	F	N value	R value	Species gained	F	N value	R value
Aesculus hippocastanum	5	7	7	*Apium nodiflorum*	10	7	7
Allium scorodoprasum	6	7	7	*Betula pendula*	5	4	4
Briza media	5	3	7	*Campanula latifolia*	5	6	7
Carex nigra	8	2	4	*Cardamine hirsuta*	5	6	6
Chaerophyllum temulum	5	7	7	*Carex panicea*	8	2	4
Daucus carota	5	3	7	*Catabrosa aquatica*	9	7	7
Epilobium ciliatum	6	6	6	*Cerastium diffusum*	4	3	6
Euphorbia helioscopia	5	6	6	*Chrysosplenium oppositifolium*	9	5	5
Helictotrichon pubescens	4	3	7	*Cymbalaria muralis*	5	6	7
Juncus conglomeratus	7	3	4	*Epilobium obscurum*	8	5	5
Larix decidua	4	3	3	*Epilobium palustre*	8	3	5
Luzula multiflora	6	3	3	*Galeopsis bifida*	5	6	6
Menyanthes trifoliata	10	3	4	*Galeopsis speciosa*	5	7	7
Myrrhis odorata	6	7	7	*Galeopsis tetrahit* s.s.	5	6	6
Orchis mascula	5	4	7	*Geranium dissectum*	5	6	7
Pinus sylvestris	6	2	2	*Hyacinthoides hispanica*	4	6	6
Potamogeton alpinus	12	5	6	*Juncus acutiflorus*	8	2	4
Potamogeton natans	11	4	6	*Lemna gibba*	11	8	7
Saxifraga tridactylites	2	2	7	*Lemna minor*	11	5	6
Sinapis arvensis	5	7	7	*Leontodon saxatilis*	5	3	6
Sonchus oleraceus	5	7	7	*Lysimachia nemorum*	7	5	4
Sparganium erectum	10	7	7	*Lysimachia punctata*	6	5	7
Tragopogon pratensis	4	5	7	*Mycelis muralis*	5	5	7
Ulex europaeus	5	5	6	*Pimpinella saxifraga*	5	3	7
Veronica arvensis	4	3	5	*Potamogeton trichoides*	12	6	7
				Primula vulgaris	5	4	6
				Ribes alpinum	5	6	8
				Sagina procumbens	6	5	6
				Sanguisorba officinalis	7	5	6
				Spirodela polyrhiza	11	7	7
				Stachys officinalis	5	3	5
				Trifolium dubium	4	5	6
				Veronica filiformis	6	7	7
				Veronica hederifolia	5	6	7
				Veronica serpyllifolia	5	5	6
Mean (20) species F = < 8		4·7	6·1	Mean (24) species F = < 8		5·1	6·3
Mean (5) species F = 8–12		4·2	5·4	Mean (11) species F = 8–12		5·2	5·8
Mean (4) species F = 10–12		4·8	5·8	Mean (5) species F = 10–12		6·6	6·8
Total No. species 25				Total No. species 35			
Mean all species		4·6	6·0	Mean all species		5·1	6·1

Survey sections varied from 0·6 km to 1·3 km with an average length of 0·8 km

If the composition of the emergent and aquatic flora of the five survey lengths is analysed in terms of net loss and net gain a less clear picture emerges. This analysis introduces species that may be lost from one section and gained in another. They include species that are perhaps less sensitive to eutrophication but respond to other more localised events (Table 5).

If only aquatics (F = 10–12) are considered the figures clearly indicate eutrophication has taken place (N = 5·4 for decreasing species and N = 6·3 for increasing species). Also the number of decreasing species (13) is only slightly more than increasing species (12). When the emergent species (F= 8–9) are analysed the species found indicate the soils have become less nutrient-rich (N = 5·3 for decreasing species and 4·8 for increasing species). However, the total number of

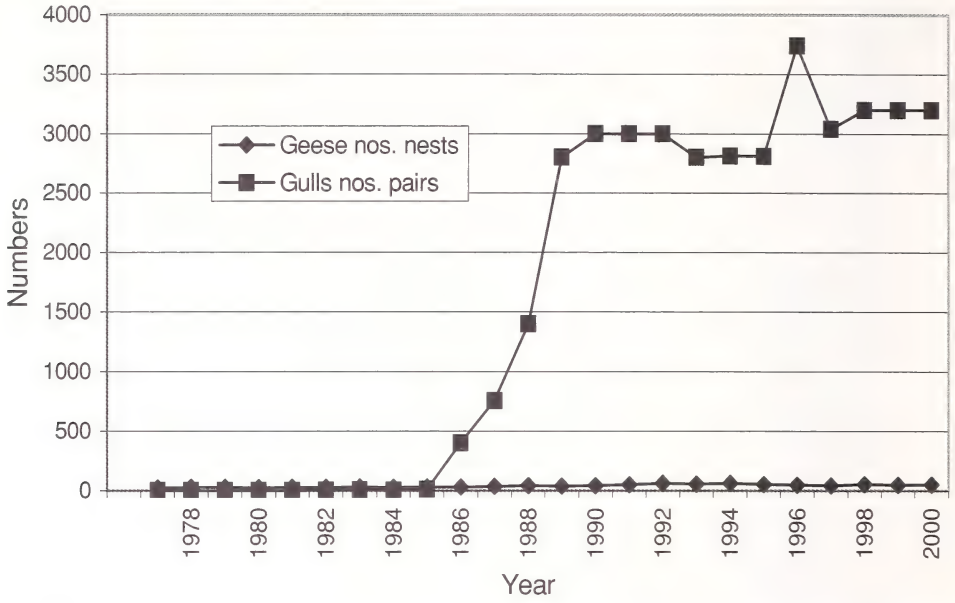


FIGURE 4. Graph showing the numbers of nesting black-headed gulls and Canada geese at Killington Reservoir, Cumbria 1977–2000.

decreasing species is 26 as against 20 for increasing species. The reaction preferences of species with moisture preferences F = 8 & 9 and those with preferences 10–12 were also different. For species where F = 10–12 some increase in the base status of the canal's water is indicated but for marginal species (F = 8 & 9) the reverse seems to have occurred.

Analysis of the changes in the number of species lost and gained (Table 6) within each survey length is also less meaningful as numbers are small. At best the changes are indicative especially as confusion between *Callitriche hamulata* and *C. hermaphroditica* and *Potamogeton berchtoldii* and *P. pusillus* is significant. However, bearing in mind the assumptions made earlier it appears that in the waterway there is evidence of increased nutrient and base status for four out of the five lengths. On the other hand when the species on the towpath and marsh plants (F = 8 & 9) usually found on the towpath side of the iron revetment are considered evidence for increased nutrient and base status is less clear and on the Glasson Branch the reverse is true.

It is difficult to explain these changes, for whereas more traditional methods of grassland management for the towpath zones appear to have favoured increased diversity, the taller emergent species close to the waterway seemed to have become less diverse. This zone may have become more of a closed community, which reduces species diversity. Greenwood (1974) demonstrated how the creation of more open habitats following herbicide treatment increased species diversity. Perhaps more significantly the changes occurring in the waterway itself and on the towpath appear to be different. In the canal the water appears to be getting increasingly nutrient-rich with enhanced base status whilst on the towpath the soils may be getting more acid and less nutrient-rich, at least in some places. The boundary between the two regimes appears to be the iron revetment separating the waterway from the towpath.

THE EFFECT OF BOAT TRAFFIC

Murphy & Eaton (1983) demonstrated that macrophyte growth and species diversity of canal waterway plants was affected by boat traffic. They developed a model of boat movements that took account of the breadth and depth of the canal. Using this model they predicted that, for a hypothetical canal 1 km long, 10 m wide and 1 m deep, between 2000 and 4000 boat movements per year (my) represented a critical range above which most macrophytes would suffer. Furthermore they and other workers suggested that the susceptibility of different species varies with boat movements.

TABLE 5. NET CHANGES IN AQUATIC SPECIES COMPOSITION (* F = 8 & 9; OTHER SPECIES F = 10–12)) IN THE LANCASTER CANAL 1989–2000 (5 SURVEY SECTIONS)

Species showing net loss	N Value	R. Value	Species showing net gain	N Value	R. Value
Alisma plantago-aquatica	7	7	*Acorus calamus*	7	7
*Angelica sylvestris**	5	6	*Apium nodiflorum*	7	7
Callitriche stagnalis	6	6	*Callitriche hermaphroditica*	5	7
*Cardamine amara**	6	7	*Carex panicea**	2	4
*Carex acutiformis**	6	7	*Catabrosa aquatica**	7	7
*Carex nigra**	2	4	*Epilobium palustre**	3	5
*Carex otrubae**	7	7	*Galium palustre**	4	5
Eleocharis palustris	4	6	*Juncus acutiflorus**	2	4
Elodea nuttallii	7	7	*Lemna gibba*	8	7
*Epilobium parviflorum**	5	7	*Nuphar lutea*	6	7
Equisetum fluviatile	4	6	*Oenanthe crocata**	7	6
*Juncus articulatus**	3	6	*Phragmites australis*	6	7
Lemna trisulca	5	7	*Potamogeton obtusifolius*	5	6
*Lotus pedunculatus**	4	6	*Potamogeton pusillus*	6	7
*Lycopus europaeus**	6	7	*Potamogeton trichoides*	6	7
*Mentha aquatica**	5	7	*Rorippa palustris**	7	7
Menyanthes trifoliata	3	4	*Salix viminalis**	6	6
*Myosotis scorpioides**	6	6	*Sparganium emersum*	6	7
Potamogeton alpinus	5	6	*Spirodela polyrhiza*	7	7
Potamogeton berchtoldii	5	6	*Veronica beccabunga*	6	6
Potamogeton natans	5	6			
Potamogeton perfoliatus	5	6			
Rorippa nasturtium-aquaticum	7	7			
*Rumex conglomeratus**	7	7			
*Salix fragilis**	7	7			
Sparganium erectum	7	6			
Mean of species F = 8 & 9	5·3	6·5	Mean of species F = 8 & 9	4·8	5·5
Mean of species F = 10 - 12	5·4	6·2	Mean of species F = 10 - 12	6·3	6·8
Total No. of species 26			Total No. of species 20		
Mean all species	5·4	6·3	Mean all species	5·7	6·3

Using boat model data from British Waterways based on boat log-book records Fig. 5 shows that boat movements vary along the Lancaster Canal with levels in excess of 4000 my from 12 to 42 km from Preston. This is a 30 km length, with the Garstang Marina not far from its centre. This is the largest marina on the canal with moorings for over 100 boats increased to 194 from 2003 (D. Lumb, pers. comm.). A two-hour cruise from the Garstang Marina almost coincides with this length of the canal where boat movements exceed 4000 my. However, only one of the 1987–2000 survey sections included this length of canal. Nevertheless four survey sections were lengths where boat movements varied from 3664 my to 2208 my; all were within the critical zone. For the surveyed section on the Glasson Branch there were only 1829 my - well below the critical level. This is also a level which Murphy & Eaton (1983) suggest achieves a satisfactory balance between ecological features and the needs of leisure users. Below this level the amount of plant growth starts to impede leisure use and with increasing plant growth seral development proceeds and in time plant diversity is reduced (see also Willby, Pygott & Eaton 2001).

If the number of licences is proportional to boat movements as recorded in log-books, then critical levels of boat movements throughout much of the canal were reached in the mid-1980s.

In general, Table 6 shows that within each survey length the numbers of species lost slightly exceeds the numbers gained. At Ellel, where boat movements were over the 4000 my threshold, losses greatly exceeded gains. Ellel is at the northern limit of a two-hour cruise from the Garstang Marina.

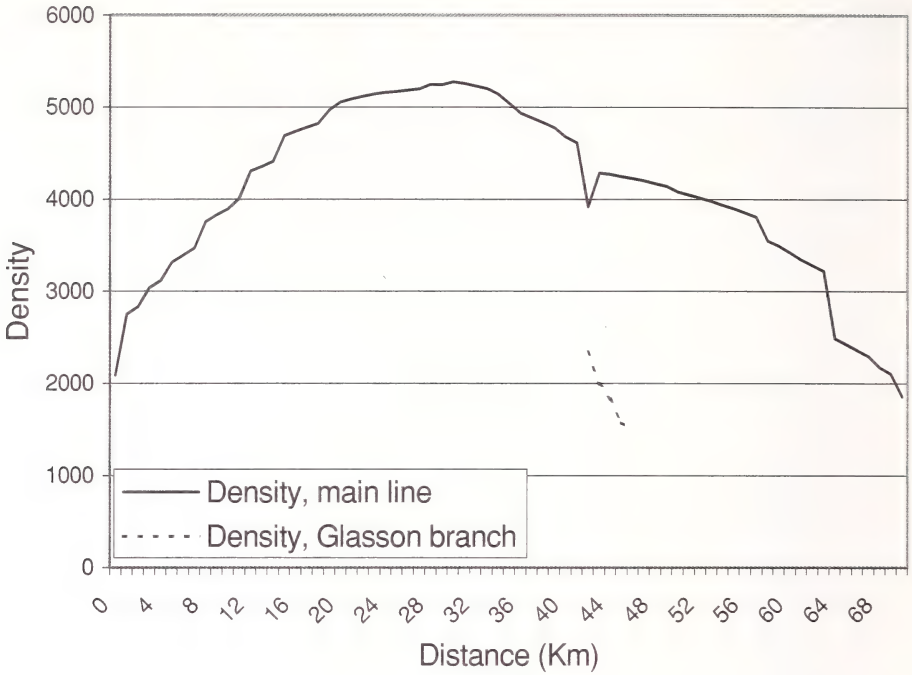


FIGURE 5. Average annual boat traffic density, Lancaster Canal in 2000.

Between 1966 and 1970 surveys of the emergent and aquatic species at Garstang were undertaken to assess the affects of herbicide treatments (Greenwood 1974). This showed that herbicides had little affect on the submerged aquatics but although the treatments eliminated the emergent species they returned with increased diversity. At that time it is believed that about half the 2000 level of boat licences were issued, implying that boat movements were between 2000 and 3000 my. In 1970 nearly twice as many species were recorded as in 1966 before herbicide treatments took place. The section chosen for these experiments was south of the present Garstang Marina at the Garstang Basin (Plate 4). This was later also developed for boat moorings including the towpath side of the canal for approximately half of the surveyed section. However, in 2000 the whole length was within a zone where boat movements were nearly 5000 my and well above the threshold for satisfactory macrophyte growth.

In 2000 this section was re-surveyed and the change in species composition observed from the towpath was dramatic. With one exception (*Elodea nuttallii*) there were no submerged aquatics and, where boats were moored, there were no emergent species. South of the mooring zone some emergent species were found but there was no well-developed tall herb/reed-bed zone. These qualitative changes can be represented quantitatively by the loss of 34 aquatic and emergent species (F = 8–12) whilst there were just two gains (Table 7). Further south, 24 km from Preston, but still with over 5000 my tall herb/reed-bed and floating leaved communities were well developed but there were no submerged aquatics.

These figures suggest that Murphy & Eaton (1983) correctly identified the importance of boat traffic and that as 4000 my is approached there is an increasingly adverse impact on aquatic and possibly emergent plants. Much above 4000 my and most aquatic macrophytes are unable to survive. The submerged aquatic, *Elodea nuttallii*, is thought to be one of the most resistant species to boat traffic and it favours highly eutrophic waters. It is, perhaps, not surprising that this is the only aquatic species to survive at Garstang. However, the adverse impact of boat traffic on emergent and floating leaved communities may not be so clear cut.

TABLE 6. MARSH AND AQUATIC SPECIES LOSSES AND GAINS, 1989–2000 (WHERE F = 8–12) FOR INDIVIDUAL SURVEY LENGTHS OF THE LANCASTER CANAL (FIGURES IN BRACKETS ARE FOR SPECIES WHERE F = 10–12)

Bridge Nos. (Location)	Losses		Gains		Boat movements
	Nos.	Mean N. Value	Nos.	Mean N. Value	Nos./ annum
84–85 (Ellel)	15 (10)	5·2 (5·2)	3 (1)	6 (6)	4679
105–106 (Lancaster)	10 (5)	5·5 (5·2)	9 (7)	6 (6·3)	3975
115–116 (Hest Bank)	10 (5)	5·4 (5·8)	6 (5)	5·7 (5·6)	3855
130–131 (Borwick)	10 (5)	6·0 (5·6)	9 (6)	6·5 (6·5)	2425
3–4 (Glasson)	11 (8)	5·5 (6·0)	8 (3)	4·6 (6·3)	1829

TABLE 7. CHANGES IN THE MARSH AND AQUATIC FLORA (F > 8) OF THE LANCASTER CANAL AT GARSTANG BETWEEN 1966–1970 AND 2000 (TABLE DERIVED FROM GREENWOOD, 1974)

Species not seen 2000	N, Value	Species seen 2000 but not 1966 - 1970	N, Value
Alisma plantago-aquatica	7	*Elodea nuttallii*	7
Apium nodiflorum	7	*Sparganium erectum*	7
Butomus umbellatus	7		
Callitriche sp.	-		
Caltha palustris	6		
Carex nigra	2		
Carex paniculata	6		
Ceratophyllum demersum	7		
Eleocharis palustris	4		
Epilobium palustre	4		
Epilobium parviflorum	5		
Equisetum fluviatile	4		
Equisetum palustre	3		
Galium palustre	4		
Hippuris vulgaris	4		
Lemna gibba	8		
Lemna minor	6		
Lemna trisulca	5		
Lotus pedunculatus	4		
Lycopus europaeus	6		
Menyanthes trifoliata	3		
Myosotis scorpioides	6		
Myriophyllum spicatum	7		
Potamogeton alpinus	5		
Potamogeton crispus	6		
Potamogeton natans	4		
Potamogeton perfoliatus	5		
Ranunculus aquatilis	5		
Rorippa nasturtium-aquaticum	7		
Sagittaria sagittifolia	6		
Scutellaria galericulata	6		
Sparganium emersum	6		
Stratiotes aloides	6		
Veronica beccabunga	-		
No. of species 34		No. of species 2	
Mean	5·3	Mean	7

DISCUSSION

Unlike experimental science, work of this kind can only use data that happen to be available. In this account data were assembled from observations made over 200 years. Over most of this period records were made casually and only plants that interested the observers were noted. Over the last 20 years more systematic data were gathered allowing for more detailed analysis.

The Canal was opened over 200 years ago and with the data available it is difficult to know the source of the colonizing species or to know how the colonization process proceeded. Normally when new habitats are created the source of colonizing species is assumed to be local. However, the natural colonization of a new habitat is a complex issue discussed by Bradshaw (1999) in the context of urban areas. Nevertheless there is evidence that the source of the colonizing species is not always local. Greenwood & Gemmell (1978) argued that many of the more interesting species colonizing inland industrial sites were derived from plants growing on the coast 48–64 km to the west. For the Lancaster Canal at least some of the more interesting species may have been derived from the Leeds–Liverpool Canal opened in stages from 1774 (Clarke 1994). The canals in Lancashire and the Mersey basin were amongst the earliest to be built in England and are well known for their interesting flora (Shaw 1963). Nevertheless little is known about the origin of their flora. As many of the species are clearly introduced, were some of these species garden escapes, as long ago as the 18th century, accidentally or intentionally introduced into the canal? Undoubtedly some more recent colonizers are derived from garden escapes, although perhaps accidentally introduced, into the Lancaster Canal, e.g. *Azolla filiculoides* and *Nymphoides peltata.* On the other hand it is probable that most species colonized the canal by natural spread from nearby populations.

However, observations over the last 100 years show a consistent trend in the changing aquatic flora. That trend is for species favouring more eutrophic conditions to replace those characteristic of less fertile conditions. Some species have an apparently narrow nutritional tolerance range, e.g. *Ceratophyllum demersum* and *Stratiotes aloides,* and, whilst favouring generally nutrient-rich conditions, disappear when conditions are too eutrophic (Preston & Croft 1997).

Boat traffic affects the growth of plants and once it reaches critical levels (2000–4000 my) some species appear more sensitive than others to its effects. More work is needed to assess the sensitivity of different species to boat traffic but at about 4000 my most aquatic species disappear. However, on the Lancaster Canal it appears that adverse affects are not clear cut. Unfortunately it was not possible to compare the effects of boat traffic in the 19th century, where horse drawn barges were used, with the current leisure craft. The boats are very different in size, structure and means of propulsion. Nevertheless it can be calculated that as many as 4500 barges passed along the canal each year, and the 'Swift' passenger boats (at least four a day at the busiest period in the 1850s) caused considerable wash. Also it is presumed that in the 19th century boat movements showed little seasonality whereas current boat movements are greatest in the summer. Nevertheless it may be that the traffic was such that in the first 40–50 years barge traffic was sufficient to impede plant colonization (Plates 1 & 4).

There is no information about the abundance of plants in the canal or on its banks. From pictorial evidence it is suggested that the centre of the towpath used by horses for towing boats was a gravel surface free of plants (Plates 1 & 4). Similarly tall plants between the horse and barge were kept low, as taller vegetation would have impeded movement. However, this does not imply that the flora was species poor. Indeed Ashfield's records (Ashfield 1858, 1860, 1862, 1864) suggest that both the aquatic and emergent flora of the canal near Preston was diverse. Furthermore recent studies suggest that when the tall herb/reed-bed zone has developed a fully closed community it is floristically less diverse than in the earlier colonizing stages where open communities prevail.

Throughout its history the vegetation of the canal was managed, although from about 1940 the amount of management decreased sharply, so that by the mid-1960s some parts of the navigable canal were nearly closed by the encroaching vegetation and siltation. For most of its history management was mechanical and often by hand (Plate 4). This is a slow and relatively inefficient system that rarely removes all plant propagules. Thus species that can take advantage of this management system are able to exploit newly created open habitats thrive. Such plants need not reproduce sexually and many of the most successful species were represented by one sex of a

dioecious species, e.g. *Acorus calamus,* and *Elodea* spp., or were sterile hybrids, e.g. *Stachys* × *ambigua*, and *Mentha* × *verticillata* etc. For these taxa, and others capable of reproducing sexually, spread is vegetative. Thus mechanical systems of management and moderate levels of propeller driven craft aid rather than hinder both plant propagation and dispersal.

The Lancaster Canal was of a size and construction (i.e. with sloping sides) that provided a favourable environment for the growth of many species of marginal, grassland and aquatic habitats. However, the habitats created and subsequently managed also provided a dynamic system constantly responding to changing environmental circumstances. An apparent continuing process of eutrophication in the waterway is one factor causing change and perhaps some loss of species diversity but on the towpath, especially on the Glasson Branch, where little eutrophication appears to be occurring or there may even be nutrient loss, current management may be leading to some species diversification. Whilst eutrophication appears to be detectable over the last 100 years it is perhaps only in the last 50 years that major nutrient enrichment has occurred. The growth of *Stratiotes aloides* in the 1960s followed by catastrophic decline is characteristic of continuing nutrient enrichment probably caused by the large increase in fertiliser use in the surrounding countryside. However, the loss in the 1990s of further species, e.g. *Potamogeton alpinus*, may be due to further enrichment, possibly caused by the black-headed gull colony at Killington Reservoir. Although some nutrients may be removed by vegetation on the Peasey Beck and in the canal above Tewitfield this may be negligible in comparison to the nutrient load entering the canal.

Exhaustive archive searches have failed to provide a complete inventory of boat licences issued by British Waterways but it is believed that in 1967 about 400 licences were issued or 44% of the 2000 total. This had risen to 537 in 1985 (59%) and during the 1980s the number of licences rose more sharply so that by 1994 nearly 900 licences were issued. There is also a suggestion that there was a substantial increase of licences issued about 1973. However, if the boat licence data are related to the boat model data, critical levels of boat movements for much of the canal were not reached until 1985. Since then boat movements have increased to over 4000 my within a two hour cruise time of Garstang where most boats are located. As a consequence most aquatic plants and many emergent species have been lost in this zone.

The two processes of eutrophication and increasing levels of boat traffic are identified as probably causing change to and loss of aquatic and marsh species in and on the banks of the canal. Furthermore by disturbing the sediments in the canal, boats may be affecting the nutrient status of the water and substrate. Moss (2001) reviewed the problems affecting plant growth in the shallow waters of the Broads in eastern England, including Hickling Broadwhere roosting black-headed gulls caused problems. He demonstrated that, whilst nutrient enrichment was a cause of plant loss, this was not a simple issue of cause and effect but involved a delicate balance of plant and animal communities where, if clear water was maintained, macrophytes flourished even at high nutrient concentrations. Unlike the Broads turbidity in the Lancaster Canal is caused by boat traffic, but during the winter with fewer boats using the canal the water generally clears and clear water is usually present in the Glasson Branch. Like the Broads the canal is an excellent coarse fishery, suggesting that the phytoplankton and their animal grazers are currently plentiful. However, that could easily change.

It appears, therefore, that whilst there has been change in the composition of the aquatic flora, probably caused by eutrophication, elimination of aquatic species is caused by boat traffic. The Glasson Branch demonstrates that in the absence of boat traffic over 2000 my there is an abundance of aquatic plants, but all the species favour nutrient-rich waters. On the other hand in the main line of the waterway, with boat movements over 4000 my, aquatic species do not survive.

With an increasing appreciation of canals as leisure facilities developments on the Lancaster Canal include the link to the River Ribble near Preston opened in 2002. For the first time this provides a link via a tidal river crossing to the rest of the canal network. It is also intended to re-open the northern reaches and provide a navigable waterway to Kendal in the English Lake District. In themselves these do not necessarily imply increased boat traffic but no doubt new marinas will be created and these will increase boat traffic in currently less well used parts of the canal with consequential adverse affects on plant life, especially if boat movements exceed 4000 my.

Therefore there is the danger that one of the charms of the waterway, the profusion of wild flowers on its banks, not to mention the unseen aquatic species, will be lost.

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Cystopteris diaphana (Bory) Blasdell (Woodsiaceae) – an overlooked native new to the British Isles?

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ABSTRACT

Cystopteris diaphana (Bory) Blasdell (Diaphanous Bladder-fern) is reported for the first time in the British Isles. This predominantly Macaronesian fern is locally abundant and appears native along nearly 1 km of the R. Camel, Cornwall (v.c. 2), where it was discovered in February 2000, after being initially misidentified as *C. fragilis* (L.) Bernh. An ongoing critical reassessment of other Bladder-fern records from S. W. England indicates that the species is also present on a Cornish hedgebank by a lane at Penjerrick, Mawnan Smith (v.c. 1), from where it has been considered to be an escape from cultivation, and in a railway cutting near Tavistock, S. Devon (v.c. 3), where its status is uncertain. Historical reports of *Cystopteris* from similar habitats in the South-west suggest that the species may have been and possibly still could be more widely distributed.

KEYWORDS: Diaphanous Bladder-fern, identification, ecology, Macaronesia, native or alien status, conservation, Cornwall.

INTRODUCTION

In February 2000, Matt Stribley found a small number of plants of the bladder-fern *Cystopteris* in rocky recesses on a damp woodland bank at Polbrock Bridge, E. Cornwall (SX06). These were initially identified as the widespread *C. fragilis* (L.) Bernh. and, as this is regionally very uncommon, its discovery stimulated further visits by various members of the local recording community. During the course of these it became clear that the plant was present in much greater quantity and luxuriance close by, on the almost vertical, heavily shaded banks of the River Camel. Here dense stands clothe the steep, c. 2 m soil slopes, beneath an overhanging fringe of *Hedera*, *Rubus*, etc. In this locality the fern is obviously periodically inundated, many of the plants being covered with deposited silt. The underlying geology of this area is of Staddon grit, a rather base-poor substrate unlike the limestone usually favoured by *C. fragilis*. This, and closer scrutiny of finer morphological characters, led the first author to question the initial identification. Discussion with Christopher Fraser-Jenkins, then working in the Natural History Museum, led to the suggestion that the plants may belong to the Macaronesian – Atlantic species *C. diaphana* (Bory) Blasdell (syn. *C. viridula* (Desv.) Desv.), a suggestion that was confirmed when specimens were sent to CFJ and FJR for determination.

Subsequent examination of other Cornish gatherings of *Cystopteris* revealed that some specimens recently collected by RJM from beside the lane bisecting the garden at Penjerrick, Mawnan Smith (v.c. 1, Grid ref. SW72) were *C. diaphana.* Plants of the genus were first noticed in this locality by Len Margetts in 1961 (Margetts & David 1981). Perhaps significantly when considering the status of the species in this locality, Christopher Fraser-Jenkins has identified both *C. diaphana* and *C. fragilis* among specimens from this site.

Knowledge of these finds and identifications spread and as a result a further British site for *C. diaphana* has come to light. Material collected by R. Hutchins from beside a disused railway line in the Tavistock area, S. Devon (v.c. 3) (SX47), was brought to the B.S.B.I. exhibition meeting in November 2003 and confirmed by FJR as this species. *Cystopteris* was first recorded in the vicinity of the recent collection as long ago as 1934 (Keble-Martin & Fraser 1939) but voucher specimens, to ascertain whether this earlier record also relates to *C. diaphana,* have not been located.

Cystopteris diaphana has long been confused with *C. fragilis*, included in *C. fragilis*, or treated at infraspecific level. Blasdell (1963) commented on their great superficial similarity of overall frond shape but placed *C. diaphana* within a separate section of the genus (section Emarginatae) from *C. fragilis* (section Cystopteris), on the basis of the venation and of cell shape characters of the adaxial epidermis and indusium. He believed that where these species occurred sympatrically these distinctions were less clear-cut and he suggested large-scale gene exchange between them was responsible. Detailed cytological or molecular examination has yet to substantiate this claim and hybridity, evidenced by spore abortion, has yet to be observed.

NOMENCLATURE

Nomenclaturally the use of the epiphet *diaphana* has been contentious, with some authors, e.g. Castroviejo *et al.* (1986) questioning the conspecificity of Macaronesian material with that from the type locality, given the wide disjunction; the basionym *Polypodium diaphanum* Bory is based on material from the remote Indian Ocean island of Réunion. The description and illustration in Tardieu-Blot (1958), under *C. fragilis,* clearly indicate that the plant from the Comoros and Réunion has the vein and spore characters of *C. diaphana sensu lato* and Prelli & Boudrie (1992) state that it is hexaploid, as are all Macaronesian and European plants counted (Dostál 1984). Prior to this confirmation the species was frequently referred to *C. viridula* (Desv.) Desv. and it is under this name that it appears in many European texts (e.g. Amaral Franco & Rocha Afonso 1982, Castroviejo *et al.* 1986, Salvo Tierra 1990).

THE WORLD DISTRIBUTION OF *C. DIAPHANA*

Cystopteris diaphana sensu lato is believed to be widely distributed in the warm temperate and tropical regions of the Old and New World. Pearman (1976) suggested that there were clear differences in spore morphology between Central and Southern American plants and those from Macaronesia; both, however, possessed what he termed spiny-lacunar perispore ornamentation which very clearly differed from the simple spines of *C. fragilis sensu stricto*. Examination of a wider range of material, however, indicates that the perceived differences among spiny-lacunar types are less clear cut than Pearman believed and we feel it is not possible to discriminate between Old and New World material on the basis of spore morphology. (cf. Fig. 2 and his Fig. 5).

In Central and Southern America *C. diaphana sensu lato* would appear effectively to replace *C. fragilis* except at the highest altitudes (see Smith 1981): it does not apparently extend as far north as North America (Haufler *et al.* 1993). In Macaronesia it is the sole species in the Azores (Schäfer 2002) and Madeira (Press & Short 1994) but in the Canaries it is replaced by *C. dickieana* at high altitude (Rumsey unpubl.). The species is also reported from North Africa (Morocco and Algeria) (Greuter *et. al.* 1984). In Europe the species is widespread in Portugal and western Spain (Castroviejo *et al.* 1986), with scattered outlying populations further east in Navarra in the Pyrenees and in the mountains of Granada in the south (Salvo Tierra 1990). It is, somewhat surprisingly, apparently absent from the area inland of Algeciras, southernmost Spain, where the majority of the Macaronesian pteridophytes and gametophytes disjunct to Europe occur (Rumsey & Vogel 1998). In France the species has been included in the national red-list (Olivier *et al.* 1995). It is restricted to a dozen sites in Corsica (on the west coast and the Tenda massif) where it is said to be under no immediate threat. On mainland France it is restricted now to a few sites in the Pyrénées-Atlantiques, where it is declining. Populations discovered in the 19th century from much further north on the Ile de Ré and in Cher in central France, where the species was present in wells (mirroring the situation of *Trichomanes speciosum* in Brittany), have apparently long since disappeared (Prelli 2001).

Pignatti (1982) largely follows Fiori (1943) in recognising, with some doubt, the occurrence of this species in Sicily, Corsica and the mountains of the Abruzzi. He gives its distinguishing characteristic as possessing a glandular indusium but does not mention venation or spore morphology. The illustrations in Fiori (1943) are unclear and the characters upon which he discriminates *diaphana* as a forma of *fragilis*, "folia bipinnatisecta", including it in the group which have "dentes plurimi lobulosum non emarginatae; nervi plurimi dorsum dentium intrantes, ad apicem desinentes" strongly suggests his concept of this taxon was in error. Prelli (2001) states that the species has been recently discovered in Lombardy.

IDENTIFICATION

The five British species of *Cystopteris* can be differentiated using all of the characters given in the key below, but microscopy is essential for confirmation. Field identification of similar species is difficult. However, although *C. fragilis* might be found in the vicinity of *C. diaphana*, within the British Isles other taxa are highly unlikely to be present to cause confusion. Therefore, *C. diaphana* and *C. fragilis* can be separated with reasonable confidence in the field using the clearest non-microscopical character that discriminates between just those two, that of the venation as used by Blasdell (1963). The majority of veins in the frond of *C. diaphana* do not end in the apices of the pinnule teeth, as in *C. fragilis*, but between them, often in emarginated notches (Fig. 1). This character is also shown to a very limited degree by *C. dickieana* but is best developed in the arctic-alpine *C. alpina* (Lam.) Desv. (syn. *C. regia* Desv.), another overlooked British native last seen in Upper Teesdale in July 1911 (Rumsey 2003, Tennant 1995). This montane taxon is distinguished by its more finely dissected fronds and by the characters outlined in the key below; it is unlikely to be naturally sympatric with *C. diaphana*.



FIGURE 1. *Cystopteris diaphana* (Bory) Blasdell.
A. Detail of pinnule showing characteristic vein endings. B. Typical frond

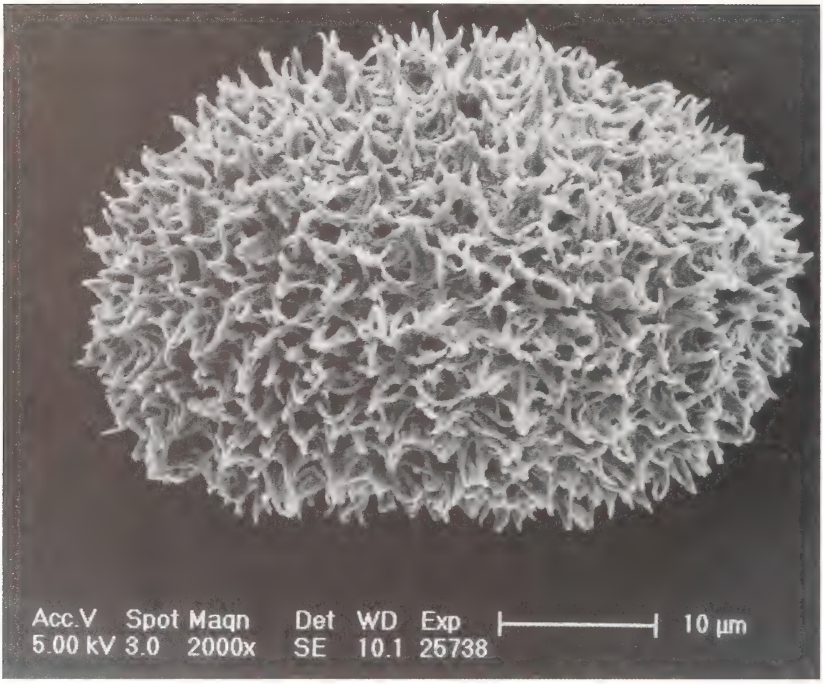


FIGURE 2A. *Cystopteris diaphana*. Bagaçinha, Terceira, Azores (*AMP98/31*).

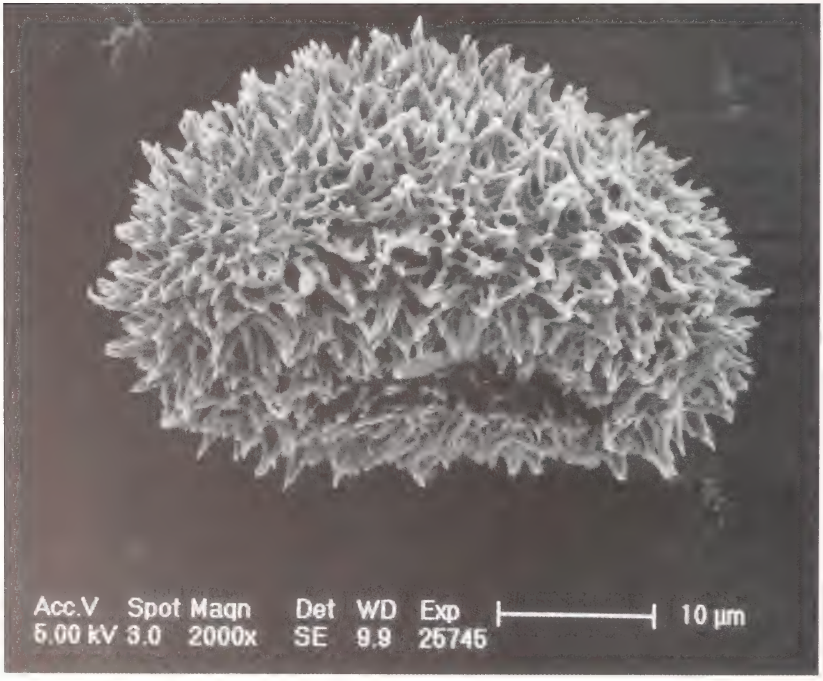


FIGURE 2B. *C. diaphana*. Polbrock Bridge, Cornwall. (*FJR 03-09-01*)

FIGURE 2. Perispore ornamentation showing typical spiny-lacunar (*C. diaphana*) as opposed to spiny (*C. fragilis*) morphology.
All specimens **BM**

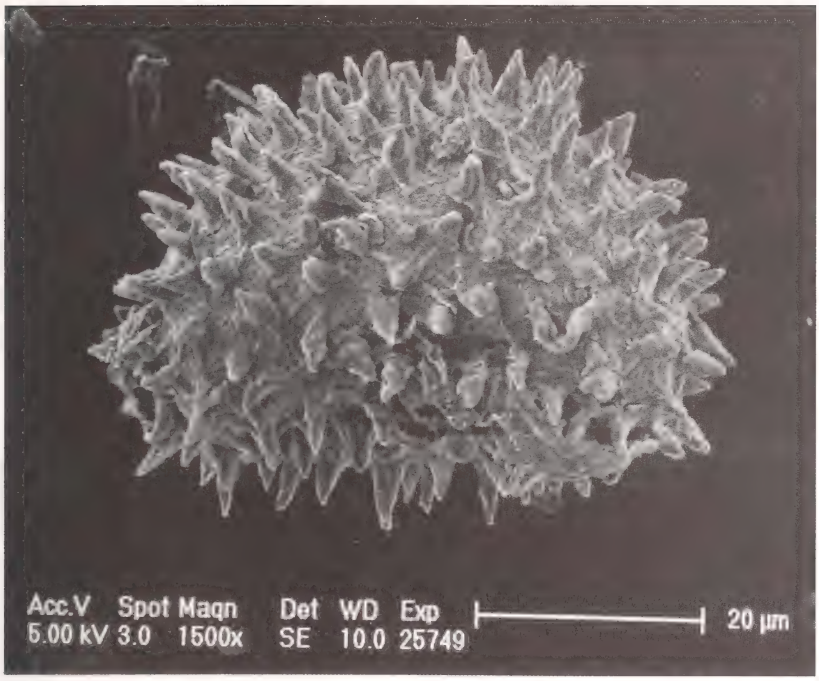


FIGURE 2C. *C. fragilis*. v.c. 64. ex herb. W. C. Barton, s.n.

In addition to the pinnule venation, *C. diaphana* can best be discriminated from the frequent and variable *C. fragilis* by examination of the ornamentation of the perispore. Both taxa have spores which appear spiny under lower magnification but, as Pearman (1976) demonstrated using electron microscopy, the spines of *C. diaphana* are composite structures made up of slender, often haphazardly arrayed units, more densely arranged than the simple stout spines of *C. fragilis* (Fig. 2). Under the light microscope the effect is such that for *C. diaphana* each "spine" appears broader at its base than the distance to the adjacent spines and the spore is more densely spinose in appearance than that of *C. fragilis*. Density and shape of the spination is, however, somewhat variable. To what extent the differences in the spiny-lacunar spore types might reflect a difference in ploidy is uncertain, Jermy & Harper (1971) having reported an increase in spine density with increasing ploidy in *C. fragilis*.

As with other species complexes within the genus *Cystopteris*, *C. diaphana* has been reported to exist at several ploidy levels, from diploid (n = 42), tetraploid (n = 84), to hexaploid (n = 126). All counts of material from Macaronesia and the European mainland to date are hexaploid (Dostál, 1984). The ploidy level of Cornish material has yet to be determined, but on spore size it appears highly likely that our material is also hexaploid.

KEY TO BRITISH *CYSTOPTERIS* SPECIES.

1 Fronds triangular, arising singly from long creeping rhizome ..... *C. montana*
1 Fronds ovate-lanceolate to lanceolate, tufted from erect to shortly creeping rhizome 2
2 Spores echinate* 3
2 Spores rugose ..... *C. dickieana*
3 ±All veins ending in apices of pinnule teeth ..... *C. fragilis*
3 Most, or all, veins ending in notches between teeth apices 4
4 Fronds deciduous, with narrow ± parallel-sided pinnules (at least below) ..... *C. alpina*
4 Fronds wintergreen, pinnules not parallel-sided ..... *C. diaphana*

* Be careful to look at mature spores. Immature spores and abortive spores from intra- and interspecific hybrids may lack characteristic surface features.

ECOLOGY OF *CYSTOPTERIS DIAPHANA*

In its first detected Cornish site the species exists as an often dense population extending almost continuously for over 700 m along the vertical, deeply-shaded, north-to east-facing banks of the River Camel, close to Polbrock Bridge (SX06). The fern extends downstream as far as the upper limit of tidal influence. A few small, scattered patches occur on the west-facing bank of the river where suitably sheltered and shaded. Some small plants also occur in damp rocky recesses on a steep woodland bank above an adjoining path up-slope of the main riverbank population. It is most likely that the small, scattered individuals on this bank, which are the most obvious to the casual visitor, derive from spores blown from the main riverbank population less than 20 m distant. The associated species are for the most part unremarkable; the most interesting, certainly from a phytogeographic viewpoint, is *Trichomanes speciosum*, which occurs in an old adit close to Polbrock Bridge, around which small plants of the *Cystopteris* are found.

The near-vertical soil and gritstone riverbanks are from c. 1·5 to 3 m tall and are shaded by a dense canopy of deciduous trees, including *Acer pseudoplatanus* L., *Alnus glutinosa* (L.) Gaertn. and *Corylus avellana* L. with a sparse understorey of scrub and herbaceous vegetation, some of which, e.g. *Hedera helix* L. subsp. *hibernica* (G. Kirchn.) D. C. McClint. and *Rubus fruticosus* L. agg., hang down over the vertical bank face. The banks themselves are largely dominated by cryptogamic species, including *Athyrium filix-femina* (L.) Roth and a range of common woodland and aquatic bryophytes, including locally extensive mats of the thallose hepatics *Conocephalum conicum* (L.) Dumort. and *Lunularia cruciata*. (L.) Dumort. ex Lindb. Herbaceous species on the bank include *Oenanthe crocata* L. and the established alien *Tolmeia menziesii* (Pursh.) Torr. & A. Gray. The *Cystopteris* forms an at times dense stand over much of the height of the bank but is sparser in the lowest third, i.e. nearest the water level, where small juvenile plants predominate. Presumably the river flow more actively dislodges plants and substratum at this level. Each individual plant produces few fronds at any one time, often only one or two, and these may be produced throughout the year from an upright, very shortly creeping rhizome. Fronds over-winter, unlike the other British species of *Cystopteris*. Most fronds are fertile to some degree once plants reach a certain size. The vast majority of spores are released from late summer through to early winter.

The presence of a fine silt encrusting the majority of the older fronds would indicate that water levels fluctuate quite markedly during the year and that the plants are forced to cope with these fluctuations and the damage to the banks that ensues. The riverbank is obviously an unstable and dynamic system but the *Cystopteris* produces copious spores and recruitment of new sporophytes is very apparent throughout the site.

At Penjerrick the species is present at the base of a Cornish hedgebank at the lowest level of a lane which bisects this impressive garden, created in the 19th Century. The area is shaded, sheltered and kept humid by a nearby flush that becomes a small stream on the other side of the hedgebank. Here it is associated with many of the same common bryophytes present by the River Camel but also with the established alien *Selaginella kraussiana* (Kunze) A. Braun, with which it naturally co-occurs in the western Azores. A *Cystopteris* species is known to occur as a garden plant in a nearby grotto section of the garden but its specific identity has yet to be determined.

The Devon locality is on the vertical wall of a steep cutting of the now disused railway line in Tavistock, which is very damp and heavily shaded. The railway runs adjacent to and crosses the River Tavy nearby.

Throughout its European and Macaronesian range characteristic habitats of *C. diaphana* are sheltered, with deep shade and high humidity, often by running water. In the westernmost Azores it may be found widely on damp rock faces and is often frequent in deep roadside drainage culverts. Farther eastwards in the archipelago it becomes scarcer as general humidity and precipitation levels fall. On Faial, in the central Azores, Schäfer (2001) reported it as "rare in crevices of wet rocks in very shady ravines, usually above 600 m altitude; restricted to the most humid habitats of the island", whereas on Sao Miguel in the drier eastern group Wilmanns & Rasbach (1973) concluded it was "one of the most hygrophilous of ferns", finding it in fissures of lava rock in gorges with dripping water.

In the Canary Islands the species is often associated with *Trichomanes speciosum* on damp shaded streamside rocks in deep gulleys under evergreen forest. The few remaining sites in the French Pyrenees (Valon du Laxia, Vallée du Bastan) have also long been noted for the presence of *Trichomanes speciosum*, *Dumortiera hirsuta*, etc. (Jovet 1933). Little information exists as to the precise habitat and associates of *C. diaphana* in the many sites reported in western Iberia, or those from North Africa and Corsica.

DISCUSSION

The British localities are by some distance the most northerly world occurrence of this species, but we suggest that this distribution is not so unremarkable as to rule out a native status. Furthermore, historical records in central France do narrow the current gap. Several frequent cryptogamic associates of *C. diaphana* in Macaronesia and the Iberian peninsula, many of them bryophytes, show similar distributions, with scattered northernmost localities in the South-west of Britain, or rarely further north up the climatically ameliorated Atlantic coast, eg. *Fissidens serrulatus* Brid., *F. polyphyllus* Wilson ex B., S & G., *Dumortiera hirsuta* (Sw.) Nees and the fern *Trichomanes speciosum*.

Against this scenario must be put the knowledge that this fern was in cultivation in Britain by the mid 19th century, although probably not widely grown. Spores from these plants rather than longer distance spore dispersal from native sites elsewhere in Europe could be responsible for the apparently native R. Camel population. Germane to this is the second site for the species, which came to light as a result of the checking of herbarium material from other south-western sites. Material from this Penjerrick site Fraser-Jenkins (*in litt.*) felt differed somewhat from that by the River Camel and he considered was possibly the form cultivated in Victorian times as "sempervirens". It seems most likely that both *Cystopteris* species are escapes from cultivation at the Penjerrick site but we cannot rule out the possibility that *C. diaphana* was naturally present in the area, as much suitable habitat exists. The Devon station is also in an artificial habitat but suitable natural sites (not yet extensively searched) and a major river are adjacent to the site. The association of the plant here with a disused railway line and the proximity of the Polbrock Bridge site to another disused line (now the Camel trail) pose additional questions as to modes of dispersal and status. Plants of the genus *Cystopteris* have however been present in, or close to, the present Tavistock site since at least as far back as 1934 (Keble Martin & Fraser 1939).

Is there compelling evidence that this species has historically been present in the British Isles, thus raising the probability of its native status? All past records of *C. fragilis* from Cornwall need to be reconsidered and must be treated with a degree of doubt. Strongly calcareous rocks are absent from the county and the records, where habitats are stated, appear not to be on walls where they might benefit from mortar, but on damp rocks. The majority of the historic records are from squares adjacent to the Polbrock Bridge *C. diaphana* site (Crackrattle Moor, Denzell downs SW86, Bosnieves SW96, Davey 1909), from elsewhere on the R. Camel (SX18, Margetts & David 1981), or by rivers in damp sheltered coastal valleys e.g. by the Tamar at Landulph (Thurston 1935) and those of the Tintagel area (SX08, Margetts & David 1981). These valleys are known to support other Macaronesian/Atlantic species, e.g. *Trichomanes speciosum* Willd. and *Dumortiera hirsuta* (Sw.) Nees. The location and examination of voucher specimens for these records is clearly desirable.

Similarly, in Devon, old records may require close scrutiny, as again many are by rivers, e.g. the Exe, Taw, Bray, Tavy and Plym and in damp, sheltered, non-calcareous areas. Interestingly, as long ago as the 1850s, it is possible that this species had been detected but even then its status was questioned. Keys (1871), citing the Rev. T. F. Ravenshaw, stated "*C. viridis*, a foreign species, hitherto unrecorded as British, was found a few years since near Ilfracombe, by Rev. J. M. Chanter, who has plants of it now in his garden. He sent specimens to Mr. Moore, who named it. The station no longer exists, someone having removed the whole of the plants." The record is repeated almost verbatim in Ravenshaw (1877). Thomas Fitzarthur Ravenshaw was curate of Ilfracombe where John Chanter was vicar. Chanter's wife Charlotte, the sister of the author Charles Kingsley, was obviously interested in pteridophytes, publishing a small work called Ferny

Coombes (Chanter 1856). Moore (1860) under *sempervirens* states "reputed to have been found both in Devonshire and Kent....There are some doubts as to the English origin of this plant.... 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."

Climatically the other region in which the species might be expected to occur but from which it is currently unreported is the south and west of Ireland. Scully (1916) regarded *C. fragilis* as rather common on damp cliffs in the mountains of Co. Kerry but also as very rare at low levels on lowland walls and rocks. It is these latter cases which are more likely to represent *C. diaphana*. Any *Cystopteris* found growing at low altitudes and particularly those in river bank habitats should be critically examined.

CONCLUSIONS

On balance we see no reason why *C. diaphana* should not be a British native but we cannot disprove the possibility that it is an escape from cultivation. The case for its native status would be greatly strengthened by examination of supporting specimens from the 19th century if they could be found.

Further search of river systems and sheltered glens in the south-west of England (and Ireland) may yet reveal the species to be more widespread.

Many ferns have suffered in the past from collection. The species is currently restricted as a probable native to one easily accessible linear population and so the conservation implications for this species must be considered. Application of the I.U.C.N. threat categories and selection criteria (I.U.C.N. 1994) suggests that on the basis of the very restricted British range (criterion D_2) this species, like *C. dickieana,* should be considered Vulnerable (VU) and would qualify for inclusion in the British Red Data listing when next revised. *Cystopteris diaphana* is present in such quantity and reproducing so freely that, if visitors to the site behave responsibly, we feel it is unlikely to be threatened by anything other than major changes to the area. The greatest risk to its continuing survival would undoubtedly be if the woodland fringing the river in this section were opened by felling. It is also highly vulnerable to any major pollution event occurring upstream. To guard against such catastrophic loss, spore gatherings should be made and the plant thus introduced to botanic gardens and the horticultural community for *ex situ* conservation.

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Sexual reproduction in British populations of *Adoxa moschatellina* L.

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ABSTRACT

Adoxa moschatellina L. is a small perennial herb found mainly in damp woodlands. Little is known about the ecology and biology of this species. The aim of this investigation was to examine seed production and the factors that influence seed set in natural populations in Worcestershire and Shropshire. Phenological studies in this species suggest the possibility of limited protogyny. Self-pollination within an inflorescence is likely, due to the overlap in anther maturation within the several flowers in an inflorescence, coupled with the foraging behaviour of the pollinators. This species is apparently adapted for pollination by small flying insects, mainly Diptera; caddis flies and moths also appear to be acting as pollinators. Potential seed set was less than 10% of that possible. Very few (about 20%) inflorescences survived to fruit. This loss of reproductive potential can be explained in terms of herbivore activity and pathogens. Of the inflorescences that did survive until mid–late June, very few (10%) produced seed. This may be due to a sporophytic and/or late acting self-incompatibility mechanism. Pollen viability (68%) does not appear to be a limiting factor.

KEYWORDS: phenology, pollination, self-incompatibility, pathogens, herbivores.

INTRODUCTION

Adoxa moschatellina was thought to be the only member of the family Adoxaceae until the early 1980s when two rare new species were recorded in China (Hara 1981; Wu 1981; Wu *et al.* 1981). Another new species from the Amur region of Russia was described in 1984 (Nepomnyashchaya 1984). The family is now thought to consist of three genera (*Tetradoxa*, *Sinadoxa* and *Adoxa*) and the *Adoxa* genus comprises two species, *A. moschatellina* and *A. orientalis* (Jianquan *et al.* 1999).

A. moschatellina has a circumpolar distribution and is present in the north-temperate zone to 2400 m (Blamey & Grey Wilson 1989). In the U.K. it is found predominantly in deciduous woodlands. Rodwell (1991) records *A. moschatellina* in woodlands with oak-hazel (W8), ash (W9) and birch-juniper (W19) communities. It is also found in other shaded habitats e.g. in the U.S. it has been recorded in coniferous woodland, on shady north-facing sandstone slopes, limestone buffs and talus slopes (Cochrane & Salamun 1974). It has been identified as an indicator of ancient woodland but is also known to become established in secondary woodlands (Brunet & von Oheimb 1998; Honnay *et al.* 1998; Bossuyt *et al.* 1999; Hill 2004). Although widespread this is a rare and protected species across most of its range (e.g. Cochrane & Salamun 1994, Envfor 2003, Northfield 2003, Ulster museum 2003). In the U.K. it is found in the south, West Midlands, Wales and as far north as the Caithness. (Preston *et al.* 2002). It is only locally frequent to scarce throughout its U.K. range (Rodwell, 1991).

Adoxa moschatellina L. (moschatel, muskroot, townhall clock) is a small (5–15 cm), delicate, hairless perennial with white musk-scented rhizomes and stolons. The above-ground parts of the plant grow in spring from the swollen scales on the rhizomes. The basal leaves have relatively long petioles and the leaves are ternately compound with deeply toothed, ovate/obovate leaflets. The cauline leaves occur as a pair on slightly shorter petioles and tend to be smaller and less deeply toothed than the basal leaves. An inflorescence arises from the axil between the cauline leaves and is usually composed of five (2–6) hermaphrodite flowers. The flowers are arranged as five sides of a cube, reminiscent in shape to a townhall clock.

The top flower is usually tetramous with four styles and four divided anthers, each part having its own anther sac. The side flowers usually have 5–6 styles and 5–6 anthers (10–12 anther sacs). The flowers are small, simple and bowl shaped. About 20–30 multicellular hairs form a cushion-like nectary at the base of the upper side of each corolla lobe. When fruiting, the gynoecia of adjoining flowers combine to form a small drupe-like fruit. The seeds have an oily endosperm and a small embryo (Cochrane & Salamun 1974; Erbar 1994).

The production of seeds is the result of a complex series of processes that are influenced by environmental and genetic factors. The structure of the inflorescence, the viability of pollen, the effectiveness and type of pollinator and the nature of the breeding system all impact on seed production (e.g. Proctor, Yeo & Lack 1996). The aim of this investigation is to examine the seed production of *Adoxa moschatellina* and the factors that influence seed set.

STUDY SITES

Populations of *Adoxa moschatellina* were studied in 1995 and 2002 at three sites in Worcestershire and Shropshire, U.K.: Knapp and Papermill (KP) (1995 only) (SO755515), Shrawley Wood (SW) (SO655807) and Bensons Brook (BB) (SO580771). The Knapp and Papermill site is floristically diverse and includes meadows, a stream, orchard and woodland: *A. moschatellina* was present alongside a footpath between the stream and meadows. Shrawley Wood is dominated by *Tilia cordata* with the floristic community typical of a W8 woodland (Rodwell 1991). The population at Bensons Brook is found within a small area of oak-ash W8-type woodland (Rodwell 1991) which encompasses the brook. *A. moschatellina* has a dispersed distribution at each of these sites and these separate clumps have been indicated as BB1, BB2 etc.

METHODS

FLOWERING PHENOLOGY

Three 0·25 m^2 quadrats were placed at random in late January 2002 at BB7 and the flowering phenology (growth of leaves, initiation and development of the inflorescence, floral maturation, duration of flowering, fruit production, causes of loss of plant material) of the 38 ramets within these quadrats was observed every three days until die back in June. Supporting notes were also recorded at BB, KP and SW in 1995. Eight plants were set aside for observation in the breeding system study in 2002 (below). These inflorescences were observed every four hours during the day for a three week period (mid March–early April). During this period the inflorescences completed the flowering process.

INFLORESCENCE AND SEED PRODUCTION

A. SW AND BB 1995

On 16 May 1995 BB2 was surveyed and, for all plants with above ground parts, the numbers of inflorescences and fruits were recorded. A further three clumps in SW (SW1, SW2 and SW3) were examined on 8 June 1995. Observations at the sites indicated that all inflorescences had matured beyond flowering. Fruits from BB2, SW1 and SW3 were collected and dissected to establish the level of seed set. To reduce the impact of the research on SW no fruits were taken from SW2. The relative numbers of inflorescences present at the BB and SW sites were compared using chi-squared tests (Fowler & Cohen 1990).

B. BB 2002

During the study of flowering phenology at BB7 (above) the numbers of inflorescences and fruits produced were also recorded every three days between January and June.

POLLEN VIABILITY

The pollen viability was estimated at five locations (BB1, BB2, KP1, KP2 and SW1) in March 1995. To ensure that different genets were examined the sampling was systematic and one mature anther was removed from a single inflorescence no closer than 1 m between plants. The pollen from each anther was mounted immediately on a microscope slide in Alexander's stain (Alexander

1969) and stored at 4°C on return from the field. The % viability, as indicated by pink staining, was recorded within 3–48 hours of sampling. The difference between the populations was examined using the Kruskal-Wallis test (Fowler & Cohen 1990).

POLLINATORS

DAY-FLYING POLLINATORS

A limited survey of all insects landing on *Adoxa moschatellina* at BB7 was carried out for a two hour period on a bright cool day on 16 April 2002. These pollinators and the inflorescences on which they had alighted were collected.

NIGHT-FLYING POLLINATORS

A Heath type light trap was set for a single, relatively warm night on 12 April 2002 within population BB7. In the morning all insects within the trap were removed and identified. Parts from each specimen were examined under a light microscope (× 400) for the presence of *A. moschatellina* pollen. A reference collection of pollen was prepared from the eight species (insect and wind pollinated) that were flowering at that time in the vicinity. The pollen from each species was mounted on a slide, in the field, in Alexander's stain and stored subsequently at 4°C. The reference collection was used both to positively identify *A. moschatellina* pollen and to exclude other species. The presence of a locally very rare moth in this first sample precluded further work.

BREEDING SYSTEM

A systematic sample of flowering *A. moschatellina* was collected from the BB population in March 2002. Plants sampled were at least 3 m apart. The original soil was supplemented by John Innes No. 1 and the plants were grown in seed trays outside in a shaded cold frame. The plants received no additional watering.

As inflorescences developed they were assigned at random to one of two categories – experimental or observation. The phenological details of the second group of inflorescences were recorded. These plants had a minimum of handling.

In the experimental group each inflorescence was covered in a cellophane pollen bag and assigned at random to one of four treatments: apomixis, cross-pollination, self-pollination or control. In the 'apomixis' and cross-pollination treatments all anthers were carefully removed from the flowers whilst immature. To test for apomixis in this species, the 'apomixis' inflorescences were then left. Pollen from one other genet was applied to each flower in the cross-pollinated inflorescences. In the self-pollinated inflorescence pollen from a mature anther within the inflorescence was transferred. In the cross-pollination and self-pollination treatments, as it was not possible to know when the stigmas were receptive, each flower was examined twice a week and pollen applied to the stigma from the time that the petals opened until when the petals began to curl back again. The control inflorescences once bagged were not handled again. Comparisons were made between the numbers of inflorescences producing seed in self- and cross-pollinated inflorescences (χ^2 test); the numbers of mature ovaries per inflorescence (Mann Whitney U test) and the number of seeds per mature ovary (z test) (Fowler & Cohen 1990).

RESULTS

PHENOLOGY

In this study the aerial parts were present from late January until mid-June. By mid-February a small compact inflorescence was produced in the axil between two leaves. The peduncle supporting the inflorescence extended to an average length of 22 mm by mid March. Normally the flower at the top of the cube-shaped inflorescence opened first (mid-March), followed an average of 2 days later (range 2–5 days) by one pair of flowers on opposite sides to each other. These were followed, on average, 4 days later (range 4–6 days) by the other opposite pair of flowers.

When the petals on the flowers first opened they were green and the style showed no further structural change once the petals opened. In the top flower all the petals opened together. The anthers started to dehisce on average 2·5 days (range 2–7 days) after the petals first opened and at this time a small volume of free nectar was seen at the base of the petals. On the side flowers the top petals opened first and the anthers matured in a similar order after 3 days (range 4–6 days).

The petals turned yellow after about 2 weeks and after a further 2·5 weeks (range 2–3 weeks) they became papery and closed back over the ovaries. At the same time (early–mid April) the petiole corkscrewed down to the ground. This process did not involve any further growth and occurred irrespective of fertilisation success. Fruits were also seen to develop and swell at this stage.

There was some variation in flowering phenology within a population and some plants flowered as late as May. The rhizomes and stolons were also observed to grow extensively during mid-May. By mid-June no plant remains were visible above ground.

INFLORESCENCE AND SEED PRODUCTION

INFLORESCENCES

In the natural populations of SW and BB in May 1995 the rhizomes produced between 670–1357 ramets but very few of these produced an inflorescence (range 1·2%–10·8%) (Table 1). This figure is likely to be a minimum since some inflorescences will have died back earlier in the growing season. The relative numbers of inflorescences produced varied significantly from one population to another (χ^2 = 111·1, p<0·001) (Table 1), with those plants growing in the *Tilia cordata* W8 woodland (SW) producing fewer inflorescences than those in the oak-ash W8 woodland at BB. Of the inflorescences present at SW and BB, signs of grazing, presumably by molluscs, were recorded on a considerable number of inflorescences (Table 1). This was more prevalent in SW than in BB (χ^2= 81·8, p<0·001).

TABLE 1. INFLORESCENCE PRODUCTION IN *ADOXA MOSCHATELLINA* AT SHRAWLEY WOOD (SW) AND BENSONS BROOK (BB2) IN MAY 1995

	Populations			
	SW1	SW2	SW3	BB2
Total no. ramets	670	1215	131	1357
No. ramets/m^2 in the population	26·25	13·75	5·0	18·25
Total no. inflorescences	8	35	3	146
Inflorescences per plant (%)	1·2	2·9	2·3	10·8
Evidence of grazing (%)	25	69	100	6

At BB7 from April–June 2002 the total number of inflorescences declined from 55 to only 11 (20% survival) (Table 2). Throughout this period up to 47% of inflorescences (average 19%) were seen to have been removed by grazing leaving only the peduncle. A further 22% of inflorescences were infected by *Puccinia* spp. (smut fungi) which led to early die back.

FRUITING.

Each fruit usually comprises five ovaries. Each ovary is partitioned into 3–5 locules and one ovum is present per locule. In the apparently fruiting inflorescences, which were collected from BB2, SW1 and SW3 in 1995 (Table 3), it was evident that the ovaries fell into one of three states: 'immature'; 'intermediate' and 'mature'. The 'mature' ovaries were swollen and translucent, apparently fully developed at 4–7 mm in diameter. Only 6% of all ovaries were 'mature'. The 'immature' ovaries were small (1–2 mm), dark green and showed no sign of development following flowering and no seeds. The 'intermediate' ovaries appear to have initiated development of the fruit but there was an air space within the locule in place of a seed. This form was either deep green or crystalline in appearance and did not develop further than 2–4 mm in diameter. That there appear to be three distinct morphological states was confirmed in observations at BB7 and in crosses in 2002 (Tables 2 and 6). Those inflorescences with ovaries in an 'immature' or 'intermediate' state never developed into a 'mature' state and since there are usually five ovaries in each drupe these different states were sometimes observed in combination (Table 3).

SEED PRODUCTION

Of the 161 inflorescences examined at BB2, SW1 and SW3 (1995) only 16 (10%) had any seeds and only two of these fruits had seeds in all the ovaries (Table 3). The remaining 14 fruits had seeds in one to four ovaries (2·6 $\pm$ 0·2). Only ovaries containing seeds had the 'mature' appearance. In these 'mature' ovaries average seed set was just over half (3·2 $\pm$ 0·2) compared to the usual maximum of five seeds.

TABLE 2. INFLORESCENCE AND FRUIT DEVELOPMENT IN *ADOXA MOSCHATELLINA*, APRIL TO JUNE 2002, AT BENSONS BROOK (BB7).

Date	29.4.02			8.5.02		
Quadrat	A	B	C	A	B	C
% grazed (Petiole only remaining)	20	47	0	23	40	0
% infected by *Puccinia adoxa*	15	12	17	8	13	0
% infected by *Puccinia albescens*	0	0	0	8	0	0
% In flower	65	41	78	38	40	50
% Fruiting ('Intermediate'/'Immature')	0	0	0	15	0	0
% Fruiting ('Mature'/'Immature')	0	0	1	8	7	50
Total no. inflorescences	20	17	18	13	15	14
Date	21.5.02			12.6.02		
Quadrat	A	B	C	A	B	C
% grazed (Petiole only remaining)	40	0	0	25	0	33
% infected by *Puccinia adoxa*	0	0	0	0	0	0
% infected by *Puccinia albescens*	0	0	0	0	0	0
% In flower	0	25	25	0	0	0
% Fruiting ('Intermediate'/'Immature')	27	50	25	0	75	0
% Fruiting ('Mature'/'Immature')	33	25	50	75	25	64
Total no. inflorescences	15	4	8	4	4	3

'In flower' indicates an inflorescence where the flowers are open and nectar evident.
The terms 'intermediate', 'immature' and 'mature' describe the appearance of the ovaries (see text).

TABLE 3. APPEARANCE OF OVARIES OF *ADOXA MOSCHATELLINA* AT BENSONS BROOK (BB2) AND SHRAWLEY WOOD (SW1 AND SW3) 1995

Population		Immature only	Intermediate only	Mature only	Immature + Intermediate	Immature + Mature	Intermediate + Mature	Total
BB2	Inflorescence development	6	29	2	87	11	0	134
BB2	No. seeds in each fruiting ovary ($\bar{x} \pm$ SE)	0	0	2·8 ± 0·6	0	3·5 ± 0·3	-	
SW1	Inflorescence development	2	0	0	0	5	0	7
SW1	No. seeds in each fruiting ovary ($\bar{x} \pm$ SE)	0	-	-	-	2·3 ± 0·5	-	
SW3	Inflorescence development	0	0	0	0	2	0	2
SW3	No. seeds in each fruiting ovary ($\bar{x} \pm$ SE)	-	-	-	-	3·3 ± 0·4	-	
Totals	Inflorescence development	8	29	2	87	18	0	161

The number of fruits dissected (Table 3) is not equal to the number recorded (Table 2) since grazing had reduced some inflorescences to only a peduncle.

POLLEN VIABILITY

Pollen viability at the five populations was found to be very variable (range 28–100%) (Table 4). However no significant difference was observed between the populations ($K = 2{\cdot}45$, $p>0{\cdot}05$). The average across all populations was 68%.

TABLE 4. % POLLEN VIABILITY IN ANTHERS FROM *ADOXA MOSCHATELLINA*, AT 5 POPULATIONS, MARCH 1995

	Populations				
	KP1	KP2	BB1	BB2	SW1
No. anthers	22	6	22	24	17
Average viability (%)	65	67	65	68	73
Range (%)	30–100	56–86	28–94	28–98	92–48

POLLINATION

DAY-FLYING POLLINATORS

Five of the seven species observed apparently acting as day-time pollinators were Diptera (Table 5). The most frequently observed species were the caddis fly *Stenophylax permistus* (30%) and the flesh fly *Scathophaga stercoraria* (20%). All the insects observed showed foraging behaviour, moving around a flower and then from one flower to its neighbour within the inflorescence. The inflorescences visited by these probable pollinators were in mid to late flowering with three to five of the five flowers in each inflorescence open with mature anthers. Pollen was present on the stigmas of these flowers.

TABLE 5. APPARENT POLLINATORS OF *ADOXA MOSCHATELLINA* AT BENSONS BROOK (BB7) IN APRIL 2002

Day (D) Night (N)	Order	Family	Species	Male (M) Female (F) Unknown (U)	Frequency of observation
D	Coleoptera	Nitidulidae	*Meligethes viridescens*	U	1
D	Trichoptera	Limnophilinae	*Stenophylax permistus*	M	3
D	Diptera	Mycetophilidae	*Cordyla crassicornis* Meigon	M	1
D	Diptera	Chironomidae	*Diamesa tonsa* (Haliday = *culicoides* Heegar).	F	1
D	Diptera	Mycetophilidae	*Exechia* sp.	F	1
D	Diptera	Scathophagidae	*Scathophaga stercoraria*	F	2
D	Diptera	Psychodidae	sp.	U	1
N	Trichoptera	Limnophilinae	*Stenophylax permistus*.	U	2
N	Lepidoptera	Noctuidae	*Orthosia gothica* L.	U	33
N	Lepidoptera	Noctuidae	*Orthosia incerta* Hufnagel	U	5
N	Lepidoptera	Noctuidae	*Orthosia munda* Denis & Schiffermuller	U	1
N	Lepidoptera	Noctuidae	*Orthosia cerasi* Fabricius	U	1
N	Lepidoptera	Noctuidae	*Lithophane hepatica* Clerck.	U	1

NIGHT-FLYING POLLINATORS

Five of the species found with *A. moschatellina* pollen adhering to their antenna or on leg hairs were Lepidoptera (moths) and of these *Orthosia gothica,* Hebrew character, was the most abundant in the light trap (Table 5). One species *Selenia tetralunaria,* purple thorn, was not found to be carrying any *A. moschatellina* pollen. Another species found to be carrying *A. moschatellina* pollen was again the caddis fly *Stenophylax permistus.*

BREEDING SYSTEM

In total, 101 inflorescences were bagged. However a third of these died or became infected with *Puccinia adoxa* and/or *P. albescens* and were excluded from the experiment. The remaining 63 inflorescences were assigned at random to one of four treatments. The control and 'apomixis' group of inflorescences set no seeds and remained 'immature' in appearance (Table 6). In the cross-pollinated group all but one set seed and in each inflorescence most, and usually all, ovaries did so. These fruits developed the swollen translucent appearance of the 'mature' ovaries seen in the natural populations. By contrast the inflorescences that were self-pollinated showed a very highly significant reduction in the numbers setting seed (5/30) compared to the cross pollinated plants (23/24) (χ^2= 34·9, p<0·001). The numbers of mature ovaries in these inflorescences was also significantly lower in the self-pollinated inflorescences (2 ± 0·5) compared to the cross-pollinated plants (4 ± 0·2) (U = 9, p = 0·05). The numbers of seeds produced per fruiting ovary in the self-pollinated group was 1·3 ± 0·5 compared to 3·5 ± 1·0 in the cross-pollinated group, again a very highly significant difference (z = 12·7, p<0·001). Interestingly, the self-pollinated ovaries took on one of two morphological forms. Those ovaries containing seed became swollen and translucent whilst the majority of those without seed took on an 'intermediate' form.

TABLE 6. FRUIT AND SEED PRODUCTION IN EXPERIMENTAL CROSSES OF *A. MOSCHATELLINA*, 2002

Treatment	No. inflorescences	No. inflorescences with at least one mature ovary	No. 'mature' ovaries in these* inflorescences ($\bar{x}$ ± SE).	No. seed in fruiting ovaries ($\bar{x}$ ± SE).
Control	3	0	-	-
Apomixis test	6	0	-	-
Self-pollination	30	5*	2·0 ± 0·5	1·0 ± 0·1
Cross-pollination	24	23*	4·0 ± 0·2	3·5 ± 0·1

DISCUSSION

The development of *A. moschatellina* in the field is in accord with that described in part by, for example, Fukuoka (1974) and Nepomnyashchaya (1984). The sequence of flower maturation reflects that seen in the embryo. Studies of early buds using a scanning electron microscope have shown that the top flowers develop first and the lateral flowers show 'top down' development (Erbar 1994; Roels & Smets 1994). The detailed observations of flowering phenology in this study would indicate the possibility of limited protogyny since the style showed no further structural change when the petals opened yet the anthers did not dehisce until several days later. Nectar was not usually evident until the anthers dehisced, however, so pollinators may not be attracted until this stage. The overlap of flowering times between the top flower and the two, staged openings of opposite pairs of flowers means that a high level of self-fertilisation is possible, the top flower being in anthesis when the side flowers first open and the first opposite pairs of flowers shed pollen when the second opposite pair of flowers opens.

In this study *A. moschatellina* has been observed to have a low level of seed set in natural populations. Very few inflorescences survived to fruit. In BB7 (2002) only 6% to 15% of inflorescences remained at the end of the flowering period. This loss of reproductive potential can be explained to some extent in terms of herbivore activity and pathogens (Tables 2, 3). Of the inflorescences that did survive until mid–late June very few (10%) produced seed. This low seed set cannot be accounted for in terms of pollen viability where the consistent average across four populations was 68% viability.

A. moschatellina is found in damp shady places and has relatively small flowers and inflorescences with freely exposed nectar and short stamens. As such it would appear to be adapted for pollination by small flying insects. Of the trn day-time visitors collected at BB7 six were small Diptera (Table 5). *A. moschatellina* is known to be entomophilous with records for

visits by Mycetophilidae (fungus gnats), Cecidomyiidae (gall midges), Simuliidae (black flies), and Chironomidae (non-biting midges) (Proctor & Yeo 1973). Flowers pollinated predominantly by Diptera usually smell aminoid and *A. moschatellina* does have a musky scent rather than the 'flowery' scent typical of plants pollinated by Lepidoptera or Hymenoptera. The flowers also have green to pale yellow petals, which is a common feature of fly-pollinated flowers (Proctor, Yeo & Lack 1996).

This species is clearly a source of resources for a number of diverse organisms since, as well as the Diptera, the plants were seen to be visited both during the day and night by the caddis fly *(Stenophylax permistus)* and during the day by a beetle (*Meligethes viridescens)* (Table 5). The presence of *S. permistus* is presumably restricted to habitats with proximity to water such as BB. *M. viridescens* is a common pollen beetle and may be an agent for pollination. *A. moschatellina* has also been recorded as being visited by small chalcid wasps and ichneumon wasps (Hymenoptera) (Proctor & Yeo 1973).

One surprising result was the presence of *A. moschatellina* pollen caught within the hairs on the antennae and legs of a number of moths (Table 5). Moths, like most Lepidoptera, tend to have a long slender proboscis which is adapted for reaching nectar at the base of narrowly tubular flowers, though it can be used for sucking up exposed liquids (Proctor, Yeo & Lack 1996). The flat bowl of an *A. moschatellina* flower may therefore provide an accessible source of nectar for these species.

Given the limitations of the survey of day-time apparent pollinators it is likely that the number of species visiting this plant is higher than ten. In this study it is also not possible to assess the effectiveness of these flower visitors as pollinators of *A. moschatellina*.

In the study of the breeding system 14·5% of the inflorescences initially bagged became infected with one of the *Puccinia* species. This is comparable to the levels of infection found within the natural populations (Table 2). Experimental crosses indicate that *A. moschatellina* is not apomictic and has reduced seed set when self-pollinated. Seed set is reduced significantly both in terms of the numbers of ovaries producing seed and the numbers of seed these ovaries produced (Table 6). This could be the result of inbreeding depression although such low numbers of seed set per ovary is thought to indicate partial self-incompatibility (Weller *et al.* 1995). Self-incompatibility of this type is usually either sporophytic or gametophytic and determined by S alleles at several genes. Although it is not known which system determines the incompatibility reaction of *A. moschatellina,* a review of self-incompatible species indicated that one key characteristic of plants with sporophytic incompatibility systems is that they have tricellular pollen unlike plants with gametophytic incompatibility systems which have bicellular pollen (Dafni 1992). Since *A. moschatellina* has tricellular pollen (Donoghue 1985), it is possible that this species has a sporophytic incompatibility system.

Three morphological forms of fruit have been observed in this species. The 'immature' form appears to be the result of 'no pollination' (Table 6). The 'mature' and 'intermediate' forms appear to be associated with pollination. Given the proposal that a self-incompatibility mechanism exists in this plant it is tempting to suggest that these latter forms in some way relate to the level of compatibility between the S alleles. Alternatively, it may be that the existence of the 'intermediate' form in self-fertilised inflorescences only indicates that the self-incompatibility system is not sporophytic but late-acting and arises following the abortion of ova after fertilisation. This is clearly an area that requires further investigation.

A. moschatellina is globally an uncommon or rare plant, existing in small fragmented populations. Vegetative reproduction does occur in this species but sexual reproduction via seed is limited. The factors that negatively affect seed set in the U.K. populations studied are inflorescence production per plant, pathogens, herbivores and one (or possibly more) self-incompatibility mechanisms. Pollen viability does not appear to be a limiting factor. The behaviour of the apparent pollinators and the phenological sequencing of anther maturation within the inflorescences may facilitate self-pollination which combined with a self-incompatibility system may be another factor contributing to the low seed set observed.

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Distribution of the western European endemic *Centaurium scilloides* (L. f.) Samp. (Gentianaceae), Perennial Centaury

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ABSTRACT

Centaurium scilloides (L. f.) Samp. is a western European endemic occurring in the Azores, northern Portugal, northern Spain, N.W. France, S.W. England and S.W. Wales. It occurs on coastal cliffs, sands, heaths and pastures, and inland in grassland, heaths and scrub. It usually occurs on nutrient-poor, acidic, dry to moist, sandy, stony or rocky soils. It has a long flowering period during the summer, and flowers later with increasing latitude and altitude. It appears to be declining in all areas except northern Spain and the Azores.

KEYWORDS: Altitude, Azores, Latitude, rare species.

INTRODUCTION

Centaurium scilloides (L. f.) Samp. is a western European endemic with a restricted world distribution in the Azores and the Atlantic coasts of Portugal, Spain, France and Britain. In France it is a Red List and legally protected species (Danton & Baffray 1995); it has declined significantly in Brittany, especially inland (Magnanon 2005, in press). In Britain it is now confined to one site, and is regarded as I.U.C.N. category 'Vulnerable' (Evans 1999). Although comprehensive survey data are not available, it appears to be declining in all areas except northern Spain and the Azores.

As part of a collaborative project into conservation of some rare Welsh plants, we have been researching the distribution, conservation biology, genetic variation and ecology of *C. scilloides*. Its world distribution has never been mapped before, and the objective of this paper is to present the first distribution map of this species.

Palhinha (1966) split *Centaurium scilloides* into two subspecies, making the new combination

C. scilloides subsp. *massonii* (Sweet) Palhinha for plants from the Azores. However, the basionym *Erythraea massonii* Sweet is based on plants described (in abbreviated form) by Sweet (1830) as being yellow-flowered, herbaceous perennials which needed growing in a frame as they were not quite hardy. As *C. scilloides* has white (rarely pink) flowers on the Azores and not yellow flowers, it is unclear to what taxon the name *C. scilloides* subsp. *massonii* (Sweet) Palhinha actually refers. In general, Azores plants differ from mainland plants in having white flowers and narrower leaflets, but white-flowered plants have been recorded in Galicia, Spain, and pale pink-flowered plants have been recorded in Cantabria, Spain and Normandy, France. Also leaflet shape is quite variable in some parts of Spain and Portugal. The Azores plants may not merit recognition as a separate taxon and Melderis (1972) did not separate them in *Flora Europaea* (see also Wilmott 1918, 1920; Druce 1919, Stapf 1926 for discussion).

METHODS

Distribution information was abstracted from the literature, U.K. Biological Records Centre, B.S.B.I. Threatened Plants Database, Conservatoire Botanique National de Brest, field work in the period 1997–2004, and from specimens at the following herbaria: **BM**, **BORD**, **BRISTM**, **CGE**, **CHE**, **E**, **FCO**, **HDD**, **K**, **LISFA**, **MA**, **NMW**, **OXF**, **P**, **PO**, **RNG**, **TBY**, **TCD** and **TRU** (herbaria abbreviations following Holmgren *et al.* 1990 and Kent & Allen 1984). Information about its habitats and the dates of flowering were also compiled from these sources.

RESULTS

DISTRIBUTION AND HABITATS

Approximately 118 localities were traced; they are summarised in Table 1 and native records mapped in Figure 1. Full details of sources are held by T. Rich and are available on request.

It occurs on all the Azores Islands, where it is scattered to rare (Sjögren 1984; Schäfer 2002, 2003). It grows in moist, moderately exposed places, mostly in relict, open, grassy *Laurus* forests, but also on open coastal rocks, cliffs, ravines and steep, grassy slopes. The altitudinal range is from near sea level to 1000 m, but it is most usually found between 400–700 m altitude. It occurs on a range of substrates from volcanic rock debris to *Sphagnum* hillocks.

In northern Portugal it is probably not uncommon, but no full inventory of sites has yet been carried out. On the coast, it grows on sand dunes, sandy pastures, Atlantic mesophyllous hay meadows and road verges. It is also found in the lower foothills and the upland granite mountain ranges of northern Portugal (such as the Serra de Peneda) in open scrub, grassy places and banks, up to 1000 m altitude or more.

It is reasonably frequent and widespread in north-west Spain. In Galicia, it occurs mainly around the coast in open, sandy ground and pastures, on cliffs and in damp, acidic, sandy places. Inland, it occurs in moist meadows, stream sides, acid pastures and rarely in open *Pinus pinaster* Aiton woodland. In Asturias to the east, it occurs on dunes, sandy coastal pastures and slopes and *Erica* heath, especially near the sea, and rarely inland. At an isolated site near Santander, Cantabria it occurs on gentle, east-facing flushed coastal slopes with *Schoenus nigricans* L. and *Asparagus prostratus* Dumort. The altitudinal range appears more limited in Spain than in Portugal or the Azores.

In northern Brittany, France there are two extant sites known on Côtes d'Armor and 11 in Finistère (Magnanon 2005, in press). Historically it has been known from about 32 sites in total. It mostly occurs inland scattered on road verges, on damp heath, in open *Ulex* or *Pteridium* scrub and open woodland, to 300 m altitude. The soils are generally acidic, dry, stony and nutrient-poor, and are derived from a range of substrates. The vegetation types are *Agrostio setacei-Ericetum cinereae* and *Ulici europaei-Ericetum cinereae*. It also occurs occasionally on the north coast, on rocky and sandy slopes in *Ulici humilis-Ericetum cinereae* and in *Ulici maritimi-Ericetum cinereae* vegetation. In N.W. Normandy (Manche), it is still very locally frequent on cliff-top grasslands, old dunes and edges of coastal paths and pastures, and on the edges of *Ulex* and

TABLE 1. SUMMARY OF LOCALITIES OF *CENTAURIUM SCILLOIDES*, ALL DATE CLASSES.

AZORES	
	Corvo. Faial. Flores. Graciosa. Pico. Santa Maria. São Jorge. São Miguel. Terceira.
PORTUGAL	
Minho:	Afife. Arredores de Melgaço, São Gregório. Guimarães. Leça de Palmeira. Matosinhos. Montedor. Paredes de Coura. Ponte de Lima. Porto (Oporto). Povoa de Lanhoso, Serra do Merouço. Ponte de Bacca Lindoso. Serra da Peneda. Serra do Gerês. Serra do Soajo, Peneda. Terras do Bouro. Vila Praia de Âncora.
SPAIN	
Galicia, A Coruña:	A Coruña. Camariñas, Cabo Villano. Carnota, O Pindo. Cee, Playa de Gures. El Burgo. La Sinolla. Neda. Peninsula de Finisterre. Playa de Baldayo, Carballo. Punta Candelaria. Punta da Estaca, Beres. Rial. Santiago de Compostela. Vimianzo. Xubia. Zas, Coto do Muiño.
	Lugo: Portocello. Ribadeo, Punta del Faro.
	Pontevedra: Baiona. Cangas de Morrazo. Mougas. San Martiño, Illas Cíes.
Asturias:	Bobia. Boal, Peña de la Mesa. Busto. Castropol. Cudillero. La Caridad, Playa de Cartavío. La Magdalena. Luarca. Navia. Porcía, El Franco. Punta de la Cruz, Figueras. Tapia de Casariego.
Cantabria:	Liencres. Playa de la Virgen del Mar, Santander.
FRANCE	
Finistère:	Berrien. Brennilis. Brest. Guimaëc. Huelgoat. La Roche Maurice. Lanhouarneau. Lannéanou. Le Cloître-Saint-Thégonnec. Locquénolé. Locquirec. Loqueffret. Morlaix. Plonévez-Porzay. Ploudiry. Plouegat Moysan. Plouezoch. Plougasnou. Plougonven. Plouigneau. Ploujean. Saint Herbot. Scrignac.
Côtes d'Armor:	Gurunhuel. Lohuec. Loguivy-Plougras.Louargat. Merléac. Saint Brieuc.
Manche:	Auderville. Barfleur. Beaumont Hague. Biville. Cherbourg. Diguileville. Eculleville. Gréville. Herqueville. Jobourg. Landinez. Omonville-La-Petite. Omonville-La-Rogue. Saint Germain-des-Vaux. Urville-Nacqueville. Vauville.
ENGLAND	
Cornwall:	Porthgwarra. Sandymouth Bay.
WALES	
Pembrokeshire:	Newport.
INTRODUCTIONS	
England:	Bramshott Common, Hampshire. Cooden and Bexhill, Sussex. Southborough, Kent.
Ireland:	Killarney, Kerry.

Pteridium scrub, and there are about eight extant sites with loss of another five.

In Cornwall, S.W. England, it was recorded on a scrubby cliff top at Porthgwarra, St Levan between 1952–1967 and on low, sandy ground in 1956 at Sandymouth Bay; both sites have been searched repeatedly and it is extinct (Margetts & David 1981; French *et al.* 1999).

In Pembrokeshire, Wales, it is locally plentiful on dry, freely-drained sea cliffs, coastal *Erica* and *Ulex* heath, dunes and adjacent pastures over three kilometres of coast near Newport, where it was first discovered in 1918 (Wilmott 1918; Evans 1999). The rocks are mainly slates and shales.

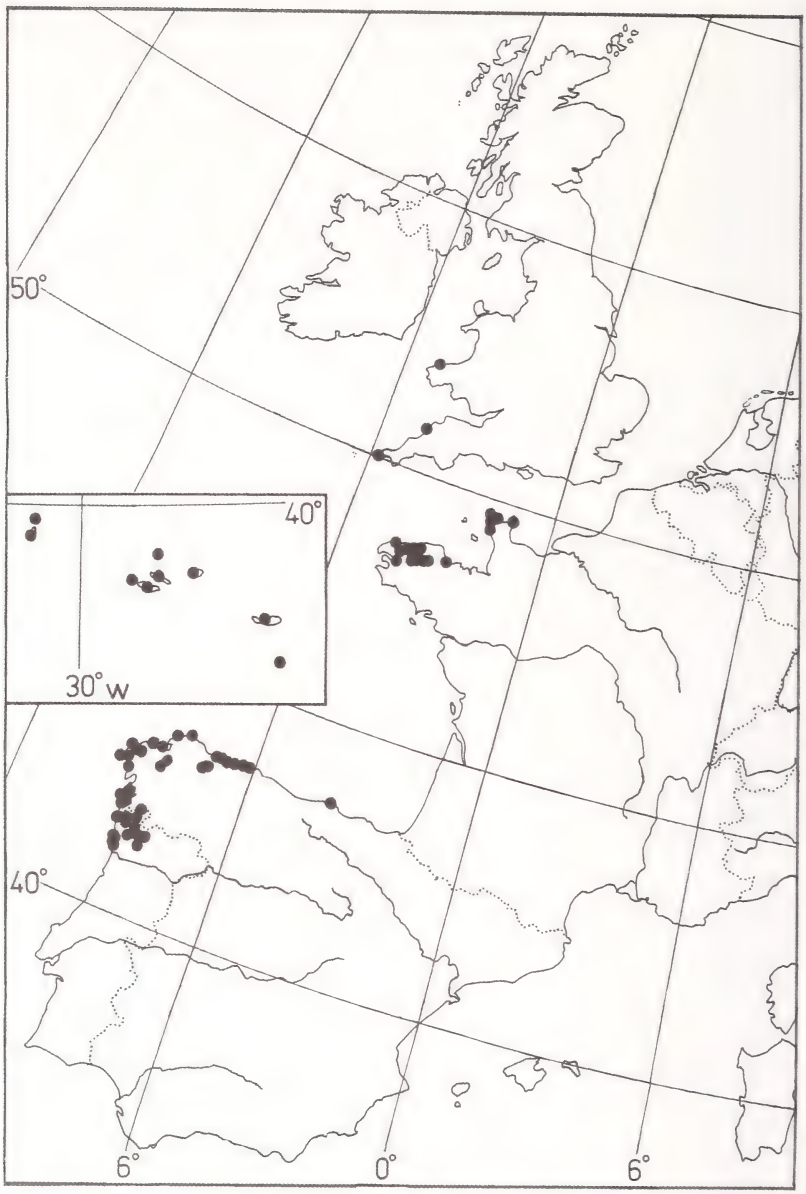


FIGURE 1. Natural distribution of *Centaurium scilloides*, inset Azores.

INTRODUCED SITES

Centaurium scilloides has been in cultivation in Britain since being introduced possibly from the Azores by W. Aiton in 1777, but the original cultivation does not seem to have survived. Pink-flowered plants were introduced from another unknown source(s) through the horticultural trade in 1881 (Stapf 1926). Colonies established in gardens and adjacent banks and verges have been reported from Cooden and Bexhill, East Sussex and Southborough, Kent (Philp 1983; FitzGerald 1987) and Bramshott Common, Hampshire (A. R. G. Mundell, pers. comm. 2003). Bowen (1968) reported it from a lawn at Killarney, Ireland.

VARIATION IN FLOWERING TIME

Excluding duplicates, there were 132 specimens with a full collection date (i.e. day and month), 32 specimens with month only, and c. 55 with year only or undated. It is assumed that the herbarium specimens were collected randomly with respect to flowering time.

The herbarium specimens indicate that overall *C. scilloides* has been collected flowering from April through to October. Within most sites flowering occurs over a period of about three months with a main peak and then lower numbers of flowers continuing as weather conditions allow (e.g. Evans 1999).

When all records with precise dates are correlated against latitude, there is a pronounced cline in flowering time from southern to northern latitudes, as might be expected, with northern plants flowering later (Figure 2; n = 131, r = 0·398, p<0·001). When only native coastal records from Portugal, Spain, France, England and Wales are included to minimise the confounding effects of climate varying with both increasing altitude and latitude, the relationship is stronger (n = 86, r = 0·625, p<0·001).

Similarly, flowering dates of coastal and inland specimens from the same latitudes can be compared to separate the effects of increasing altitude. In Portugal where there is a strong altitudinal gradient from the coast to the mountain ranges inland (which reach 1469 m), there is a significant increase (two-tailed t-test, p<0·001) in mean flowering date from 10 June (n = 13) for coastal collections to 21 July (n = 8) for inland collections, indicating flowering occurs later at higher altitudes. In Brittany, mean flowering dates of coastal specimens (19 July, n = 32) are not significantly different from those of inland specimens (24 July, n = 9); possible explanations include the smaller altitudinal range and the location of some inland sites at relatively low altitudes (two-tailed t-test, p>0·4).

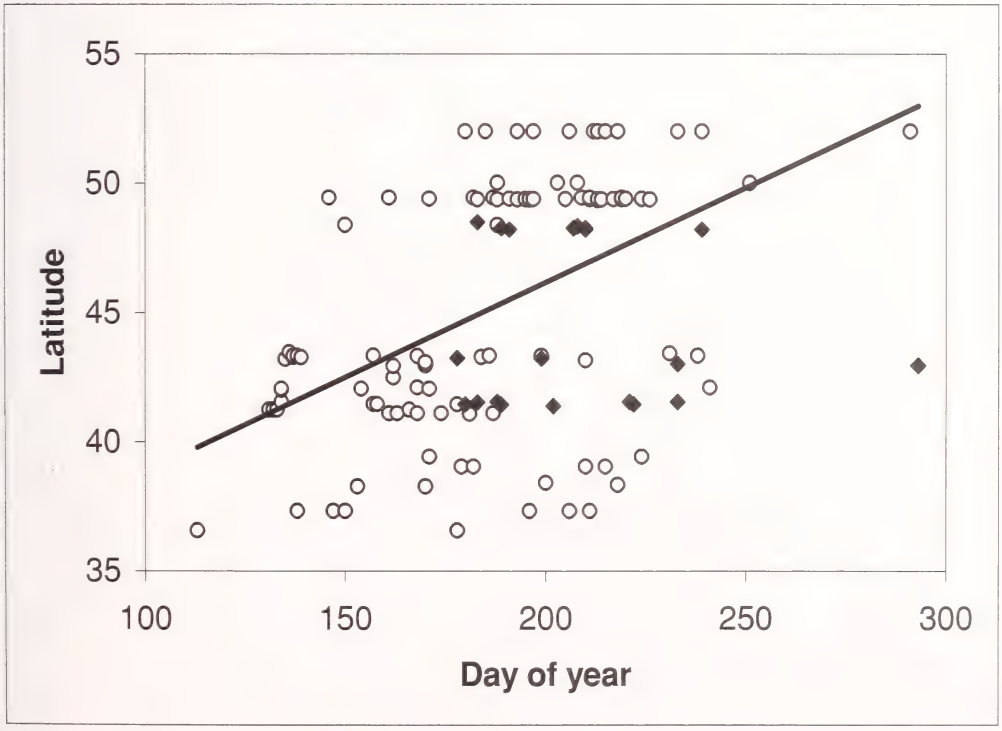


FIGURE 2. Variation in flowering date of herbarium specimens of *Centaurium scilloides* with latitude, 10 April (day 100) to 27 October (day 300). ○ Coastal populations. ◆ Inland populations. Introduced localities not included. A best-fit line is also shown.

DISCUSSION

The distribution of *C. scilloides* (Fig. 1) shows several interesting features. Although this Oceanic species is predominantly coastal, it also occurs inland in the N.W. Iberian Peninsula and Brittany, sometimes to quite high altitudes in the former. This contrasts with the distribution of two other western European endemics with generally similar distribution patterns but which are otherwise exclusively coastal: *Rumex rupestris* Le Gall which occurs in N.W. Spain, N.W. France, S.W. England and Wales (Jalas & Suominen 1994), and *Asparagus prostratus* Dumort. which occurs from N.W. Spain to N.W. Germany, England, Wales and Ireland (Kay *et al.* 2001). Although clearly tolerant of salt spray, *C. scilloides* is presumably either less sensitive to climatic factors such as frost or is a better competitor in the absence of significant soil salinity than these two species.

The distribution may be partly related to climate. The regions where *C. scilloides* grows are characterised by mild winters (January mean temperature of 5–15°C) and temperate summers (mean July temperature of 15–25°C) and an annual rainfall of between 800 and 1600 mm. There is a reasonable correlation between the winter isotherms and the distribution pattern, but not with summer isotherms. Winter temperatures may be important because it is evergreen, and shoots start elongating in the autumn and grow through the warmer parts of the winter, eventually to flower in early summer.

Its habitats can be characterised as being relatively short, open grassland or heathland vegetation on the coast or inland, and more rarely in scrub or open woodland. The soils appear to be generally acidic, nutrient-poor and damp to dry but not permanently wet, and they are generally rocky, stony or sandy. There is also a noticeable change in habitat from moist sites in the Iberian Peninsula to dry sites in Wales.

The distribution has a series of disjunct populations, some with large clusters of records (e.g. N. W. Iberian Peninsula and N.W. France), and others where it is scattered or rare (Cantabria, England, Wales). This pattern could be relict from a more continuous distribution earlier in this interglacial but is more likely to be indicative of re-colonisation from a few glacial refugia, as once established in an area it seems to grow well and colonise a range of habitats. The pattern may thus result from dispersal from the well-established populations in areas with suitable habitats to the smaller, more recently colonised sites. This pattern of expansion of range is now being fragmented through loss of populations due to man-induced changes of habitats (e.g. losses in Cornwall and Brittany).

Its seeds are tiny (c. 0·3–0·4 mm), subglobose and have a deep reticulate surface pattern. Beyond being shaken out of the sides of the capsules after they split, the seeds have no obvious dispersal mechanism. Gentianaceae seeds in general are usually dispersed by the wind, rarely by water or animals (Bouman *et al.* 2002). *Centaurium scilloides* seeds float readily in water by surface tension and are difficult to wet, which could allow dispersal by the sea provided they are tolerant of salt water. Schäfer (2003) regards the seeds as both wind- and water-dispersed.

Genetic analysis may clarify the re-colonisation history after the last glaciation, as has been shown for the northward spread of *Cakile maritima* Scop., *Carex arenaria* L. and *Eryngium maritimum* L. along the coast (Clausing *et al.* 2000, Jonsson & Prentice 2000). It may also clarify the relationship between the Azores and mainland European plants; the fact that, within the predominately pink-flowered genus *Centaurium* occasional albino forms occur sporadically in many species, suggests that the Azores plants are derived from mainland populations and not *vice versa*.

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Conservation of Britain's biodiversity: *Hieracium neocoracinum* (Asteraceae), Craig Cerrig-gleisiad Hawkweed

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ABSTRACT

Hieracium neocoracinum Pugsley (Asteraceae), Craig Cerrig-gleisiad Hawkweed, is a very rare, endemic plant, confined to Craig Cerrig-gleisiad National Nature Reserve in the Brecon Beacons (v.c. 42), Wales. It was first found in 1895 and has occurred in at least two places within Craig Cerrig-gleisiad. In 1975, its population was estimated to be 60 plants in one population. Field surveys in 2003 revealed 147 plants at the same place, and it was not refound in the second site. The population increase is probably due to colonisation of bare ground created by a landslip, and relaxation of grazing. Seed was collected for the Millennium Seedbank, and it is being cultivated at the National Botanic Garden of Wales.

KEYWORDS: Brecon Beacons, endemic, lectotype, rare species, Wales.

INTRODUCTION

Hieracium neocoracinum Pugsley (Asteraceae), Craig Cerrig-gleisiad Hawkweed, is a very rare, endemic plant, as far as is known confined to cliffs of Craig Cerrig-gleisiad National Nature Reserve (N.N.R.) in the Brecon Beacons (v.c. 42 Brecon), Wales, where it was first found and collected in 1895 by Augustin Ley (Ley 1899). It has not been found anywhere else (Fig. 1).

Hieracium neocoracinum is one of 79 rare hawkweeds included in the Vascular Plant Red Data Book (Wigginton 1999). As there was no information on its current population size, a joint project was set up between the National Museums & Galleries of Wales, the National Botanic Garden of Wales and the Countryside Council for Wales to establish its current status, genetic variation and determine its needs for conservation. In this paper the information that is available about *H. neocoracinum* is summarised; full details can be found in Rich & Hill (2004). The genetic variation will be reported separately (Lledo & Rich, in prep.).

Craig Cerrig-gleisiad (historically also known as Craig Gledsiau) is a dramatic, ice-carved, north-east facing valley in the central Brecon Beacons, with cliffs to 150 m high, screes, moraines and terraces. The strata of the Old Red Sandstone, which form the underlying geology, vary in structure and composition with some hard, massive beds and some softer, thinner beds. These rocks give rise to a range of soils, some of which are relatively base-rich but most are fairly neutral in pH. Over time some soils can become quite acidic where leached or where organic matter builds up.

Over 500 higher and lower plant species have been recorded in Craig Cerrig-gleisiad N.N.R., including a number of arctic-alpines such as *Saxifraga oppositifolia* which are at about their southern limits in Britain, and at least 16 other *Hieracium* species. The vegetation history has been studied using pollen in the partial peat-cores extracted from the valley floor by Walker (1982). Following the cold period of the Loch Lomond advance about 8000 B.C. when tundra was present, *Juniperus* scrub became established which was followed by *Betula* with (probably) *Sorbus aucuparia* and subsequently *Corylus*. *Quercus, Betula* and *Pinus* then colonised, and by about 5000 B.C. the climate became wetter resulting in expansion of *Quercus* and *Alnus* and a decrease in *Ulmus, Pinus* and *Betula*. Unfortunately the peat records then end. Presumably most *Hieracium* species colonised the site before extensive woodland developed in the Brecon Beacons.



FIGURE 1. Distribution map of *Hieracium neocoracinum*, plotted using DMAPW by Alan Morton.

TAXONOMY AND IDENTIFICATION

Hieracium neocoracinum was first described as a distinct taxon by Ley (1899), who named it *Hieracium caesium* Fries var. *coracinum* Ley. Pugsley (1941) raised it to species status using the epithet '*neocoracinum*' as the combination *H. coracinum* Dahlst. was already in use for a European species. He included it in Section *Vulgata* (Griseb.) Willk. & Lange, Subsection *Bifida* Pugsl., Series *Eu-Bifida* Pugsl. (Pugsley 1948). A lectotype has been selected and hereby designated by P. D. Sell for *Hieracium caesium* var. *coracinum* A. Ley, for which *H. neocoracinum* Pugsley is a *nom. nov.*, as the sheet from Craig Gledsiau, Brecon Beacons, 9 July 1895, A. Ley in **herb. Ley** (currently in **CGE**) with Ley's original description attached.

In the field at Craig Cerrig-gleisiad *H. neocoracinum* is a quite distinct species, almost instantly recognisable from the other *Hieracium* species with which it grows (Fig. 2). The basal rosette leaves have long petioles with strong decurrent teeth, are quite bright yellowish-green, and hairy only on the petioles and midribs. There are no stem leaves (other than the very reduced bracts at the bases of the inflorescence branches), and the inflorescence is clustered at the top of the stem. The involucral bracts have frequent long, simple hairs with blackish bases, a few black glandular hairs, and many white, appressed, cobwebby, stellate hairs. The styles are darker than the ligules.

DISTRIBUTION AND ECOLOGY

Historical records of *H. neocoracinum* were traced from the literature and herbaria, and are summarised in Table 1. It has only ever been recorded from Craig Cerrig-gleisiad, and being such a distinct species is unlikely to have been over-looked elsewhere in the Brecon Beacons. The records indicate it has been recorded in at least two places within Craig Cerrig-gleisiad. Ley noted it occurred in 'certain parts' and at 'altitudes' of 460–550 m (note the plurals), B. A. Miles and M. Porter have recorded it from the 'main gully', and P. D. Sell *et al.* recorded it from a low cliff to the north of the main gully.

The historical records were used to direct field surveys on 16 June and 10 July 2003. At least 147 plants occurred in Sell's site, highly concentrated in two areas of adjacent open soil caused by landslips at SN/961219, altitude c. 550 m. A few plants occurred on the cliffs and ledges above. About ⅔of the population were flowering, and there was abundant regeneration with rosettes of varying sizes. The vegetation ranged from good examples of the CG10a *Festuca ovina-Agrostis capillaris-Thymus praecox* grassland, *Trifolium repens-Luzula campestris* sub-community to a poor example of the U5e *Festuca ovina-Agrostis capillaris-Galium saxatile* grassland *Vaccinium myrtillus-Deschampsia flexuosa* sub-community (*sensu* Rodwell 1992). Six other *Hieracium* species grew with the *H. neocoracinum*, all clearly being rapid colonists of the open ground caused by the landslip. The soil was an immature reddish, stony, granular, moist ranker, pH 6·2 (measured with a pHep2 Hanna pocket-sized pH meter in a 50:50 mixture with distilled water) derived from the Old Red Sandstone.

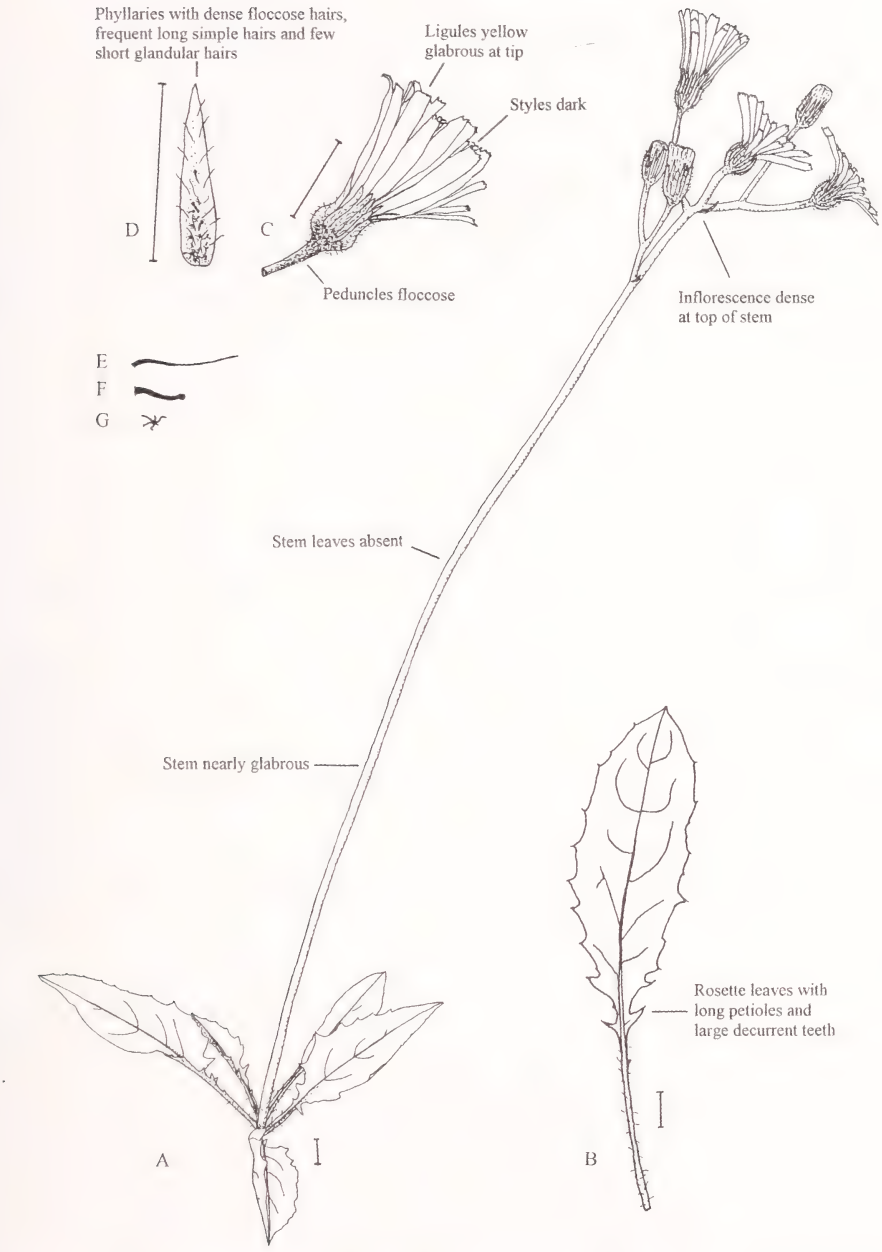


FIGURE 2. Illustration of *Hieracium neocoracinum* showing main identification features. A. Whole plant. B. Basal rosette leaf (younger leaves are often more acuminate towards the apex). C. Capitulum. D. Involucral bract. E. Long simple hair. F. Short glandular hair. G. Floccose hair. Scale bars A–D, 1 cm. E–G not to scale.

No *H. neocoracinum* was found in the main gully or other adjacent gullies (three searches), though it is difficult to search the site thoroughly due to the high cliffs and loose rocks; M. Porter considers that his recent site may have been lost due to another landslip (pers. comm. 2004).

TABLE 1. HERBARIUM AND LITERATURE RECORDS OF *HIERACIUM NEOCORACINUM*.

Date	Collector	Site	Source and notes*
24 July 1893 (?)	A. Ley	Craig Gledsiau	**CGE**; date unclear
9 July 1895	A. Ley	Craig Gledsiau, on old red sandstone	**BM**, **CGE**
7 July 1896	F. J. Hanbury	Gledsiau	**BM**
9 & 10 July 1896	A. Ley	Craig Gledsiau	**BM**
28 June 1898	A. Ley	Craig Gledsiau	**BIRM, CGE**
24 July 1899	A. Ley	Craig Gledsiau	**BIRM, LIV** (Corrie *et al.* 2000)
27 July 1900	A. Ley	Craig Gledsiau	**LIV**
2 August 1900	A. Ley	Craig Gledsiau	**CGE**
July 1902	A. Ley	Craig Gledsiau	**NMW**
July 1902	H. J. Riddelsdell	Craig Gleisiad	**BM, CGE, E**
3 Jul 1905	A. Ley	Craig Gledsiau, fairly abundant on certain parts of this precipice	**BM**, **CGE**, **NMW**
8 July 1951	J. E. Lousley	Craig Cerrig-gleisiad	**CGE**
22 June 1953	P. D. Sell	Craig Cerrig-gleisiad, cliffs	**CGE**
5 July 1958	B. A. Miles	Craig Cerrig-gleisiad, main gully	**CGE**
4 July 1964	J. N. Mills	Craig Cerrig-gleisiad, rock ledge in gully, SN962218	**MANCH**
27 June 1975	P. D. Sell, M. Massey & L. Farrell	Craig Cerrig-gleisiad (original grid reference incorrect), grassy rock crevices, SN961219	60 plants; Rare species form held by CCW. **CGE**, photograph in **NMW**.
11 July 1975	M. Porter	Craig Cerrig-gleisiad, cliffs, SN961219	**herb. M. Porter**, det. P. D. Sell
11 July 1999	M. Porter	Craig Cerrig-gleisiad, cliffs	field record

*Material in **BM**, **E** and **NMW** mainly determined by D. McCosh, material in **BIRM** and **CGE** determined by P. D. Sell, material in **MANCH** and **LIV** determined by J. N. Mills.

CONSERVATION

The historical records indicate at least two sites within Craig Cerrig-gleisiad, but it was not refound in the main gully so there is now only one population. Given the large expanse of potentially suitable habitat at Craig Cerrig-gleisiad this restricted distribution was quite surprising.

It is difficult to estimate population trends from the fragmentary historical data. It was described as 'scattered over the cliff, but not abundant' by Ley (1899), 'fairly abundant on certain parts…' by Ley in 1905, and 'in fair quantity' by Ley (1909). The only detailed estimate of its population size was of 60 mature/flowering plants in one population by P. D. Sell *et al.* in 1975. In 2003, this population was larger with c. 100 flowering plants and many vegetative rosettes. This increase may be a temporary situation due to the colonisation of suitable habitat created by the landslip. The second population in the main gully may have been lost (perhaps temporarily) to a different landslip.

Colonisation of landslips by *Hieracium* species was also noted elsewhere on the site, where different assemblages occurred depending on the colonisation from immediately adjacent populations, and is clearly a key feature of the biology of some *Hieracium* species in the N.N.R. and presumably throughout the post-glacial forest maxima. The landslips cover areas of up to c. 10 m × 5 m and provide open, if somewhat unstable, ground amongst the dense, closed *Vaccinium myrtillus* heath. It is not clear if the landslips are the result of softer rock strata eroding and causing small scale slips, heavy winter snowfall and frost-heave causing small avalanches which strip the ground of the vegetation cover, or heavy rain-wash and surface water.

Relaxation of grazing in recent years may also have helped increase the population size of *H. neocoracinum*. Most *Hieracium* species are intolerant of grazing, and in sheep-grazed areas are usually confined to ungrazed ledges and rocks, but at Craig Cerrig-gleisiad they are spreading onto accessible open ground. Craig Cerrig-gleisiad was exclusively sheep-grazed for many years, though not heavily, and was changed to low intensity cattle-grazing with no sheep in the early 1990s (R. Preece, pers. comm. 2003). The cattle do not appear to graze the steep slopes (or do so only very occasionally), and the *Hieracium* species are spreading onto the ungrazed open ground. In the longer term the low level of grazing may result in development of scrub, but this does not currently seem to be a threat.

Under the 1994 IUCN Threat Criteria used by Wigginton (1999) *H. neocoracinum* qualifies as 'Endangered' (total population less than 250 individuals). The site is well-protected, being designated as a National Nature Reserve within the Brecon Beacons S.S.S.I. in the Brecon Beacons National Park. *H. neocoracinum* should be added to the S.S.S.I./N.N.R. schedule as a reason for designation of the site at the next revision, but the site is also important for at least six other Red Data Book or very local endemic *Hieracium* species (*H. angustatiforme, H. eustomon, H. repandulare, H. rubiginosum*, etc.). The biggest threats to *H. neocoracinum* are either from a major rock-fall smothering the remaining population, or stabilisation of the landslip and colonisation by competitive species which might then restrict it to a few plants on the cliffs. As the landslips are somewhat unstable, trampling by hikers or stock may result in movement of the soil with consequent damage to some plants, though the population is well off the heavily-used walking routes elsewhere on the site.

Seed was collected from 14 plants for the Millennium Seed Bank on 10 July 2003, and material is being cultivated at the National Botanic Garden of Wales (N.B.G.W. accession no. 20021482).

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Notes

NORTH WALES SPECIES OF *RUBUS* L. (ROSACEAE) IN THE ISLE OF WIGHT

In 1982 two sizeable populations of *Rubus effrenatus* Newton, a species up till then (and still) otherwise known only in north-west Wales, v.cc. 46–49, were discovered in the Isle of Wight, v.c. 10, at a distance of 11 km from each other. One population is near the Island's southernmost tip, mainly among bracken along a crescent of gravel overlying the chalk on the north face of Head Down but with an outlying patch in a deep 'green lane' about 1·4 km to the north-west. The other site is towards the Island's south-east corner, along a much-frequented public footpath forming the north boundary of Sandown Golf Course, a relic fragment of a once-extensive tract of partly-wooded acid ground that constituted Blackpan and Lake Commons. The species is unrepresented in *Rubus* collections made in these two localities by 19th century specialists in the genus, and that negative evidence, taken together with a subjective impression that both populations have expanded slightly in the years since their discovery, could be interpreted as indicating a relatively recent arrival in each case (Allen 2003). Though the two may have had independent origins, it is equally possible that one population has been derived from the other – in which case that on Head Down seems the more likely to be the parent colony.

In 2002–4 two successive finds of another *Rubus* species provided a near-duplicate of this very unexpected national distribution pattern. This one, *R. griffithianus* Rogers, while not otherwise exclusive to north-west Wales (so far as is known) like *R. effrenatus* – for it has proved to have three widely-separate secondary centres, in v.cc. 55, 60 and H27 (Newton & Randall 2004) – is heavily concentrated there, its striking abundance in the adjacent portions of Caernarvonshire, v.c. 49, and Anglesey, v.c. 52, having been responsible for its original gaining of taxonomic recognition (Rogers 1895). Merely on grounds of statistical probability north-west Wales thus seems the likeliest source of the Isle of Wight occurrences. In contrast to those of *R. effrenatus*, these both consist of apparently solitary patches, one on a ride near the south end of the Island's largest tract of woodland, Parkhurst Forest, on the west side of Newport, the other in the middle of a small copse on the south outskirts of Ryde in the Island's north-east corner. The latter gives the impression of being long-established and may have been the source of the other, even though, again, the localities are a considerable distance (in this case 13 km) apart and, again too, there are ample suitable habitats in between.

Apart from accidental introduction with forestry nursery stock, a possibility in the case of the Parkhurst Forest patch, the respective ecological contexts point to frugivorous birds as the dispersal agency most likely to be responsible for the long-distance transport that would seem to have been involved. Field observation by ornithologists in Britain and the Iberian Peninsula has identified blackberries as "probably one of the most important sources of easily obtained energy for migrant passerines", the principal feeders on them being blackbirds and (to a much lesser extent) robins in early September and starlings in October-November (Snow & Snow 1988). Unfortunately, though, the study of passage movements has yet to attain the level of technological development that would enable particular routes, or the particular kinds of birds following those, to be inferred without the great difficulty that at present attends that line of work (J. Clark, pers. comm. 2004). For the time being non-stop flights of some 300 km of perhaps some regularity that the evidence presented in this note implies can therefore be no more than surmise. However, it seems a reasonable guess that the Severn and Wye Valleys serve as well-used southward flyways; it may well be, too, that the conspicuousness of Southampton Water as a landmark has the effect of funnelling migrants on to the Isle of Wight and using it as a halting-place preparatory to the lengthy onward flight across the English Channel.

That plant species otherwise restricted largely or even wholly to the foothills of Snowdonia can persist and even flourish in a lowland area some 300 km to the south is not as surprising as it may appear at first sight. The climate of the Isle of Wight is a similarly moist, maritime one (only one of the four localities identified above is more than 2 km from the sea, perhaps significantly) and though its summer temperatures are considerably higher, cooler conditions are the norm there throughout the autumn migration period. In this connection the distribution of a third *Rubus* species, *R. riparius* W.C. Barton ex Newton, may be instructive. Up to the time of its eventual description (Newton 1972) and for more than two decades subsequently this was believed to

resemble *R. effrenatus* in being restricted to north-west Wales exclusively. Since then, however, it has been found to have several large populations along the coastal belt of Central South England, from Hayling Island to the far west of Dorset, as well as occurring in a wide scatter of localities in the Isle of Wight (Allen 20003, Newton & Randall 2004), where it turns out to have been collected as long ago as 1868. More surprisingly, that distribution has proved to extend across the English Channel to the Orne Valley in central Normandy with an outlier 35 km further south still, almost halfway to the Loire (Allen 2002). This would seem to suggest that temperature is not a seriously restrictive factor until much further south than one might suppose for species occurring in greatest quantity in as distant a region as north-west Wales.

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EPIPACTIS PHYLLANTHES VAR. *CAMBRENSIS* (C. A. THOMAS) P. D. SELL AND OTHER UNUSUAL *EPIPACTIS* AT KENFIG NATIONAL NATURE RESERVE

BACKGROUND

C. Thomas (1950) published a paper entitled "The Kenfig Epipactis" describing his discovery in July 1941 of two delicate, yellowish-green plants with yellowish white flowers, *Epipactis cambrensis* C. Thomas (1950), more recently *Epipactis phyllanthes* var. *cambrensis* (C. A. Thomas) P. D. Sell (1996) ("*cambrensis*"), growing on the steep sides of sand heaps at Kenfig Burrows (now Kenfig N.N.R.) and the adjacent Margam Burrows. He also listed other *Epipactis* which he had found growing at Kenfig, including a form of *Epipactis helleborine* growing in the open dunes and an unidentified *Epipactis* ["No 4"] which he described as "closely resembling *E. dunensis*".

C. Thomas deposited a specimen of *cambrensis* collected on 19 July 1941 with **NMW** ("paratype") and a further specimen (in bud) collected 18 July 1942 with **BM** ("holotype"). A description of *cambrensis*, based on C. Thomas's original description and an inspection of the **BM** holotype (per. comm., 2004), was included by P. D. Sell and J. G. Murrell (1996) in the *Flora of Great Britain and Ireland*. However, the existence of *cambrensis* as a distinct taxon has not been generally accepted and it is normally listed in reference works (most recently Delforge, 2001 and Lang, 2004) only as a synonym under *E. phyllanthes*. Indeed, only two years after Thomas's paper, D. P. Young (1952), in a study of *Epipactis phyllanthes*, was dismissive, stating:

> "I do not understand *E.* [*phyllanthes* var.] *cambrensis* ... and have left it out of account here. Thomas's type in Hb. Mus. Brit. [**BM**] is immature; specimens in various other herbaria determined (by him and others) as *E.* [*phyllanthes* var.] *cambrensis* appear to me to be *E. phyllanthes* var. *vectensis*, which he himself (1950) records (as *E. pendula*) from the same locality. On several visits to the Kenfig dunes I have not been able to find plants corresponding exactly to his description of *E.* [*phyllanthes* var.] *cambrensis* although *E. phyllanthes* was seen both on tops of dunes and in the slacks. More evidence that *E.* [*phyllanthes* var.] *cambrensis* is distinct from *E. phyllanthes* and not just a dwarfed state of it would be welcome."

Similarly, D. M. Turner Ettlinger (1997) reported that no-one had been able to re-find or identify *cambrensis* with certainty and this was still the position up until 2004.

RE-DISCOVERY OF THE "KENFIG EPIPACTIS", *EPIPACTIS PHYLLANTHES* VAR. *CAMBRENSIS* (C. A. THOMAS) P. D. SELL

Although up until 2004 no-one had been able to re-find or identify *cambrensis* with certainty, S Moon did find a small number of unusual *Epipactis* plants with whitish flowers in the dunes at Kenfig N.N.R. during the 1990s while he was Warden there (pers. comm., 2004). A photograph of one such plant with about 20 greenish white flowers, which he described as exceptionally robust (and may therefore be a hybrid), is included under the name *Epipactis phyllanthes*, var. *pendula* in a poster of Kenfig flora on show at the Kenfig N.N.R. Visitor Centre. On 26 July 2004, we searched the area of dunes where he had discovered these plants and found a single small, lax yellowish-green *Epipactis*, in bud but with one whitish flower beginning to emerge, growing on the north face of a steep sand heap. When the site was revisited on 6 August, the plant was fully in flower (Figure 1). Two similar plants, one gone over and the other immature, were found in a similar location on another sand heap close by. A fourth plant, just going over, was found on a later visit. The fact that this fourth plant was overlooked on 6 August, despite being 23 cm high, presumably in flower and growing just 60 cm from one of the other plants, shows how difficult these plants are to find in the dense vegetation.

The four newly-found plants were compared with C. Thomas's description of *cambrensis* and the herbarium specimens he deposited at **BM** and **NMW**. As noted above, like *cambrensis*, these plants were growing on the steep sides of sand heaps, largely concealed by *Salix repens*. The three mature plants were respectively 16, 19 and 23 cm high, i.e. within the normal range of 10 to 24 cm (exceptionally up to 35 cm) reported by C. Thomas. The plants were lax with four to six flowers, consistent with C. Thomas's description of *cambrensis* as few flowered with robust plants bearing about 10 flowers (the holotype appears to have 12 flowers and the paratype has six). As further described by C. Thomas, *cambrensis* is a lax yellowish-green plant with a purple tint at the base of the stem. The leaves, which are alternate and clasp opposite sides of the stem at their base; are simple, ciliate-edged and oblong-lanceolate; they appear very slender because they are sharply folded upwards on the midrib. The bracts are linear-lanceolate and upwardly pointing, the lowest being longer than the flowers but diminishing to shorter than the flowers at the top. The pedicel is a slightly curved down, but less so than is normal for *E.* [*phyllanthes* var.] *pendula* and *vectensis* so that the flowers do not appear to hang loosely but tend to give the whole plant a somewhat sinuous aspect. The ovary is long and narrow, smooth and flattened above and below. The sepals and petals are acuminate, 10·5 mm and 9 mm long, respectively and 5 mm wide; the sepals and petals of the paratype have noticeably out-turned tips. The rostellum is rudimentary. Flowers are yellowish white. The labellum is complete, about 7·5 mm long. The hypochile is small (about 3 mm long), well-formed and uncoloured. The epichile is white, not reflexed, 4·5 mm long and pointed. The epichiles of the two new plants found in flower were a yellow-greenish white rather than white (or yellowish white) and, in some cases, were not reflexed. However, in all other respects, the new plants accorded with C. Thomas's description of *cambrensis* and the herbarium specimens he deposited.

Photographs and details of the four plants we found were submitted to A. J. Richards, the BSBI Referee for *Epipactis*. After further comparison with C. Thomas's description and herbarium specimens, he confirmed that, in his view, the plants were indeed *cambrensis* (pers. comm., 2004)



FIGURE 1. *Epipactis phyllanthes* var. *cambrensis* (C. A. Thomas) P. D. Sell

He also confirmed that the plants were a form of *Epipactis phyllanthes* G. E. Smith. In addition, he observed that the leaves were extremely narrow giving the plants a distinctly unusual appearance. It is interesting to compare this with C. Thomas's observations that *cambrensis* differed from any *Epipactis* that he had previously encountered and that its leaves appeared very slender because they are folded sharply upwards on the midrib. According to P. Delforge (2001), the normal leaf size for *E. phyllanthes* is 15 to 35 mm wide x 35 to 75 mm long. The leaf measurements of the plant shown in Figure 1 are 7·5 mm × 15 mm, 12 mm × 42 mm, 9 mm × 48 mm and 7·5 mm × 42 mm. The widest leaf of the other three plants found was 16 mm. Although C. Thomas describes *cambrensis* in detail and comments on the narrow appearance of the leaves, he does not specify the range of leaf measurements. However, he does give the measurements for a single plant having leaves up to 35 mm wide, but it would appear that this must have been particularly robust since 35 mm is stated to be the maximum leaf width and the broadest leaves of the holotype (which was also a robust plant with 12 flowers, compared with the normal maximum of 10) and paratype are both about 20 mm wide.

It is apparent that since this *Epipactis* is a form of *E. phyllanthes* it cannot be accorded specific rank, as initially proposed by C. Thomas. However, in view of its noticeably different appearance from other forms of *E. phyllanthes*, in particular its narrow oblong-lanceolate leaves sharply folded about midrib, it may warrant the same rank as other British subsidiary taxa of *E. phyllanthes* (namely var. *pendula*, *degenera* and *vectensis*) consistent with the nomenclature *Epipactis phyllanthes* var. *cambrensis* (C. A. Thomas) P. D. Sell. However, since such rank is based on the morphology of only four contemporary plants and two herbarium specimens, it must be regarded as provisional. It is hoped that further plants can be found in future years to enable a more extensive comparison with the other subsidiary taxa of *E. phyllanthes* to be carried out.

EPIPACTIS HELLEBORINE AFF. *NEERLANDICA*

During the searches of Kenfig N.N.R. for *cambrensis* in the 1980s and 1990s by S. Moon (*v. supra*) and others, two other unusual *Epipactis* were found growing in open dunes with *Salix repens* (A. J. Richards pers.comm., 2002, D. M. Turner Ettlinger, 1997 and 1998). We also found both of these forms in August 2002 and, in much smaller numbers, in 2004 (No search was made in 2003 because of the effects of the severe drought on the Kenfig dune flora in late July.).

The first form (Figure 2) grows in small numbers in open dunes at Kenfig. It has a characteristic deep green colour and dark, dull purplish-pink flowers. It is therefore presumably the same as the *E. helleborine* which C. Thomas (1950) reported as growing in open dunes at Kenfig. As reported by D. M. Turner Ettlinger (1997, 1998), it also grows in other dune systems on the South Wales coast. C. Thomas states that the only concession to the exposed open situation in which these plants grow is "that all the flowers turn their back to the midday sun." However, as also reported by D. M. Turner Ettlinger (1997), there is a more significant adaptation, namely the fact that the leaves are short and round, have irregular toothing at leaf margins and closely sheath the stem. In these respects, as well as in overall appearance, the plants closely resemble *E. helleborine* subsp. *neerlandica* (Vermeulen) Buttler which also grows with *Salix repens* in Continental dune slacks bordering the North Sea. In view of these similarities, D. M. Turner Ettlinger (1997, 1998) and P. Delforge (2001) have presented this South Wales dune form of *E. helleborine* as subsp. *neerlandica*. Although this is a possibility, the precise rank of this *Epipactis* is still to be established since it was not included in the recent genetic studies of the genus *Epipactis* by J. Squirrell *et al.* (2002) and P. M. Hollingsworth (2003). It is therefore suggested that it should be referred to as *Epipactis helleborine* aff. *neerlandica* pending further study of its taxonomy.

EPIPACTIS HELLEBORINE AFF. *YOUNGIANA*

The most immediately noticeable characteristics of the second *Epipactis* growing at Kenfig (Figure 3) are its distinct yellowish-green colour and pink bell-like flowers, often very densely clustered together. It would seem probable that it is the same as *Epipactis* "No. 4" described by C. Thomas (1950) as resembling *E. dunensis*, a specimen of which is preserved in the Spirit

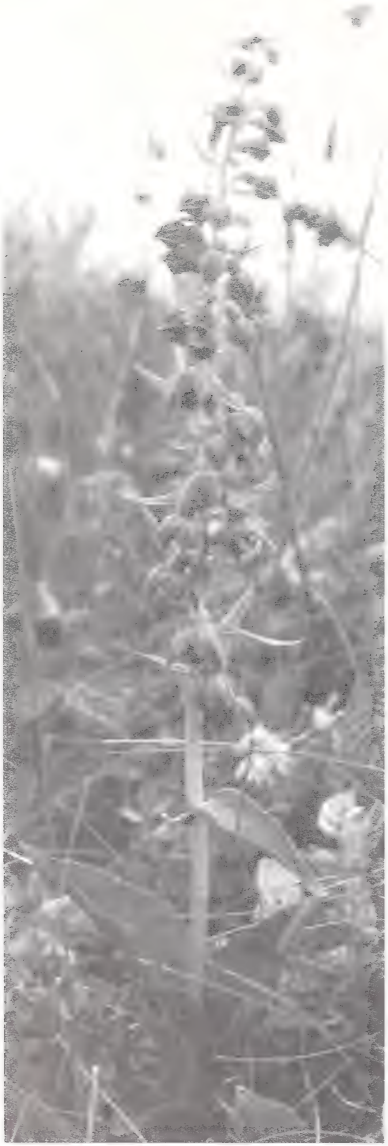


FIGURE 2. *Epipactis helleborine* aff. *neerlandica*



FIGURE 3. *Epipactis helleborine* aff. *youngiana*

Collection at **K** labelled "...base of stem purplish-pink; leaves pale yellowish-green, midrib yellower; petals very pale pink, midrib yellowish, lip epichile pale pink, apex yellowish, hypochile deeper pink, column whitish, rostellum white, ovary yellowish-green." This second form grows in the open dunes with *E. helleborine* aff. *neerlandica*, but in even smaller numbers. We found only two plants in 2004, compared with 11 in 2002. However, further plants may well have been overlooked since, despite their bright yellowish colour, they can be difficult to find amongst the *Salix repens* and other dune vegetation. Unlike aff. *neerlandica*, there appears to be no record of it having been found elsewhere in South Wales.

Like *E. helleborine* aff. *neerlandica*, the rank of this *Epipactis* is still to be established since it also was not included in the recent genetic studies of the genus by J. Squirrell *et al.* (2002, 2003).

In fact, it resembles *E. youngiana* A. J. Richards and A. F. Porter even more closely than *E. dunensis* (T. & T. A. Stephenson) Godfrey. This resemblance has led to suggestions that it may actually be *E. youngiana* by D. M. Turner Ettlinger (1997, 1998) (who recorded it as being from Porthcawl, the nearest town to Kenfig N.N.R.), P. Delforge (2001), and D. Lang (2004). If so, this has legal and conservation consequences since *E. youngiana* is classified as Endangered in Great Britain and fully protected under the Wildlife and Countryside Act 1981, Schedule 8, as well as being a UK Biodiversity priority species. However, since Kenfig is well separated from other *E. youngiana* sites (which are in Northumberland and Scotland), it would seem more likely that these plants are a form of *E. helleborine*. This would also be consistent with the view (P. M. Hollingsworth, 2003) that *E. youngiana* does not exist as a distinct species but, instead appears to be attributable to a series of morphologically complex and atypical populations of *E. helleborine*. As *E. youngiana* is only known from polluted sites, one of us (L. Lewis, 2003) has previously speculated that these Kenfig plants may be a similar adaptation to wind-blown pollution from Port Talbot steel works which lie just to the north-west. It is therefore suggested that this *Epipactis* should be referred to as *Epipactis helleborine* aff. *youngiana* pending further study of its taxonomy.

ACKNOWLEDGMENTS

We would like to thank Prof. A. J. Richards for his extensive advice on the identification of the plants we found and on the dune forms of *Epipactis* which had previously been found at Kenfig; Steve Moon, a former Warden at Kenfig N.N.R., for information on his earlier finds at Kenfig, and the Keepers of **BM**, **K**, and **NMW** for access to, scans of, and information on, herbarium specimens deposited by C. Thomas.

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PLANTS FOUND IN IRELAND BUT NOT IN BRITAIN

During the final editing of *Vice-county Census Catalogue of the Vascular Plants of Great Britain* (Stace *et al.* 2003) the taxa for which no records had been received were investigated. Many of these were listed under two categories on pp. xv–xvi, but a third category of "almost 40 taxa", those found in Ireland but not in Britain, was not detailed. The following lists analyse in more detail those non-British taxa, as it is thought that they might be of use and interest to botanists. The "almost 40" taxa (actually 41) are those in the first two lists below not bearing an asterisk or dagger. The following symbols apply:

*** taxon formerly native in Britain but now extinct; now naturalised in Britain
** taxa formerly native in Britain but now extinct
* taxa naturalised in Britain
††† taxon formerly naturalised in Britain but no longer so
†† taxa not in Britain but native in Isle of Man
† taxa recorded as casual in Britain
Irish endemics in boldface

TAXA OCCURRING AS NATIVES IN IRELAND BUT NOT NOW OCCURRING AS NATIVES IN BRITAIN

Equisetum hyemale × *ramosissimum* = *E.* × *moorei*†
Asplenium onopteris
Asplenium adiantum-nigrum × *onopteris* = *A.* × *ticinense*
Polystichum setiferum × *lonchitis* = *P.* × *lonchitiforme*
Arenaria ciliata* subsp. *hibernica
Minuartia recurva
Limonium recurvum* subsp. *pseudotranswallianum
Helianthemum oelandicum subsp. *piloselloides*
*Daboecia cantabrica**
*Arbutus unedo**
Erica mackaiana†
Erica mackaiana* × *tetralix* = *E.* × *stuartii
*Erica erigena**
*Saxifraga spathularis**
Saxifraga spathularis × *hirsuta* = *S.* × *polita**
*Saxifraga hirsuta**
Saxifraga hypnoides × *S. rosacea*
Saxifraga rosacea subsp. *rosacea****
Saxifraga rosacea* subsp. *hartii
Rubus hesperius
Rubus lettii††
Rosa spinosissima* × *rugosa
Rosa spinosissima × *agrestis* = *R.* × *caviniacensis*
Rosa tomentosa × *agrestis*
Rosa sherardii × *agrestis*
Sorbus hibernica
Gentianella amarella* subsp. *hibernica
Euphrasia salisburgensis
Euphrasia arctica × *salisburgensis*
Euphrasia nemorosa × *salisburgensis*
Euphrasia micrantha × *salisburgensis*
*Pinguicula grandiflora**
Pinguicula grandiflora × *vulgaris* = *P.* × *scullyi*
Taraxacum webbii
Taraxacum amarellum

Hieracium scullyi
Hieracium hibernicum
Hieracium sparsifrons
Hieracium basalticola
Hieracium hartii
Inula salicina†
*Otanthus maritimus***
Potamogeton natans × *berchtoldii* = *P.* × *variifolius*
Potamogeton coloratus × *berchtoldii* = *P.* × *lanceolatus***
Potamogeton lucens × *alpinus* = *P.* × *nerviger*
Potamogeton praelongus × *crispus* = *P.* × *undulatus***
Luzula multiflora* subsp. *hibernica
Carex muricata* × *divulsa
Carex divulsa × *remota* = *C.* × *emmae***
Carex hirta × *vesicaria* = *C.* × *grossii*
Simethis planifolia†††
*Sisyrinchium bermudiana**
Neotinea maculata††

The two Scottish records of *Equisetum x moorei* in the 1962 *Atlas* (Perring & Walters 1962) have never been confirmed and are presumed to be errors.

TAXA NATURALISED IN IRELAND BUT NEVER SO IN BRITAIN

Hypericum pseudohenryi
Hypericum canadense†
Hydrangea sargentiana
Haloragis micrantha
Eucalyptus urnigera
Eucalyptus johnstonii
Carlina acaulis†
Juncus planifolius
Libertia caerulescens

All but *Hypericum canadense*, *Haloragis micrantha* and *Juncus planifolius* are only rather marginally naturalised in neglected gardens or forestry plantations, but they have not been recorded even in this state in Britain. The *Libertia* needs careful vetting. Records of *Hebe elliptica* (Webb *et al.* 1996) might be well-founded but need expert confirmation; plants so recorded from Britain have proved to be variants of *H.* × *franciscana*.

TAXA FORMERLY NATURALISED IN IRELAND BUT NEVER SO IN BRITAIN

Persicaria sagittata†
Margyricarpus pinnatus
Aetheorhiza bulbosa†

"Formerly" naturalised implies either now known to be extinct, or not recorded since 1970. The *Aethiorhiza* was only rather marginally naturalised in neglected gardens.

TAXA RECORDED AS CASUAL OR MARGINALLY NATURALISED IN IRELAND BUT NOT SO IN BRITAIN

Cyathea dealbata
Sidalcea neomexicana
Rubus linkianus
Acacia dealbata
Acer macrophyllum
Onosma taurica

None of these six represents a very convincing member of the Irish wild flora and they have been listed here simply because they are included in Reynolds (2002) but not in Clement & Foster (1994). The *Onosma* was a casual in 1905, the *Sidalcea* a garden relic in 1986, the *Rubus* possibly a misdetermination of the frequent *R. armeniacus* (fide D. E. Allen, S. Reynolds pers. comm.), and the other three have only been recorded as self-sowing in parks or 'wild gardens'. In addition to the *Rubus*, the *Sidalcea* and *Acacia* need careful vetting. *Echium wildpretii* ("*wildprettii*") was also listed by Reynolds (2002) but this (fide Patrick Forde per Charles Nelson) was a misidentification of *E. pininana*.

ACKNOWLEDGMENTS

I am grateful to David Allen, Eric Clement, Paul Hackney, Clive Jermy, Naomi Kingston, Alex Lockton, David McCosh, Charles Nelson, David Pearman, Sylvia Reynolds, John Richards and Rosalind Smith for helpful comment and information.

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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* (VCCC), 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.
- 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 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.

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

1/4.1. DIPHASIASTRUM ALPINUM **104**, N. Ebudes (Eigg): The Sgurr, NM461846, B. Averis & J. Chester, 2002. 1st record for Eigg.

4/1.1. EQUISETUM HYEMALE *__45__, Pembs.: Several plants in disturbed sandy area, wet hollow in dune & dune scrub, Whitesands Dunes, St Davids, SM735266, S.B. Evans, 2002.

4/1.3. EQUISETUM VARIEGATUM **95**, Moray: The Lein, Kingston, NJ327657, I.P. Green, 2003. 1st record since 1970.

4/1.4×5. EQUISETUM × LITORALE (E. FLUVIATILE × E. ARVENSE) *__108__, W. Sutherland: Flush beside Halladale River, NC904474, H.S. McHaffie, 2002, **E**, det. C.N. Page.

4/1.4×8. EQUISETUM × DYCEI (E. FLUVIATILE × E. PALUSTRE) *__108__, W. Sutherland: In river gravel on edge of water, Halladale River, NC896506, H.S. McHaffie, 2002, **E**, det. C.N. Page.

4/1.5×8. EQUISETUM × ROTHMALERI (E. ARVENSE × E. PALUSTRE) *__52__, Anglesey: Wet grassland, near Llyn Penrhyn, SSSI & RSPB reserve, SH309766, T.D. Dines & BPS visit, 2002. Field and laboratory examination confirms an earlier report of this hybrid from this locality. In cultivation at Treborth Botanic Garden, **herb. IRB**.

4/1.6. EQUISETUM PRATENSE **104**, N. Ebudes (Raasay): Several dozen plants on damp heather-covered slope, W of Meall Daimh, NG570403, S.J. Bungard, 1996. 1st record for Raasay.

N. Ebudes (Eigg): Bank of burn, Abhainn a Cham Loin, Laig, NM4787, J. Bevan, P. Braithwaite & C.W. Murray, 1996. 1st record for Eigg.

4/1.6×7. EQUISETUM × MILDEANUM (E. PRATENSE × E. SYLVATICUM) *__108__, W. Sutherland: Small colony on cliff ledge, Creagan Meal Horn, Reay Forest, NC349458, R.W.M. Corner, 1997, **herb. C.N. Page**, det. C.N. Page.

5/1.2. OPHIOGLOSSUM AZORICUM *__104__, N. Ebudes (Raasay): More than 50 plants in close cropped coastal turf, Eilean Tigh, NG596543, S.J. Bungard, 1996, **BM**, det. A.M. Paul. Coastal turf. N. tip of Eilean Fladday, NG589520, S.J. Bungard, 1997. 4 plants, only one fertile. Additional hectad for Scarce Plant.

11/1.1 × 2. POLYPODIUM × MANTONIAE (P. VULGARE × P. INTERJECTUM) *__1b__, Scilly: On granite hedgewall in presence of both parents, St Mary's, SV915122, R.J. Murphy & R. Parslow, 2003, conf. R.J. Cooke.

11/1.2. POLYPODIUM INTERJECTUM **104**, N. Ebudes (Raasay): Hallaig area, NG5938, E.J. Baker, 1997. 1st record for Raasay.

11/1.2×3. POLYPODIUM × SHIVASIAE (P. INTERJECTUM × P. CAMBRICUM) *__2__, E. Cornwall, On mortared wall with both parents, Wearde Bridge, near Wearde Quay, Saltash, SX423577, M. Atkinson, I.J. Bennallick & R.J. Murphy, 2001, **herb. R.J. Murphy**, det. R.J. Cooke. 1st authenticated record for v.c. 2 and Cornwall. First seen in 1998 by M.Atkinson & C.N.Page. Also ▣St Germans, SX357574, M. Atkinson, I.J. Bennallick & R.J. Murphy, 2001, **herb. R.J. Murphy**, det. R.J. Cooke. *__46__, Cards.: Old mortared wall of St. Mary's churchyard, Cardigan, SN180460, A.O. Chater, 1998, **NMW**, conf. A.C. Jermy.

[15/2.3a. ASPLENIUM OBOVATUM subsp. LANCEOLATUM **9**, Dorset: Delete. Specimen not accepted.]

15/3.1. CETERACH OFFICINARUM **29**, Cambs.: About 30 plants on brick wall of old barn, Outwell Basin, TF506046, R.M. Payne, 2002, **CGE**. Second, only recent, and only extant record.

‡16/1.1. MATTEUCCIA STRUTHIOPTERIS *__42__, Brecs.: Several plants in old shrubbery along footpath in damp woodland, Gurnos, between Ystradgynlais and Ystalyfera, SN777092, M. & C. Porter, 2002. *__46__, Cards.: Naturalised in damp woodland, 200m E of Plas Gogerddan, SN631838, A.O. Chater, 2003, **NMW**. *__81__, Berwicks.: Naturalised by pond, Newton Don, NT712369, M.E. Braithwaite and ENHS party, 2002.

16/4.1. GYMNOCARPIUM DRYOPTERIS **2**, E. Cornwall: On steep bank of wooded valley of River Inny, near Laneast, SX222833, I.J. Bennallick, 2003, **BM**. The only extant record for Cornwall, not seen since 1930.

16/4.2. GYMNOCARPIUM ROBERTIANUM ‡__29__, Cambs.: Two clumps growing below coping of E end of high garden wall, St Mary's School, Bateman Street, Cambridge, TL453573, P.H. Oswald, 1999, **CGE**, det. A.O. Chater. 1st record since 1763.

[16/5.1. CYSTOPTERIS FRAGILIS **9**, Dorset: Alter to Introduction]

16/5.dia. CYSTOPTERIS DIAPHANA *__2__, E. Cornwall, rocky woodland banks and steep riverside banks, by the Camel River, Polbrock Bridge, near Wadebridge, SX013695, M.J. Stribley, 2000, det. C. Fraser-Jenkins & F.J. Rumsey. New to British Isles. Originally identified as *C. fragilis* but re-identified in 2002 as *C. diaphana*.

16/6.2. WOODSIA ALPINA **104**, N. Ebudes (Skye): 1 plant on cliff face to W of Sgurr a Mhadaidh Ruaidh, Trotternish, NG469585, G.P. Rothero, 2001, **E**, conf. H.S. McHaffie. 1st record since 1880s and not at the Quiraing. 2nd site found by S.J. Bungard in 2002, to E of G.P.Rothero's original site.

17/3.1. DRYOPTERIS OREADES **104**, N. Ebudes (Raasay): Boulder scree, between Brochel road and Meall Daimh, NG564403, S.J. Bungard, 1997, **BM**, det. A.M. Paul. New to Raasay.

‡22/1.1. ARAUCARIA ARAUCANA *__42__, Brecs.: Sapling (c. 30cm) regenerating from mature planted tree in scrub and waste ground, cemetery of derelict church, 0.5km W of Princetown, SO106098, M. & C. Porter, 2002.

‡24/1.1. LAURUS NOBILIS *__29__, Cambs.: Two young plants on wall top, Green Lane, Ely, TL5281, R.M. Payne, 2002. Large, probable parent tree in garden nearby.

26/2.2. NUPHAR PUMILA *__108__, W. Sutherland: Fresh-water loch, Loch Beannach, 1 m. deep at this point, NC141267, G. Richards & C. Bolshaw, 2003, det. P. & I. Evans.

‡28/9.2. ANEMONE APENNINA *__58__, Cheshire: roadside verge, Mill Lane, Heswall, SJ2781, E. F. Greenwood, 2000. Precise location uncertain. *__69__, Westmorland: Woodland, Helm Lane, Oxenholme, SD527888, A. Boucher, 2003, **LANC**.

‡28/12.5, CLEMATIS VITICELLA *__44__, Carms.: On *Corylus avellana* in scrubby dunes, Pembrey Burrows, SS433995, J. Green *et al.* 2001.

‡28/13.16. RANUNCULUS ACONITIFOLIUS *__94__, Banffs.: Single plant on S side of road, SE of Speyside Cooperage, opposite house, near junction of A491 and un-numbered minor road, NJ296438, A.G. Amphlett, 2003. Flore pleno.

[28/13.19×20. RANUNCULUS × NOVAE-FORESTAE (R. OMIOPHYLLUS × R. TRIPARTITUS) **52**, Anglesey: Wet open heathland, Tre Wilmot, SH228814, M. Sutton, 2001. R.V. Lansdown has now examined photographs of the plants and is confident they are within the range of variation of *R. tripartitus*.]

28/13.22. RANUNCULUS TRICHOPHYLLUS *__101__, Kintyre: 2 plants in mud in dune hollow, Clochkeil, NR654241, I. Teesdale & A. Stewart, 2003, conf. N.F. Stewart.

28/13.24. RANUNCULUS PELTATUS *__91__, Kincardines.: Pool in stream, Mill of Muchalls, NO901912, D. Welch, 2003, **herb. D. Welch**.

¢29/1.4. BERBERIS WILSONIAE *__81__, Berwicks.: Hedge, A1 by Lemington, NT856627, M.E. Braithwaite, 2001.

‡30/1.2. PAPAVER ATLANTICUM *__41__, Glam.: Established along pavement and at base of old wall, south-central Swansea, SS652926, C.R. Hipkin, 2002. *__44__, Carms.: Dozens of plants in dumped rubble, Delta Lake site, Machynys, SS508984, T. & V. Lewis, 2004.

†30/1.3a, PAPAVER SOMNIFERUM subsp. SOMNIFERUM *__44__, Carms.: Disturbed sandy ground, old boat yard E of Pickle Factory, Burry Port, SN443004, T. & V. Lewis, 2002. 1st record for subspecies.

†30/1.3b. PAPAVER SOMNIFERUM subsp. SETIGERUM *__44__, Carms.: Disturbed sandy ground, old boat yard E of Pickle Factory, Burry Port, SN443004, T. & V. Lewis, 2002. 1st record for subspecies.

†30/1.4. PAPAVER RHOEAS **94**, Banffs.: 3 plants in set-aside field, Manse of Ord, NJ625894, A.G. Amphlett, 2003. 1st record since 1970.

†31/5.3. FUMARIA BASTARDII *__81__, Berwicks.: Four plants in set-aside, near Broomdykes, NT887539, M.E. Braithwaite, 2002. Also 2 plants below Silverwells, NT 885662.

31/5.6. FUMARIA PURPUREA *__109__, Caithness: Frequent in two fields at John o' Groats, ND362730, J. Crossley & J.K. Butler, 2001, **herb. J.K.B.**, det. H.S. McHaffie.

31/5.8. FUMARIA DENSIFLORA **1a**, W. Cornwall: A few plants in arable field (Spring Barley), Trevemedar Farm, Porthcothan, SW856716, I.J. Bennallick, 2003, **NMW**, conf. R. Lansdown. 1st record since 1970.

¢34/1/1. CANNABIS SATIVA *__43__, Rads.: Shore of Llandrindod Lake, SO062605, A.G. Shaw, 2002. Probably from fishing bait or birdseed. *__52__, Anglesey: In a field, opposite Fron Capel, Gaerwen, SH491728, W. McCarthy & M. Stead, 2003.

34/2.1. HUMULUS LUPULUS *‡__93__, N. Aberdeen.: In snowberry bush, Artrochie, NK002322, D. Welch, 2003.

‡35/2.1. FICUS CARICA **42**, Brecs.: A well grown plant c. 5-6m tall in disused limestone quarry, 1km SW of Clydach, SO222124, M. & C. Porter, 2002. 2nd record and 1st since 1941.

36/1.16. URTICA DIOICA subsp. GALEOPSIFOLIA *__39__, Staffs.: Wooded marshland, Jackson's Marsh, Bishop's Offley, SJ787298, A. Leak, 1997.

‡36/2.off. PARIETARIA OFFICINALIS *__29__, Cambs.: Abundant under shrubs by bowling green, Brooklands Avenue, Cambridge, TL455570, A.C. Leslie, 2002, **CGE**. Known as a weed in the Botanic Garden, which runs beside the bowling green, but not recorded outside it before.

‡36/3.1. SOLEIROLIA SOLEIROLII *__81__, Berwicks.: Established by path, Paxton, NT936530, M. E. Braithwaite, 2001.

¢39/4.3. QUERCUS ILEX *__81__, Berwicks.: Planted near Carfrae, NT502551, M.E. Braithwaite, 1997.

‡41/1.1. PHYTOLACCA ACINOSA *__81__, Berwicks.: Established in ditch, East Morriston, NT610420, L.W. Gaskell, 2003.

†43/1.5. CHENOPODIUM GLAUCUM ▣__39__, Staffs.: Weed in disturbed soil of garden, Oldbury, SO999881, M.W. Poulton, 2003.

43/1.6. CHENOPODIUM RUBRUM *94, Banffs.: 18 plants at rubbish dump, Nether Dallachy, NJ362644, I.P. Green, 2003. Perhaps only ephemeral at this location.

†43/1.10. CHENOPODIUM HYBRIDUM **5**, S. Somerset: Single plant growing where new sewer has been put across field, Washford, ST0441, J. & T. Webb, 2003. 1st record since 1849.

¢43/3.1. ATRIPLEX HORTENSIS *42, Brecs.: One plant in river shingle, near Bronllys Castle, SO150349, M. & C. Porter, 2002. *58, Cheshire: Disturbed ground, Meols, SJ234900, R.F. Goodchild, 2003, det. E.J. Clement.

43/3.2×3. ATRIPLEX PROSTRATA × A. GLABRIUSCULA *109, Caithness: 1 plant on Dunbeath south shore, ND163293, J.K. Butler, 2002, **herb. J.K.B.**, det. J.R. Akeroyd.

43/3.3. ATRIPLEX GLABRIUSCULA **113**(S), Channel Is. (Sark): Sand among rocks at foot of sea cliffs near spring high-water mark, Dixcart Bay, WV466750, R.M. Veall, 2003, **herb. Société Sercquiaise**. 1st localised record for Sark since 1897.

43/3.3×4. ATRIPLEX × TASCHEREAUI (A. GLABRIUSCULA × A. LONGIPES) *109, Caithness: 2 plants on Thurso Beach, ND113687, J.K. Butler, 2002, **herb. J.K.B.**, det. J.R. Akeroyd.

43/3.4. ATRIPLEX LONGIPES ▮9, Dorset: Top of salt-marsh, Brands Bay, SZ014850, E.A. Pratt, 2002.

43/3.6. ATRIPLEX LITTORALIS *48, Merioneth: In quantity in one spot on driftline where sea encroached with high tides in Feb. 2002, between Llanaber and Talybont, SH5919, P.M. Benoit, 2002, **NMW**. 2nd, and 1st recent record.

43/4.1a, BETA VULGARIS subsp. MARITIMA **104**, N. Ebudes (Muck): rock ledge above shore, Port an T-Seilich, NM418784, A. White & J. Taylor, 2000, **E**. 1st record for Muck and 2nd for v.c. 104.

43/5.1. SARCOCORNIA PERENNIS ▮9, Dorset: The Fleet, SY613810, B. Edwards, 2003.

43/7.2. SUAEDA MARITIMA **104**, N. Ebudes (Raasay): Top of shore, Old Harbour, NG5436, S. J. Bungard & C.W. Murray, 2001. 1st record for Raasay since 1930s.

¢44/1.1. AMARANTHUS RETROFLEXUS *85, Fife & Kinross: Garden, Cupar, NO378147, W. Hay, 2003, det. D.R. McKeen Bird-seed alien.

¢44/1.1×2. AMARANTHUS × OZANONII (A. RETROFLEXUS × A. HYBRIDUS) *29, Cambs.: One plant on disturbed ground by new buildings, Chesterton Hospital, TL461599, A.C. Leslie, 2002.

¢44/1.2. AMARANTHUS HYBRIDUS *70, Cumberland: Flower bed, bird seed casual, Wetheral Pasture, NY460533, F.J. Roberts, 2003, **LANC**, conf. T.B. Ryves.

¢44/1.bli. AMARANTHUS BLITUM **6**, N. Somerset: Nursery weed, Yatton, ST437643, I.P. Green, 2003. 1st record since 1911.

¢44/1.pow. AMARANTHUS POWELLII *6, N. Somerset: Plentiful weed in maize field, Westhay Level, ST423425, R. Woodhall, 2003, det. E.J. Clement. *34, W. Gloucs.: 3 plants on road verge, Cowhill, ST616912, M.A.R. & C. Kitchen, 2003, det. E.J. Clement.

[45/3.1b. MONTIA FONTANA subsp. VARIABILIS **9**, Dorset: Alter to extant Native.]

46/7.2. CERASTIUM ARVENSE **91**, Kincardines.: riverbank, Crathes, NO735961, D. Welch, 2003. 1st record since 1960.

46/7.8. CERASTIUM GLOMERATUM **104**, N. Ebudes (Canna): West side of Sanday, NG2604, P. F. & M.E. Braithwaite, 2001. 1st record for Canna.

46/7.11. CERASTIUM PUMILUM ▮9, Dorset: Chalk downland, Ballard Down, SZ031812, E.A. Pratt, 2001.

46/8.1. MYOSOTON AQUATICUM **78**, Peebless.: Garden weed at Traquair House, NT328353, R.W.M. Corner, 2002, **E**, conf. D.J. McCosh. 1st localised record (listed by F.R. Balfour in Buchan's *History of Peeblesshire*).

46/10.1. SAGINA NODOSA **104**, N. Ebudes (Muck): rock cleft on shore, Gallanach, NM4080, P.F. Braithwaite, 1999. 1st record for Muck - not in Dobson list.

46/10.3. SAGINA SUBULATA **81**, Berwicks.: 177 plants on bare, peaty patch on knowe, St Abbs Head NNR, NT911691, M.E. & P.F. Braithwaite, 2002. 1st record since 1893.

46/10.8. SAGINA MARITIMA **104**, N. Ebudes (Canna): In gravel of pier, Canna, NG2705, M.E. Braithwaite, 2001. 1st record for Canna.

‡46/14.1. ILLECEBRUM VERTICILLATUM ▮9, Dorset: On tracks used by tanks, Woolbridge Heath, SY841891, B. Edwards, 2002. Arrived with Army vehicles.

46/17.2. SPERGULARIA MEDIA **104**, N. Ebudes (Raasay): Salt marsh, Oskaig, NG546377, S.J. Bungard, 2002. 1st record for Raasay.

46/17.3. SPERGULARIA MARINA *†**42**, Brecs.: Many plants along c. 100m of verge of 'Head of Valleys' road (A465), Blackrock, SW of Gilwern, SO219127, M. & C. Porter, 2002.

46/17.4. SPERGULARIA RUBRA **104**, N. Ebudes (Raasay): In the tarmac, Dun Caan' carpark, NG561405, S.J. Bungard & C.W. Murray, 2001. 1st record for Raasay.

‡46/18.cha. LYCHNIS CHALCEDONICA *__46__, Cards.: Naturalised at fen edge, 150m W of Clyngwyn Troed-y-rhiw, SN488536, A.O. Chater, 2003. *¢**81**, Berwicks.: Quarry, near Fans, NT615417, M.E. Braithwaite, 2002.

¢46/19.1. AGROSTEMMA GITHAGO *__81__, Berwicks.: From sown mix, Earnscleugh House, NT545518, M.E. Braithwaite & L.W. Gaskell, 2001.

¢46/22.2. SAPONARIA OCYMOIDES *__9__, Dorset: Gutter weed, Swanage, SZ026798, D.C. Leadbetter, 2000.

‡46/25.3. DIANTHUS PLUMARIUS *__39__, Staffs.: Grassland near playground, Ruiton, SO919918, B. Hopton, 2001. Waste ground, Castletown, SJ913233, I.J. Hopkins, 2003.White-flowered form. Additional hectad for Scarce Plant.

46/25.5. DIANTHUS DELTOIDES *‡**93**, N. Aberdeen: Derelict railway yard, Insch, NJ630276, D. Welch, 2003, **herb. D. Welch**.

¢47/1.2. PERSICARIA CAMPANULATA *__81__, Berwicks.: Policies, Paxton House, NT9352, W. Frost & E. Isherwood, 1960, **BM**. Established by stream, Coldingham, NT9065, J. McNeill, 1977, **herb. Dept. Agriculture, Ottawa**. 1st record since 1960.

‡47/1.7. PERSICARIA AMPLEXICAULIS *__49__, Caerns.: Edge of field, Fachwen, Llanberis, SH576617, W.M. McCarthy, 2002.

¢47/1.13. PERSICARIA PENSYLVANICA *__81__, Berwicks.: Turnip factory tip, Old Cambus quarry, NT808705, J. Muscott & ENHS party, 2003, det. M.E. Braithwaite.

47/1.16. PERSICARIA MINOR **5**, S. Somerset: By stream in draw-down zone, Clatworthy Reservoir, ST034304, W. Bleeker & T.C.G. Rich, 2003. 1st record since 1938.

¢47/1.cap. PERSICARIA CAPITATA *__46__, Cards.: Pavement weed, Trefechan, Aberystwyth, SN582811, R.A. Jones, 2003.

47/4.1. POLYGONUM MARITIMUM **1b**, Scilly: 2 small plants on strandline, Great Porth, Bryher, SV875145, E. Sears, 2003, conf. R.E. Parslow. 1st record since 1909.

47/4.2. POLYGONUM OXYSPERMUM *__91__, Kincardines.: Shore, Stonehaven, NO876860, I.P. Green, 2002.

†47/4.3. POLYGONUM ARENASTRUM **104**, N. Ebudes (Raasay): rough ground, Eyre, NG5834, S.J. Bungard & C.W. Murray, 2001. 1st definite record for Raasay.

†47/4.6. POLYGONUM RURIVAGUM **1a**, W. Cornwall, Arable field, Towan Farm near Porthtowan, SW694487, A.J. Byfield & D.A. Pearman, 2003. The only extant record for W. Cornwall. **2**, E. Cornwall: Arable field, Churchtown Farm, near Saltash, SX416581, I.J. Bennallick, 2003, det. J.R. Akeroyd. The only extant record for E. Cornwall. *__39__, Staffs.: Disturbed ground, edge of new section of road, Laney Green, SJ959069, G.M. Kay & J.H. Clarke, 2003. *__50__, Denbs.: Headland of barley field, Abergele, SH967762, J.A. Green, 2003, det. J. R. Akeroyd.

‡47/5.1×2. FALLOPIA × BOHEMICA (F. JAPONICA × F. SACHALINENSIS) *__58__, Cheshire: Well established on edge of mown grass in parkland, Preston, SJ30(5)85(9), E.F. Greenwood, 2000.

‡47/6.1. MUEHLENBECKIA COMPLEXA *__29__, Cambs.: Brick churchyard wall with *Pseudofumaria alba*, Little Thetford, TL531762, R.M. Payne, 2002, det. K.A. Beckett.

‡47/8.3d. RUMEX ACETOSA subsp. AMBIGUUS *__29__, Cambs.: Large colony on waste ground, north side of King's Hedges Road, Cambridge, TL452617, A.C. Leslie, 2002, **CGE**.

†47/8.6. RUMEX PSEUDOALPINUS ▮**39**, Staffs.: roadside, Near Heaton, SJ958617, J.E. Hawksworth, 2000. Road verge, Tickhill, SJ955440, I.J. Hopkins, 2001. Additional hectad for Scarce Plant.

47/8.8 ×19. RUMEX × HYBRIDUS (R. LONGIFOLIUS × R. OBTUSIFOLIUS) *__81__, Berwicks.: With parents, old railway, Fans, NT613416, M.E. Braithwaite, 2002.

‡47/8.11. RUMEX CRISTATUS *__39__, Staffs.: Several well-established plants by two ditches, Castletown, Stafford, SJ915231, I.J. Hopkins, 2002.

47/8.14×21. RUMEX × KNAFII (R. CONGLOMERATUS × R. MARITIMUS) *__29__, Cambs.: 20-30 plants in a large mixed population of both parents on shore of shallow lake, W of Ely North Junction, Ely, TL559811, A.C. Leslie, 2003, **CGE**.

47/8.15 ×19. RUMEX × DUFFTII (R. SANGUINEUS × R. OBTUSIFOLIUS) *__81__, Berwicks.: With parents, gravel by Kirk Burn, Polwarth, NT751496, M.E. Braithwaite, 2002.

47/8.18×19. RUMEX × OGULINENSIS (R. PULCHER × R. OBTUSIFOLIUS) *__29__, Cambs.: With both parents in meadow, Impington, TL448632, P.D. Sell with B. & R. Chapman, 1999, **CGE**.

48/2.1. ARMERIA MARITIMA *‡__39__, Staffs.: Eastern verge of Smestow road, Swindon, SO854920, B.R. Fowler, 1994. Spread to western verge by 2002.

‡49/1.off. PAEONIA OFFICINALIS ◧__39__, Staffs.: Uncultivated derelict ground, Doxey, SJ905235, I.J. Hopkins, 2003. By brook, Wombourne, SO878929, C.B. Westall, 2002, Additional hectad for Scarce Plant. *__94__, Banffs.: Bank of river Spey, c. 100m downstream from mouth of River Fiddich, NJ293454, A.G. Amphlett, 2003. Planted - perhaps best considered casual.

‡51/1.3×4. HYPERICUM × INODORUM (H. ANDROSAEMUM × H. HIRCINUM) *__H32__, Monaghan: Dartry, H603163, I. McNeill, 2003, det. P. Hackney.

51/1.9. HYPERICUM TETRAPTERUM **104**, N. Ebudes (Canna): Garbh Asgarnish, NG281059, M.E. Braithwaite, 2001. 1st record for Canna.

‡51/1.for. HYPERICUM FORRESTII *__70__, Cumberland: Two plants by shore of Derwentwater, NE of Barrow Beck, NY266202, F.J. Roberts, 2003, **LANC**, det. N.K.B. Robson.

¢53/1.2. MALVA ALCEA *__9__, Dorset: Trackside, Durlston, Swanage, SZ028778, E.A. Pratt, 2002, **RNG**, det. E.J. Clement.

‡53/2.3×olb. LAVATERA × CLEMENTII (L. THURINGIACA × L. OLBIA) *__50__, Denbs.: roadside, Bodelwyddan, SH982762, J.A. Green, 2003, **NMW**.

55/1.1×3. DROSERA × BELEZANIA (D. ROTUNDIFOLIA × D. INTERMEDIA) *__9__, Dorset: Acid flushes in 5 sites, Godlingston Heath, SZ014827, D.A. Pearman, 2002, det. A. Culham. 1st confirmed British record.

57/1.5. VIOLA REICHENBACHIANA **46**, Cards.: river bank, 200m SE of Hafod Wen, Llechryd, SN204429, A.O. Chater & J.P. Woodman, 2003. 1st confirmed record since 1941.

57/1.12×13. VIOLA × CONTEMPTA (V. TRICOLOR × V. ARVENSIS) *__91__, Kincardines.: Arable field, Auchenblae, NO724799, D. Welch, 2003, conf. D. Moore.

‡59/1.1. FRANKENIA LAEVIS *__49__, Caerns.: One plant on shingle beach, West Shore, Llandudno, SH768822, W.M. McCarthy, 2002.

¢60/CUT.pep. CUCURBITA PEPO *__57__, Derbys.: Two plants on muck heap, Brook Farm, Muggington Bottoms, SK281434, C. Higginbottom, C.N. Smith & M. Smith, 2003.

¢61/1.4×del. POPULUS × GENEROSA (P. TRICHOCARPA × P. DELTOIDES) *¢__81__, Berwicks.: Planted, Craigswalls, NT836554, L.W. Gaskell, 2002.

61/2.1. SALIX PENTANDRA **91**, Kincardines.: Fen carr, Annie's Dam, NO801717, D. Welch, 2003. 1st record since 1923.

‡61/2.3 × bab. SALIX SEPULCRALIS (S. ALBA × S. BABYLONICA) *__2__, E. Cornwall: Along the bank of the Bude Canal, SS208056, Botanical Cornwall Group and R.D. Meikle, 2003, det. R.D. Meikle. Probably planted.

†61/2.4×9. SALIX × MOLLISSIMA (S. TRIANDRA × S. VIMINALIS) *__2__, E. Cornwall: Along the bank of the Bude Canal, SS207058, Botanical Cornwall Group and R.D. Meikle, 2003, det. R.D. Meikle. Always an introduction. New to Cornwall.

61/2.5×9. SALIX × RUBRA (S. PURPUREA × S. VIMINALIS) ¢__9__, Dorset: Planted in hedge in country park, Durlston, Swanage, SZ032773, E.A. Pratt, 2002, RNG, det. R.D. Meikle. 1st record since 1970.

61/2.9 × 10. SALIX × SMITHIANA (S. VIMINALIS × S. CAPREA) *__2__, E. Cornwall: Along the bank of the Bude Canal, SS210056, Botanical Cornwall Group and R.D. Meikle, 2003, det. R.D. Meikle. **49**, Caerns.: river bank, Capelulo, SH744765, W.M. McCarthy, 2002. 1st recent record.

104, N. Ebudes (Raasay): 2 trees, possibly planted, Eyre, NG5734, S.J. Bungard, 1996, det. R.D. Meikle, 1st record for Raasay and perhaps for v.c. 104.

‡61/2.9×10×11. SALIX × CALODENDRON (SALIX VIMINALIS × S. CAPREA × S. CINEREA) *__91__, Kincardines.: Streamside, Glenbervie, NO758807, D. Welch, 2003, **herb. D. Welch**, conf. R.D. Meikle.

61/2.10. SALIX CAPREA **104**, N. Ebudes (Rona): West coast, north of Dry Harbour, NG65, S.J. Bungard, 2001. 1st record for Rona.

61/2.10×11. SALIX × REICHARDTII (S. CAPREA × S. CINEREA subsp. OLEIFOLIA) *2, E. Cornwall: Along the bank of the Bude Canal, SS209056, Botanical Cornwall Group and R.D. Meikle, 2003, det. R.D. Meikle.

61/2.11. SALIX CINEREA **104**, N. Ebudes (Canna): Open moor, S of An t-doan, Sanday, NG283041, M.E. & P.F. Braithwaite, 2001. Planted? Seems to be 1st record for Canna.

61/2.11×12. SALIX × MULTINERVIS (S. CINEREA × S. AURITA) **104**, N. Ebudes (Skye): roadside ditch, Loch Mealt, NG5065, C.W. Murray, 1997, **E**, det. D.R. McKean, 1st definite record for Skye.

61/2.12×16. SALIX × AMBIGUA (S. AURITA × S. REPENS) *81, Berwicks.: Fen, Lurgie Loch, NT6739, A. Brotherstone, 1878.

61/2.17×19. SALIX × PSEUDOGLAUCA (S. LAPPONUM × S. ARBUSCULA) **90**, Angus: Steep rocky slope on mica-schist, Coire Sharroch, Glen Clova, NO27, D.J. Tennant, 2000, **herb. D.J.T**. 1st record since 1913.

[61/2.17×20. SALIX LAPPONUM × S. MYRSINITES **92**, S. Aberdeen, Glen Callater, D.J.Tennant, 1995. D.J.Tennant reports that recent (2003) changes in growth of cultivated material suggest that the proposed parentage is not correct. He advises that all records for this combination should be removed.]

¢62/2.1. DESCURAINIA SOPHIA **81**, Berwicks.: Cumledge, NT7956, A.J. Smith, 1977, 1st record since 1970.

‡62/9.1. MALCOLMIA MARITIMA **11**, S. Hants.: W of public carpark, Stanpit, SZ165927, P.A. Budd, 2003, conf. B. Goater. 1st record since 1970.

[62/10.2. MATTHIOLA SINUATA **9**, Dorset: Alter to Neophyte.]

¢62/10.lon. MATTHIOLA LONGIPETALA **95**, Moray: rubbish tip, Elgin, NJ2363, I.P. Green, 2003. 1st record since 1970.

62/12.3. RORIPPA ISLANDICA *2, E. Cornwall, Gravelly shore to Upper Tamar Lake, SS288117, P.R. Green, 2003, **NMW**, det. T.C.G. Rich. 1st record for Cornwall. *6, N. Somerset: Bare soil in area used for parking, Chew Valley Lake, ST580604, P.R. Green, 2003. *42, Brecs.: 40-50 plants of various sizes in drainage channel in rock beside minor road, 1.5km NW of Troedrhiwdalar, SN942547, M. & C. Porter, 2002, conf. A.O. Chater. *81, Berwicks.: Colony on wet bank, Mellerstain Lake, NT652386, P.F. Braithwaite, 2001, det. T.C.G. Rich.

62/12.4. RORIPPA PALUSTRIS **95**, Moray: Christie's Garden Centre, Fochabers, NJ350583, I.P. Green, 2003. 1st record since 1970.

62/12.5. RORIPPA SYLVESTRIS **1a**, W. Cornwall, bulbfield, Varfell Farm near Long Rock, Penzance, SW506322, R.J. Murphy & H.M. Meredith, 2003. The only extant record for v.c. 1 and the first since 1959.

[62/12.6. RORIPPA AMPHIBIA **9**, Dorset: Delete. No specimen. Not accepted.]

‡62/14.4. CARDAMINE RAPHANIFOLIA *6, N. Somerset: One clump on bank of stream, Tobury, Bruton, ST680348, S. Parker, 2003. *46, Cards.: Naturalised in Llethi dingle, N of Llanarth, SN426581, A.O. Chater, 2003, **NMW**.

62/14.5. CARDAMINE PRATENSIS *‡**113(A)**, Channel Is. (Alderney), 100+ plants in flower in 3×5m area of gravel in streambed, by the Lavoiret at Ladysmith, WA570076, B. Bonnard, 2002.

62/14.7. CARDAMINE FLEXUOSA **104**, N. Ebudes (Canna): NG20, M.E. & P.F. Braithwaite, 2001. 1st record for Canna.

‡62/14.cor. CARDAMINE CORYMBOSA *29, Cambs.: Garden weed, 13 Landbeach Road, Milton, TL478631, G.M.S. Easy, 2003, **herb. G.M.S. Easy**, conf. A.C. Leslie. *46, Cards.: Abundantly naturalised for c. 8 years, paths and nursery, below Bach-y-rhew, Ffostrasol, SN363477, A.O. Chater, 2002, **NMW**.

[62/15.2. ARABIS GLABRA **9**, Dorset: Alter to Casual. No specimen; casual at best.]

‡62/18.2. ALYSSUM SAXATILE *39, Staffs.: Pavement, Common Road, Wombourne, SO873924, C.B. Westall, 2002.

62/22.1. EROPHILA MAJUSCULA *39, Staffs.: roadside verge, near Weag's Bridge, Manifold Valley, and nearby, SK101541, J.E. Hawksford, 2002. Also near Sugarloaf, north of Wetton Mill SJ097957, J.E.Hawksford, 2002. **50**, Denbs.: Quarry, Llangollen, SJ223425, E. Milleur, 2003. 2nd, and 1st recent record.

62/22.3. EROPHILA GLABRESCENS *__39__, Staffs.: Edge of footpath across river bridge, Ilam Country Park, SK133506, J.E. Hawksford, 2002. Also in large numbers on tilled garden soil, Lindale Drive, Wombourne, SO865918, C.B. Westall 2002.

62/23.5. COCHLEARIA DANICA __104__, N. Ebudes (Eigg): Saltmarsh, Eilean Feoir, NM485842, J. Bevan, 2000. 1st record for Eigg since Heslop Harrison in 1930s.

‡62/28.5. THLASPI MACROPHYLLUM *__85__, Fife & Kinross: Edge of small wood by farm, near Stravithie, south of St Andrews, NO527102, E.D.Cormack, 2003, **herb. G.H.B**. Planted here, probably in 1930s, and now well naturalised.

‡62/29.1. IBERIS SEMPERVIRENS *¢__29__, Cambs.: One large flowering plant on old soil heap, SE of Hills Road railway bridge, Cambridge, TL461569, A.C. Leslie, 2002, **CGE**.

62/30.3. LEPIDIUM HETEROPHYLLUM __104__, N. Ebudes (Eigg): On gravel in old quarry, W of Kildonan road, NM4885, J. Chester, 1996, conf. C.W. Murray. 1st record for Eigg.

62/31.1. CORONOPUS SQUAMATUS __93__, N. Aberdeen: Hard-standing by house, Sandhaven, NJ958677, D. Welch, 2003. Only extant site.

‡62/31.2. CORONOPUS DIDYMUS *__108__, W. Sutherland: Two large patches on soily area at edge of car park, Droman Pier, NC186592, I.M. Evans, 2003.

62/42.1a. RAPHANUS RAPHANISTRUM subsp. RAPHANISTRUM ¢__52__, Anglesey: Casual, near Club House, Rhosneigr, SH324739, M. & W. Walton, 2002. 1st post-1970 record.

62/42.1b. RAPHANUS RAPHANISTRUM subsp. MARITIMUS __48__, Merioneth: One large plant on drift line near shore, near the mouth of Afon Dysynni, SH5603, P.M. Benoit, 2002, **NMW**. 1st recent record for subspecies.

¢62/42.sat. RAPHANUS SATIVUS *__81__, Berwicks.: 5 plants in kale field, Raecleuch, NT612509, L.W. Gaskell, 2003, det. M.E. Braithwaite.

66/1.1. PYROLA MINOR, ▣__104__, N.Ebudes (Skye): Hazel scrub, Skernish, NG418502, C.W. Murray, 1999, **herb. C.W.M.**, det. D.R. McKean. 2nd record for Skye.

66/1.2. PYROLA MEDIA __104__, N. Ebudes (Raasay): NW of Screapadal, NG574448, S.J. Bungard, 1996. 1st record for Raasay

66/1.3. PYROLA ROTUNDIFOLIA *__104__, N. Ebudes (Raasay): Cliff ledge, east coast, NG583424, S.J. Bungard & C.W. Murray, 1997, det. H.J. Nolte.

[69/2.1. HOTTONIA PALUSTRIS __9__, Dorset: Alter to Neophyte]

‡69/3.2. CYCLAMEN COUM *__11__, S. Hants.: Bitterne Road East, SU460130, P.A. Budd, 2003, **herb. M.W. Rand**, conf. E.J. Clement.

‡69/4/4. LYSIMACHIA CILIATA __43,__ Rads.: roadside verge and river bank beside R. Ithon, N of Dolau Jenkin, Penybont, SO110654, R.G. Woods & J. Poole, 2002. 1st recent record.

‡69/4.6. LYSIMACHIA TERRESTRIS *__9__, Dorset: Ditches in water meadows, East Holme, SY909859, P.A. Grey & E.A. Pratt , 2003, **herb. E.J. Clement**, det. E.J. Clement. 1st record away from Lake District.

‡71/1.1. PHILADELPHUS CORONARIUS *__91__, Kincardines.: Steep river bank next to curtilage, Tilquhillie, NO712959, D. Welch, 2003.

‡72/1.1. ESCALLONIA MACRANTHA *__39__, Staffs.: Waste, rough grassland near canal, off Waldron Avenue, Brierley Hill, SO909868, A.P. Daly, 2002.

‡73/5.10. SEDUM RUPESTRE __85__, Fife & Kinross: Well established on old wall top, forming several small patches, Cairneyhill, at west end, NT035861, R.I. Milne, 2003. 1st definite record since 1907.

‡73/5.13. SEDUM SEXANGULARE ¢__29__, Cambs.: Gutter of church roof and garden wall, Wimblington, TL4192, R.M. Payne, 2002. 1st record since 19th Century.

‡74/1.1 × ros × chi. ASTILBE × ARENDSII (A. JAPONICA × A. ROSEA × A. CHINENSIS) *__81__, Berwicks.: Established patch near timber stack, Mincie Moss, NT631383, M.E. Braithwaite, 2002.

‡74/4.1. DARMERA PELTATA *__41__, Glam.: Stream-bank, near Merthyr Mawr, SS884774, A.S. Lewis, 2002. First seen here 1998.

‡74/6.1. HEUCHERA SANGUINEA *__58__, Cheshire: Eleven plants self-seeded on wall, New Brighton, Wirral, SJ307929, R.F. Goodchild, 2000.

‡75/3.1×2. SPIRAEA × ROSALBA (S. SALICIFOLIA × S. ALBA) *__85__, Fife & Kinross: river bank, one bush, near Cluny, by river Ore, NT245963, R.I. Milne, 1998.

‡75/3.1×3. SPIRAEA × PSEUDOSALICIFOLIA (S. SALICIFOLIA × S. DOUGLASII) *__81__, Berwicks.: Extensively established, Mellerstain Lake, NT652386, M.E. & P.F. Braithwaite, 2001.

‡75/5.1. HOLODISCUS DISCOLOR *__109__, Caithness: 1 tree in a conifer plantation, Langwell, ND100223, F. Higgins & J.K. Butler, 2001.

‡75/8.2. RUBUS TRICOLOR *__46__, Cards.: Pathside by Afon Rheidol, Aberystwyth, SN586811, A.O. Chater, 2002, **NMW**. *__47__, Monts.: Local Authority planting as ground cover and spreading on roadside, Buttington, SJ250086, R.A. Dawes, 2002.

‡75/8.11. RUBUS COCKBURNIANUS ▮__39__, Staffs.: Becoming rampant on railway embankment, Wombourne, SO871925, C.B. Westall, 2000. *__46__, Cards.: Naturalised on field edge, by Clawdd Helyg, Commins Coch, SN612823, A.O. Chater, 2003.

75/8.79. RUBUS ROBIAE *__11__, S. Hants.: , Locally common under bracken, Broomy Plain, New Forest, SU1910, D.E. Allen, 2002, **BM** & **HCMS**, conf. A. Newton..

75/8.83. RUBUS SILVATICUS *__10__, Wight: Nunneys Wood, Ningwood, SZ4089, D.E. Allen, 2002, **BM** & **HCMS**, conf. A. Newton.

75/8.90. RUBUS AMPLIFICATUS *__29__, Cambs.: One small colony along 10-15m of hedge on NE side of track running beside White Wood, Gamlingay, TL213525, A.L. Bull, 2002, **CGE**.

75/8.154. RUBUS LANATICAULIS *__10__, Wight: In plenty, Knighton East Wood, SZ5787, D.E. Allen & C.R. Pope, 2003, **BM**, **HCMS**, **NMW**, conf. A. Newton.

75/8.158. RUBUS ORBUS *__46__, Cards.: Felled woodland, Coed Newydd, Coedmor, SN196443, D.E. Allen & A.O. Chater, 1999, **NMW**, conf. A. Newton.

75/8.185. RUBUS GRIFFITHIANUS *__10__, Wight: Single large patch, Cothey Bottom Copse, Ryde, SZ607908, D.E. Allen, 2003, **BM**, conf. A. Newton.

75/8.194. RUBUS MICANS *__29__, Cambs.: Small colony at edge of station car park, Meldreth, TL377454, A.C. Leslie, 2002, **CGE**, det. A. Newton. *__46__, Cards.: roadside hedgebanks, 300m SW of Penffynnon, Llandysul, SN395408, D.E. Allen & A.O. Chater, 1999, **BM**, conf. A. Newton.

75/8.220. RUBUS MORGANWGENSIS *__44__, Carms.: Hedgerow in partial shade, Maerdy, Pantyffynnon, SN627100, R.D. Randall, 1994, **NMW**.

75/8.257. RUBUS SECTIRAMUS *__10__, Wight: Acid scrub, Brading Down, SZ5986, D.E. Allen, 2002, **BM** & **HCMS**, conf. A. Newton.

75/8.286. RUBUS SCABRIPES *__11__, S. Hants.: , Old wood-bank, Coopers Wood, near Bucklers Hard, SZ393987, D.E. Allen & B. Goater, 2002, **BM**, conf. A. Newton..

75/8.290. RUBUS THYRSIGERIFORMIS *__12__, N. Hants.: Hedgebank, on one-time Froxfield Common, near Hawkley, SU700284, D.E. Allen, 2002, **BM**.

75/8.301. RUBUS SCABER *__10__, Wight: Patch under tall pines, near Wooton Creek, Firestone Copse, SZ553911, D.E. Allen, 2002, **BM** & **HCMS**, conf. A. Newton.

75/8.302. RUBUS ADENOLEUCUS *__12__, N. Hants.: Hedges and copses about Laverstoke, SU4948, D.E. Allen, 2003, **BM**.

75/8.309. RUBUS HALSTEADENSIS *__47__, Monts.: Trackside in mixed woodland, Bwlchycibau, SJ184176, K. Thorne & M. Wainwright, 2002, det. D.E. Allen.

75/8.311. RUBUS INTENSIOR *__11__, S. Hants.: Cleared area, Southampton Common, SU414147, B.S.B.I. field meeting, 2003, **BM**.

75/8.319. RUBUS TUBERCULATUS *__47__, Monts.: Hedgerow in village, Bwlchycibau, SJ178174, K. Thorne & M. Wainwright, 2002, det D.E. Allen. 1st recent record.

75/8.321. RUBUS CAESIUS *__85__, Fife & Kinross: Sea brae, Kincraig, west of Earlsferry, NT470999, G.H. Ballantyne, 2003, **herb. G.H.B.**, conf. A. Newton. 1st confirmed record - an extensive and extending (low) stand.

75/9.5. POTENTILLA ARGENTEA *__91__, Kincardines.: Dry grassland close-grazed by rabbits, Crathes sand-pit, NO745962, D. Welch, 2003, **herb. D. Welch**.

75/9.13×14. POTENTILLA X SUBERECTA (P. ERECTA × P.ANGLICA) __39__, Staffs.: Sandy waste ground, Wellington Road, Shobnall, SK234225, M.E. Smith, 2002, conf. B. Harold. 1st record since 1970.

‡75/11.2. FRAGARIA MURICATA *__93__, N. Aberdeen: Track of former railway, Esslemont, NJ933287, D. Welch, 2003.

‡75/12.1. DUCHESNEA INDICA *__46__, Cards.: Disused railway, Llanerchaeron, SN475600, T. Goss, **NMW**, det. G. Hutchinson.

‡75/13.3. GEUM MACROPHYLLUM *__93__, N. Aberdeen: roadside, Gask, NJ723479, D. Welch, 2003, **herb. D. Welch**.

[75/17.1. SANGUISORBA OFFICINALIS **81**, Berwicks.: Bemersyde Moss, NT612330, M.E. Braithwaite & L.W. Gaskell, 2003. Last recorded in 1978, now considered extinct here and in v.c.]

‡75/18.1. ACAENA NOVAE-ZELANDIAE *__23__, Oxon: A mat 1.5 x 0.5 m on the concrete base of a former hut , Christmas Common, SU714930, R. Barber, 2000.

‡75/18.3. ACAENA OVALIFOLIA *__85__, Fife & Kinross: Track-side, Glenduckie Hill, near Dunbeg, NO281189, R. & H. Ingram, 2003, **herb. G.H.B**, det. D.R. Mckeen. Probably a cast-out from nearby hamlet of Glenduckie.

75/21.4×11. ROSA × PSEUDORUSTICANA (R. ARVENSIS × R. STYLOSA) *__46__, Cards.: roadside by stream bridge, Tynewydd, Tremain, SN232475, R. Maskew & A.O. Chater, 2002, **NMW**, conf. A.L. Primavesi.

75/21.4×12. ROSA × IRREGUKARIS (R. ARVENSIS × R. CANINA) **5**, S. Somerset: Bush in roadside hedge, Cuckold's Cross Bridge, ST001307, P.R. Green, 2003, det. A.L. Primavesi. 1st traceable record. *__81__, Berwicks.: Established at roadside, Chirnside Bridge, NT852562, M.E. Braithwaite, 2001.

75/21.4×13. ROSA ARVENSIS X R. CAESIA *__39__, Staffs.: In lane hedge, Beresford Dale, SK118583, R. Maskew & A.L. Primavesi, 2003. With *R. caesia* as female parent.

75/21.4×16. ROSA ARVENSIS × R. SHERARDII *__44__, Carms.: Laneside hedge, near Cilycwm, SN754388, R. Maskew, 2003, conf. A.L. Primavesi.

75/21.5×12. ROSA × HIBERNICA (R. SPINOSISSIMA × R. CANINA) *__9__, Dorset: Hedgerow, Townsend, Swanage, SZ024781, E.A. Pratt, 2000, det. A.L. Primavesi.

75/21.5×16. ROSA × INVOLUTA (R. SPINOSISSIMA × R. SHERARDII) *__81__, Berwicks.: rocky bank, Lumsdaine Dean, NT860693, M.E. Braithwaite, 2001, det. R. Maskew.

‡75/21.10. ROSA GALLICA *__6__, N. Somerset: Several bushes in roadside hedge, Bagborough, ST627395, P.R. Green, 2003, det. A.L. Primavesi.

75/21.12×13a. ROSA × DUMALIS (R. CANINA × R. CAESIA subsp. CAESIA) *__50__, Denbs.: S side of lane, Dinmael, SH995496, G.M. Kay, 2002.

75/21.12×13b. ROSA × DUMALIS (R. CANINA × R. CAESIA subsp. VOSAGIACA) *__50__, Denbs.: roadside, Dinmael, SH993445, G.M. Kay, 2002.

75/21.12×14. ROSA × DUMETORUM (R. CANINA × R. OBTUSIFOLIA) *__50__, Denbs.: Hedgerow, Cobblers Lane, Burton, SJ335579, G.M. Kay, 2002, conf. A.L. Primavesi.

75/21.12×15. ROSA × SCABRIUSCULA (R. CANINA × R. TOMENTOSA) **9**, Dorset: Hedgerow, Durlston, Swanage, SZ032774, E.A. Pratt, 2000, **RNG**, det. A.L. Primavesi. 1st record since 1970. **49**, Caerns.: Wood, near Keeper's Cottage, Penrhynside, Llandudno, SH809811, W.M. McCarthy, 2002. 1st recent record.

75/21.12×17. ROSA × MOLLETORUM (R. CANINA × R. MOLLIS) *__47__, Monts.: roadside hedge, N of Dolanog, SJ068143, K. Thorne & M. Wainwright, 2002, det. A.L. Primavesi.

75/21.12×18. ROSA × NITIDULA (R. CANINA × R. RUBIGINOSA) *__9__, Dorset: Hedgerow, Knitson, SZ0005808, E.A. Pratt, 2000, **RNG**, det. A.L. Primavesi.

75/21.13a×16, ROSA CAESIA subsp. CAESIA × R. SHERARDII *__50__, Denbs.: Hedgerow, Llangwyfan, SJ123657, G.M. Kay, 2002, conf. A.L. Primavesi.

[75/21.13b. ROSA CAESIA subsp. VOSAGIACA **9**, Dorset: Delete. No specimen. Not accepted]

75/21.13b×16. ROSA CAESIA subsp. VOSAGIACA × R. SHERARDII *__50__, Denbs.: road verge, Prion, SJ044618, G.M. Kay, 2002, conf. A.L. Primavesi.

75/21.14. ROSA OBTUSIFOLIA *__9__, Dorset: Hedgerow, Lulworth Cove, SY820803, R. Maskew, 2001. **46**, Cards.: roadside hedgebank , 150m W of Troed-yr-aur church, SN325453, R. Maskew & A.O. Chater, 2002, **NMW**, 2nd and only extant record. *__50__, Denbs.: Hedgerow, Cobblers Lane, Burton, SJ334579, G.M. Kay, 2002, conf. A.L. Primavesi.

75/21.20. ROSA AGRESTIS *__51__, Flints.: Scrub on limestone, Graig Fawr, Meliden, SJ062805, G.M. Kay, 2002.

¢75/22.1. PRUNUS PERSICA *__29__, Cambs.: One young plant (c. 30cm tall) at base of fence, junction of Milton Road and Elizabeth Way, Cambridge, TL457600, A.C. Leslie, 2002, **CGE**.

‡75/30.1. AMELANCHIER LAMARCKII *__29__, Cambs.: Clinkered area edge of rail, amongst much *Cotoneaster bullatus* and *C. sternianus* etc, March, TL416980, G.M.S. Easy, 2003, **herb. G.M.S. Easy**. Near major bird roost area.

‡75/32.6. COTONEASTER OBTUSUS *__29__, Cambs.: Numerous self-sown or bird-sown plants on waste ground between Hills Road and Station Road, Cambridge, TL459572, A.C. Leslie, 2002, **CGE**, det. J. Fryer.

[‡75/32.11. COTONEASTER DAMMERI __69__, Westmorland: Delete. The locality, Silverdale, is in v.c. 60 W. Lancs.]

‡75/32.11×18. COTONEASTER × SUECICUS (C. DAMMERI × C. CONSPICUUS) *__69__, Westmorland: Edge of playing field, Allithwaite, SD388768, W. Nelson, 2003, **LANC**, conf. J. Fryer.

‡75/32.26. COTONEASTER DIVARICATUS *__70__, Cumberland: Old Side, Siddick, NY995302, R. E. Groom, 2003, **LANC**, det. J. Fryer.

‡75/32.38. COTONEASTER SPLENDENS *__9__, Dorset: Scrub by roadside, Knitson, SZ010801, E. A. Pratt, 2000, **RNG**.

‡75/32.39. COTONEASTER FRANCHETTI *__85__, Fife & Kinross: Scrubby area (planted with bushes and trees to attract bird migrants), Fife Ness Muir, NO636096, G.H. Ballantyne, 2003. May well self sow soon. With *Cotoneaster simonsii* and *C. bullatus*.

[‡75/32.asc. COTONEASTER ASCENDENS __69__, Westmorland: Delete. The locality, Eaves Wood, Silverdale, is in v.c. 60 W. Lancs.]

‡75/32.obs. COTONEASTER OBSCURUS *__49__, Caerns.: Disused quarry, Cwm Mountain, Llandudno, SH788808, W.M. McCarthy, 2002.

‡75/32.vil. COTONEASTER VILMORINIANUS *__29__, Cambs.: Birdsown under railings, Coleridge Community College, Radegund Road, Cambridge, TL471571, A.C. Leslie, 2002, **CGE**, det. J. Fryer.

¢77/1.1. ROBINIA PSEUDOACACIA *__81__, Berwicks.: Planted, Newton Don, NT7137, M.E. Braithwaite & ENHS party, 2002.

77/6.1. ONOBRYCHIS VICIIFOLIA *‡__113(A)__, Channel Is. (Alderney): Bank of south cliffs path, at Cognons, WA587069, B. Bonnard & T. Davenport, 2002. Established from fodder crop.

77/7.1a, ANTHYLLIS VULNERARIA SUBSP. VULNERARIA __104__, N. Ebudes (Rum): ridge below Hallival, NM3996, A.J. Silverside, 1995, **herb. A.J.S.** 1st definite record for Rum.

77/8.3. LOTUS PEDUNCULATUS __104__, N. Ebudes (Eigg): Field, E of Manse Wood, NM4885, J. Chester, 1997, conf. C.W. Murray. 1st record for Eigg.

‡77/12.1. HIPPOCREPIS EMERUS *__29__, Cambs.: Self-sown flowering plants along railings, in front of Coleridge Community College, Radegund Road, Cambridge, TL471571, A.C. Leslie, 2002. Planted parent shrubs in college grounds.

‡77/14.14. VICIA BITHYNICA *__39__, Staffs.: Bank on side of Burton Road, Elford, SK191100, C. Higginbottom, C.N. Smith & M. Smith, 2003.

77/15.2. LATHYRUS JAPONICUS ▣__9__, Dorset: On shingle in huge quantity, Chesil Beach, SY617801, B. Edwards & D.A. Pearman, 2003.

‡77/18.2b. MEDICAGO SATIVA subsp. VARIA *__50__, Denbs.: Established on sand dunes, Kinmel Bay, SH987807, BSBI group, 2001. 1st record of subspecies.

77/18.5. MEDICAGO ARABICA __39__, Staffs.: Kinver Edge, SO837835, B Hopton & I.C. Trueman, 2002. 1st definite record as a native plant.

‡77/19.4. TRIFOLIUM HYBRIDUM __104__, N. Ebudes (Muck): Weedy potato patch above Camus Mor, NM408794, P.F. & M.E. Braithwaite, 2000. 1st record for Muck - not in Dobson list.

77/19.13. TRIFOLIUM MICRANTHUM *‡__81__, Berwicks.: Established on lawn, Mellerstain, NT647390, M.E. & P.F. Braithwaite, 2002, det. D.A. Pearman.

¢77/21.alb. LUPINUS ALBUS *__81__, Berwicks.: Forage crop, near Berryhill Cottage, NT804635, M.E. Braithwaite, 2002.

‡77/23.2. CYTISUS MULTIFLORUS ▣__39__, Staffs.: Dry, sandy bank, Oakley, SJ703361, I.J. Hopkins, 2003.

‡77/24.1. SPARTIUM JUNCEUM *__46__, Cards.: Naturalised on railway verge, Plas Crug crossing, Aberystwyth, SN589811, A.O. Chater, 2002.

77/26.3. ULEX MINOR *‡__43__, Rads.: SW facing shale bank of road, A470 near Penlanole, Doldowlod, SN986629, R.G. Woods & D.R. Drewett, 2002. *‡__47__, Monts.: Several large clumps in flower, probably sown at time of road-widening in 1970s, SSW facing shale-rich roadside bank, beside A44 c. 3km W of Llangurig, SN879809, R.G. Woods, 2002.

¢77/GLC.max. GLYCINE MAX *58, Cheshire: Disturbed ground (landfill), Bidston Dock, SJ298909, R.F. Goodchild, 2003, **herb. G.M. Kay**, det. E.J. Clement.

‡78/2.1. ELEAGNUS UMBELLATA *29, Cambs.: One birdsown plant in crevice of a grave, cemetery, Wisbech, TF465105, A.C. Leslie, 2002, **CGE**, conf. K.A. Beckett.

[79/2.1. MYRIOPHYLLUM VERTICILLATUM 9, Dorset: Delete. Reported in 1799 but no specimen.]

‡79/2.2. MYRIOPHYLLUM AQUATICUM *23, Oxon: Almost covering farm pond, Stadhampton, SU6098, H.J. Killick, 1997, **OXF**. 113(S), Channel Is. (Sark): On mud in almost dried-up dewpond, Grand Dixcart, WV463752, M.L. Long, 2003, **herb. Société Sercquiaise**. Unknown source. First record for Sark.

84/1.1. EPILOBIUM HIRSUTUM *104, N. Ebudes (Skye): Waste ground behind shore, Redcliffe, Portree, NG4843, M. Henriksen, 1997, conf. C.W. Murray. Introduced?

84/1.1×2. EPILOBIUM × SUBHIRSUTUM (E. HIRSUTUM × E. PARVIFLORUM) *81, Berwicks.: Dunglass Dean, NT7671, A. Craig-Christie, 1888, **E**, det. D.R. McKean.

84/1.1×8. EPILOBIUM × NOVAE-CIVITATIS (E. HIRSUTUM × E. CILIATUM) *46, Cards.: Disused quarry, 900m N of The Arch, Devil's Bridge, SN764764, A.O. Chater, 2001, **NMW**, det. T.D. Pennington.

84/1.2×3. EPILOBIUM × LIMOSUM (E. PARVIFLORUM × E. MONTANUM) *1a, W. Cornwall, 2 plants on railway ballast, Lelant Station by Hayle Creek, SW544366, G.D. Kitchener, 2002.

84/1.2×9. EPILOBIUM × RIVULARE (E. PARVIFLORUM × E. PALUSTRE) *104, N. Ebudes (Eigg): Burn to S of 'Singing Sands', NM473896, P.F. Braithwaite, 1999, det. G. Kitchener.

84/1.3×6. EPILOBIUM × AGGREGATUM (E. MONTANUM × E. OBSCURUM) 49, Caerns.: Forest track, near Llyn Bychan, SH7559, W.M. McCarthy, 2002, det. A.O. Chater. 1st recent record.

84/1.3×8. EPILOBIUM × INTERJECTUM (E. MONTANUM × E. CILIATUM) *50, Denbs.: Edge of lane, Pwllglas, SJ120549, J. Clarke, 2003, det. G. Kitchener. *91, Kincardines.: Waste ground, Glensaugh, NO670782, D. Welch, 2003, **ABD**.

84/1.4. EPILOBIUM LANCEOLATUM 42, Brecs.: Waste ground on rocky limestone site, Clydach, SO231134, M. & C. Porter, 2002. 2nd record and 1st since 1952

84/1.6×8. EPILOBIUM X VICINUM (E. OBSCURUM × E. CILIATUM) *39, Staffs.: Ditch, near Axstones Spring, SK955621, J.H. Clarke, 2001, det. G.D. Kitchener. Also present in second site near Axstones Spring.

84/2.1. CHAMERION ANGUSTIFOLIUM 104, N. Ebudes (Muck): Port nam Maol, NM4280, J. Bevan, P. Braithwaite & C.W. Murray, 1995. 1st record for Muck.

¢84/4.1. OENOTHERA GLAZIOVIANA *81, Berwicks.: On old railway, Purvishaugh, NT600393, L.W. Gaskell, 2002, det. M.E. Braithwaite.

84/6.1. CIRCAEA LUTETIANA 104, N. Ebudes (Muck): Scrub woodland above shore, Port Maol, NM4280, J. Bevan, P. Braithwaite & C.W. Murray, 1995. 1st record for Muck.

‡85/1.4. CORNUS MAS *42, Brecs.: In silt on top of bank of River Usk, 1km E of Llangattock, SO220177, D. Pearman, 2002. 1st Welsh record.

‡84/4.4. OENOTHERA CAMBRICA *52, Anglesey: Few plants by gateway, Fron Capel, Gaerwen, SH491727, I.R. Bonner, W. McCarthy & M. Stead, 2003.

¢91/2.2. EUPHORBIA MACULATA *6, N. Somerset: Nursery weed, Yatton, ST437643, I.P. Green, 2003.

¢91/2.7. EUPHORBIA SERRULATA *11, S. Hants.: Small field by M27, Eastleigh, SU438194, P. J. Selby, 2003, **herb. P.J. Selby**. *‡69, Westmorland: Abundant in overgrown garden, Sedgwick, SD513870, C.E. Wild, 2003, **LANC**, conf. C.A. Stace.

91/2.12×13. EUPHORBIA PORTLANDICA × E. PARALIAS *46, Cards.: Ynys-las Dunes NNR, SN607945, S.P. Chambers, 2003, **herb. S.P. Chambers**, conf. P.M. Benoit.

‡91/2.14×15. EUPHORBIA × PSEUDOESULA (E. ESULA × E. CYPARISSIAS) *9, Dorset: Swanage, SZ034804, E.A. Pratt, 2001, det. A.R. Radcliffe-Smith.

‡91/2.obl. EUPHORBIA OBLONGATA *23, Oxon: By track, Alvescot, SP275042. Garden escape with *Cicerbita macrophylla*.

‡93/2.2. PARTHENOCISSUS INSERTA *9, Dorset: Hedge in nature reserve, Swanage, SZ026782, E.A. Pratt, 2001, **RNG**.

‡93/2.3. PARTHENOCISSUS TRICUSPIDATA *29, Cambs.: One bird-sown plant on the steps of the Clarkson Memorial, South Brink, Wisbech, TL461096, A.C. Leslie, 2002.

‡94/1.2. LINUM USITATISSIMUM *¢**52**, Anglesey: Single plant, casual, in oat crop, small field, Cors Goch, SH493810, I.R. Bonner, 2002.

‡99/1.6. ACER NEGUNDO *__29__, Cambs.: Single, self-sown plant, wall base outside Cripps Court, Grange Road, Cambridge, TL439581, A.C. Leslie, 2003.

‡102/1.10. OXALIS DEBILIS *__39__, Staffs.: Persistent weed in greenhouse and in plant pots outside, Wombourne, SO873924, C.B. Westall, 2002.

¢102/1.12. OXALIS TETRAPHYLLA *¢__44__, Carms.: One plant in flower in dumped soil, disturbed ground above beach, The Green, Llanstephan, SN356109, R.D. Pryce & K.A. Cottingham, 2002, **NMW**, det. G. Hutchinson.

¢102/1.14. OXALIS INCARNATA *__85__, Fife & Kinross: Greenhouse weed, Hill of Tarvit (N.T.S. mansion/garden), NO379118, R.I. Milne, 1997.

‡102/1.dec. OXALIS DECAPHYLLA *__70__, Cumberland: Garden weed, present 10 years, Brackenthwaite, Wigton, NY294468, A. Bliss, 2003, **LANC**, det. G. Halliday.

‡103/1.3. GERANIUM NODOSUM *__39__, Staffs.: Several, near graves and seeded in path, churchyard, S. of Handworth Wood, SP056903, M.W. Poulton, 2003.

†103/1.11. GERANIUM DISSECTUM __104__, N. Ebudes (Rona): Head of Acairseid Mhor, NG619570, S.J. Bungard, 2001. 1st record for Rona.

¢103/1.15. GERANIUM PUSILLUM __84__, W. Lothian: Locally abundant in strawberry beds. Inadvertantly introduced with plants soil or straw? West Craigie Farm, NT158763, J. Muscott, 2003. 1st record since 1934.

‡103/1.17. GERANIUM MACRORRHIZUM *__95__, Moray: Balnacoul Wood, Mosstodloch, NJ326597, I.P. Green, 2003.

‡103/1.22. GERANIUM MADERENSE __113(S)__, Channel Is. (Sark): Planted on verge of unmetalled track near La Genetière, WV466768, R.M. Veall, 2002, **herb. Société Sercquiaise**. 1st record for Sark.

†103/2.2. ERODIUM MOSCHATUM __50__, Denbs.: Gravelly, recently made, river bank, Llanfair Talhaiarn, SH926703, J.A. Green, 2002, **NMW**. 1st recent record.

¢103A/LIM.dou. LIMNANTHES DOUGLASII *__47__, Monts.: river stones at low water below aquaduct over River Rhiw, Berriew, SJ189006, K. Thorne, 2002.

‡106/1.1. HEDERA COLCHICA *__81__, Berwicks.: Established on shaded rocks, Stichill Linn, Newton Don, NT706375, M.E. Braithwaite & ENHS, 2002.

106/1.2b, HEDERA HELIX subsp. HIBERNICA *__23__, Oxon: D. Hughes, 1983.

‡107/1.ran. HYDROCOTYLE RANUNCULOIDES *__2__, E. Cornwall: In the River Inny (near a holiday village), Tremail near Davidstow, SX153870, A. Brown, 2003, det. T. Renals. The environmental officer is trying to eradicate it. 1st for Cornwall.

‡107/4.2. ERYNGIUM PLANUM *__11__, S. Hants.: Anglesey Road/Brodrick Avenue S, SZ603990, E.J. Clement & D.R. Allan, 2003, det. E.J. Clement. *__29__, Cambs.: One well-established plant on NE verge of A14, Honey Hill, Fen Ditton, TL497602, A.C. Leslie, 2002, **CGE**.

¢107/6.cer. ANTHRISCUS CEREFOLIUM *__11__, S. Hants.: Allotments, Paignton Road, SU386141, P.A. Budd, 2003, **herb. M.W. Rand**, conf. M.W. Rand.

[107/13.1. PIMPINELLA MAJOR __9__, Dorset: Delete. No specimen. Not accepted.]

[107/19.2. OENANTHE SILAIFOLIA __9__, Dorset: Extinct pre-1970.]

107/19.4. OENANTHE LACHENALII __39__, Staffs.: Railway Pool, Alvecote, SK245045, M.A. Arnold, 2002. Known here since 1956. 2nd record and 1st as a native.

[107/19.7. OENANTHE AQUATICA __9__, Dorset: Delete. Record not accepted.]

¢107/21.1. FOENICULUM VULGARE *__81__, Berwicks.: In set-aside, near Hardiesmill Place, NT666413, L.W. Gaskell, 2003, det. M.E Braithwaite.

107/30.1. SISON AMOMUM __42__, Brecs.: Spread over 120m of hedgerow and road verge, between Bronllys Castle and Bronllys village, SO147347, M. & C. Porter, 2002. 1st record since 1908.

‡107/37.2. ANGELICA ARCHANGELICA __29__, Cambs.: Abundantly naturalised along E bank of R. Cam, between Horningsea and Clayhithe, TL492.629, G.M.S. Easy, 2002. 2nd, and only recent record.

¢107/ANE.gra. ANETHUM GRAVEOLENS *__46__, Cards.: Union Street, Aberystwyth, SN584811, S.P. Chambers, 2003.

108/1.1. CICENDIA FILIFORMIS ▮**9**, Dorset: Horse-grazed pasture, Crab Orchard, SU078066, A.J. Byfield, B. Edwards & D.A. Pearman, 2002. Small damp field, Studland, SZ030828, N.J.H. Sturt, 1994. Additional hectad for Scarce Plant.

108/3.5. CENTAURIUM TENUIFLORUM ▮**9**, Dorset: On clayey undercliff, St Gabriels, SY398922, P.A. Cramb, 2002.

¢110/1.1. NICANDRA PHYSALODES *__46__, Cards.: Arable weed, IGER, Plas Gogerddan, SN631835, J. Valentine, 2003, det. A.O. Chater.

110/3.1. ATROPA BELLADONNA *¢**93**, N. Aberdeen.: Rose border, Haddo House, NJ867347, P.R. Green, 2002.

¢110/6.per. PHYSALIS PERUVIANA *__85__, Fife & Kinross: Sewage waste, Cupar, NO391147, R. I. Milne, 1999.

‡110/7.1. LYCOPERSICON ESCULENTUM *¢**91**, Kincardines.: Shingle by river below sewage outfall, Banchory, NO710957, D. Welch, 2003.

‡110/8.8. SOLANUM LACINIATUM *__11__, S. Hants.: Priddy's Estate, Gosport, SU613011, E.J. Clement & D.R. Allan, 2003. Photographic record D.R.Allan. *__58__, Cheshire: Waste ground, Capenhurst, SJ371742, R.F. Goodchild, 2002, det. E.J. Clement.

¢110/8.ros. SOLANUM ROSTRATUM *__58__, Cheshire: Disturbed ground (landfill), Bidston Dock, SJ298909, R.F. Goodchild, 2003, **herb. G.M. Kay**. *__85__, Fife & Kinross: Garden, Cupar, NO378147, W. Hay, 2003, det. D.R. Mckeen. Bird seed alien. *__95__, Moray: rubbish tip, Elgin, NJ237630, I.P. Green, 2003.

¢110/9.1. DATURA STRAMONIUM *__107__, E. Sutherland: Disturbed ground outside garden wall, Distillery Road, Brora, NC903054, B. Wallace, 2003, conf. J.K. Butler. Probably from bird seed, following exceptional summer.

‡110/NIC.ala × for. NICOTIANA × SANDERAE (N. ALATA × N. FORGETIANA) *__11__, S. Hants.: W of public carpark, Stanpit, SZ165927, P.A. Budd, 2003, conf. B. Goater. ¢**113(S)**, Channel Is. (Sark): On dumped soil among other garden outcasts on edge of small quarry, Eperquerie Common, WV461773, M.L. Long, 2003, **herb. Société Sercquiaise**, det. E.J. Clement. Some plants with white flowers, others with mauve. 1st record for Sark.

¢110/NIC.rus. NICOTIANA RUSTICA *__9__, Dorset: Garden weed in cultivated crop of Brazilian tobacco in garden, Kington Magna, near Gillingham, ST7623, A.R. Perry, 2003, **herb. A.R. Perry**, det. G. Hutchinson.

¢110/PET.axi × int. PETUNIA × HYBRIDA (P. AXILLARIS × P. INTEGRIFOLIA) *__58__, Cheshire: Possibly self-sown in debris in roadside gutter, Dee Park Road, Gayton, SJ281804, E.F. Greenwood, 2001.

111/3.2b, CALYSTEGIA SEPIUM subsp. ROSEATA *‡__39__, Staffs.: Hedge and fence around deep excavations and industrial waste, lane near Crooked House Pub, E. of Himley, SO899913, C.B. Westall, 2000. *__52__, Anglesey: Wet heath, about 250m. from the coast, Penrhosfeilw Common, SH220798, I.R. Bonner & S. Priest, 2003.

111/3.3×4. CALYSTEGIA × HOWITTIORUM (C. PULCHRA × C. SYLVATICA) *__39__, Staffs.: Wren's Nest NR, SO9391, R. Labrenz, 2002, conf. R.K. Brummitt.

[112/1.2. CUSCUTA EUROPAEA **9**, Dorset: Alter to Casual. No specimen. Casual at best]

‡115/1.1. PHACELIA TANACETIFOLIA *__52__, Anglesey: Field margins, Cefn Maesoglen, Llangaffo, SH463671, T.D. Dines, 2003. Grown as a crop in 2002, several plants re-appeared along field margins in 2003. *¢**81**, Berwicks.: Game crop, Nether Huntlywood, NT628436, M. E. Braithwaite, 2001.

116/4.1×2×3. SYMPHYTUM OFFICINALE × S. ASPERUM × S. TUBEROSUM **33**, E. Gloucs.: Small patch with parents by side of A 419, near Royal Agricultural College, Cirencester, SP001015, M. A.R. & C. Kitchen, 2003, conf. F.H. Perring. Only post 1970 record.

‡116/4.1×2×4. SYMPHYTUM 'HIDCOTE BLUE' (S. OFFICINALE × S. ASPERUM × S. GRANDIFLORUM) *__57__, Derbys.: Wayside, near Linnet Clough, SK975880, J. Hawksford, 2003. In the south-west quadrant of a cross of footpaths waymarked Strines, Charlesworth, Marple Bridge, Mellor and Cobden Edge.

116/11.1. MERTENSIA MARITIMA **101**, Kintyre: Shore, Keil, Southend, NR679076, I. Teesdale & A. Stewart, 2003. Re-discovery, original colony washed away. Last recorded in 1988.

‡116/12.2. AMSINCKIA MICRANTHA *__104__, N. Ebudes (Muck): Weed in potato patch, Port Mor Guesthouse, NM4279, J. Bevan, P. Braithwaite & C.W. Murray, 1996, **herb. J. Bevan**.

116/17.1. CYNOGLOSSUM OFFICINALE **81**, Berwicks.: 9 plants on steep eroding bank, Lumsdaine Dean, NT862694, M.E. Braithwaite, 2001. 1st record since 1956.

¢116/LAP.squ. LAPPULA SQUARROSA *__58__, Cheshire: Flower bed, Stockport, SJ896906, G.M. Kay, 2003, **herb. G.M. Kay**.

¢117/1bon. VERBENA BONARIENSIS *__29__, Cambs.: One plant on verge, W side of Queen's Road, Cambridge, TL443586, P.J. Reynolds, 2002.

118/1.1. STACHYS OFFICINALIS **81**, Berwicks.: Woodland clearing, Greenwood, NT835642, A. McBride, 2002. 1st record since 1950.

‡118/1.2. STACHYS BYZANTINA *__85__, Fife & Kinross: A small patch on rough ground by track by shore below cliff, Pettycur, at foot of Sand Gill holiday site cliff, NT262863, R.I. Milne, 2003. Pretty certainly originating from caravan site high above.

118/1.5×6. STACHYS × AMBIGUA (S. SYLVATICA × S. PALUSTRIS) **43**, Rads.: Large clump on bank of R.Aran, Rhydllyn, between Dolau and Penybont, SO127659, R.G. Woods & J. Poole, 2002. 1st recent record.

‡118/5.2. LAMIUM MACULATUM **81**, Berwicks.: Established on roadside near East Morriston, NT609419, M.E. Braithwaite, 2002. 1st record since 1931.

†118/5.4. LAMIUM HYBRIDUM **94**, Banffs.: Disturbed ground by sea shore, Buckie, NJ414654, H.S. McHaffie, 2003. 1st record since 1970. *__104__, N. Ebudes (Eigg): Garden weed, Kildonan House, NM4985, J. Bevan, P. Braithwaite & C.W. Murray, 1998.

118/6.5. GALEOPSIS BIFIDA **104**, N. Ebudes (Raasay): Ditch, Inverarish, NG552357, S.J. Bungard, 1995. 1st record for Raasay. 2nd at Oskaig NG 549379.

¢118/10.1. SCUTELLERIA ALTISSIMA *__81__, Berwicks.: Blinkbonnie, Earlston, NT5738, K.E.H. Brownlie, 2000, det. D.R. McKean.

118/12.2. AJUGA PYRAMIDALIS **104**, N. Ebudes (Canna): 100+ plants on crumbly rock above track, E of Tarbert, NG242056, M.E. & P.F Braithwaite and C.W. Murray, 2001. 1st record since Heslop Harrison in 1930s.

118/14.1. GLECHOMA HEDERACEA **104**, N. Ebudes (Raasay): One plant in woodland, Raasay House, NG548365, S.J. Bungard, 1998. 1st record for Raasay.

‡118/23.3×lon. MENTHA × VILLOSONERVATA (M. SPICATA × M. LONGIFOLIA) *__39__, Staffs.: Roadside, Tatenhill Common, SK195222, T.W.J.D. Dupree & D.L. Brookman, 1999. Grass verge, near Warslow, SK082589, J.E. Hawksworth, 2001. Additional hectad for Scarce Plant.

‡118/24.1. ROSMARINUS OFFICINALIS *__39__, Staffs.: behind houses, Westminster Road, Charlemont, SP007938, M.W. Poulton, 2000.

‡118/25.1. SALVIA SCLAREA *__11__, S. Hants.: By the fence, Felicia Park S, SU610010, D.R. Allan, 2003, conf. E.J. Clement. Photographic record D.R. Allan.

121/1.3b. PLANTAGO MAJOR subsp. INTERMEDIA *__44__, Carms.: Frequent in shallows of large pond, Pembrey Burrows, SS423994, T. & V. Lewis, 2002, **NMW**. First record for subspecies.

*__6__, N. Somerset: Shore of Chew Valley Lake, ST580605, P.R. Green, 2003.

‡122/1.3. BUDDLEJA GLOBOSA *__29__, Cambs.: One self-sown plant at wall base by Jesus College grounds, Victoria Avenue, Cambridge, TL454588, A.C. Leslie, 2003.

‡123/1.sus × vir. FORSYTHIA × INTERMEDIA (F. SUSPENSA × F. VIRIDISSIMA) *__85__, Fife & Kinross: A component of an old hedge, all that is left of an old mining site, Balgonie, NT304005, G.H. Ballantyne, 2003.

‡123/JAS.nud. JASMINUM NUDIFLORUM *__39__, Staffs.: Roadside bank, Lyne Hill, Penkridge, SJ924130, J.E. Hawksford, 2003. *__85__, Fife & Kinross: Growing over high wall of former walled garden at ruin of Largo House, NO420035, G.H. Ballantyne, 2003. Garden neglected for 40-50 years.

‡124/1.1. VERBASCUM BLATTARIA **39**, Staffs.: On dumped soil, east of Otherton Lock, Staffs. & Worcs. Canal, Penkridge, SJ932124, J.E. Hawksworth, 2003. 1st record since 1970. *__42__, Brecs.: Over 100 plants on river shingle, near Bronllys Castle, SO150348, M. & C. Porter, 2002.

¢124/1.5. VERBASCUM PHLOMOIDES *__81__, Berwicks.: 30 plants in set-aside, Nether Huntlywood, NT628435, M.E. Braithwaite, 2001.

124/2.2. SCROPHULARIA AURICULATA *‡__81__, Berwicks.: Pond, Harryburn Stables, Lauder, NT524484, J. Mercer, 2002, det. M.E. Braithwaite. Accidentally introduced to pond and established.

‡124/4.2. MIMULUS GUTTATUS **81**, Berwicks.: R. Tweed, Birgham, NT785385, M.E. Braithwaite, 1995, widespread. Listed in error in VCCC as pre-1970 only.

†124/8.2. CHAENORHINUM MINUS *__109__, Caithness: 4 plants on Caithness railway line, ND040479, H.S. McHaffie, 2003, **E**.

‡124/16.18, VERONICA PEREGRINA *__93__, N. Aberdeen: Flower bed, Haddo House, NJ867347, P.R. Green, 2002.

‡124/16.21. VERONICA PERSICA **104**, N. Ebudes (Muck): Garden weed, Port Mor, NM4279, J. Bevan, P. Braithwaite & C.W. Murray, 1995. 1st record for Muck.

‡124/16.23. VERONICA FILIFORMIS **104**, N. Ebudes (Muck): Garden 'weed', Port Mor Guest House garden, NM4279, J. Bevan, P.F. Braithwaite & C.W. Murray, 1999. 1st record for Muck.

‡124/16.25. VERONICA LONGIFOLIA *¢__44__, Carms.: One plant on disturbed ground, Morfa, Llanelli, SS519988, Llanelli Naturalists, 2002, conf. G. Hutchinson. 2nd record and 1st since c. 1960.

¢124/17.1. HEBE SALICIFOLIA *__46__, Cards.: Back alley, Queen Street, Aberaeron, SN457629, A.O. Chater, 2003.

124/20.2. EUPHRASIA RIVULARIS *__44__, Carms.: Flush by Afon Sychlwch, Blaenau, Llanddeusant, SN799237, S. Thomas *et al.* 2003, **NMW**, det. A.J. Silverside.

124/20.5b×9. EUPHRASIA ARCTICA × E. CONFUSA *__35__, Mons.: About 20 plants on trackside, Barbadoes, Tintern, SO522007, T.G. Evans, 1984, **herb. T.G.E.**, det. A.J. Silverside.

124/20.6. EUPHRASIA TETRAQUETRA *__81__, Berwicks.: Colony on sea braes, Barefoots, Eyemouth, NT938648, V. Jones, G. Battershall, M.E. Braithwaite & WFS party, 2002.

124/20.7×8. EUPHRASIA NEMOROSA × E. PSEUDOKERNERI *__35__, Mons.: About 40 plants in short turf over Carboniferous limestone, both parents present, MOD Caerwent, ST490915, T.G. Evans, 1999, **NMW**, det. A.J. Silverside.

124/20.7×18. EUPHRASIA NEMOROSA × E. MICRANTHA **46**, Cards.: Cwmsymlog lead mine, SN696836, A.O. Chater, 2000, **NMW**, det. A.J. Silverside. 1st record since 1899.

124/20.18×19. EUPHRASIA × ELECTA (E. MICRANTHA × E. SCOTTICA) *__81__, Berwicks.: Flush , Blythe Edge, NT618559, M.E. Braithwaite, 2000. **104**, N. Ebudes (Raasay): Moorland, NW of Carn Mor, NG566447, S.J. Bungard, 2002, det. A.J. Silverside. 1st record for Raasay.

124/20.off. EUPHRASIA OFFICINALIS *__35__, Mon.: More than 20 plants in meadow with *Succisa pratensis* and *Centaurea nigra*, Penperlleni, SO327055, T.G. Evans, 1997, **NMW**, det. A.J. Silverside.

124/23.1. PARENTUCELLIA VISCOSA *‡__94__, Banffs.: c. 200 plants established in damp grassy area amongst rushes, Nether Dallachy, NJ362645, I.P. Green, 2003. Beside row of pine trees on N side of track, N of rubbish dump.

125/2.2. OROBANCHE RAPUM-GENISTAE **39**, Staffs.: Many spikes on *Cytisus scoparius*, hillside, Walton-on-the-Hill, SJ959217, I.J. Hopkins, 2002. 1st record since 1904.

[128/1.3. PINGUICULA VULGARIS **9**, Dorset: Alter to extinct pre-1970. Misidentification of planted *P. grandiflora*]

128/2.6. UTRICULARIA MINOR *__78__, Peebless.: Peaty ditches, N of Annanhead Hill, N of Moffat, NT057137, R.W.M. Corner, M.S. Porter & F.J. Roberts, 2003.

‡129/1.5. CAMPANULA MEDIUM *__39__, Staffs.: Waste ground, St. Paul's Road, West Smethwick, SP009892, M.W. Poulton, 1997.

‡129/1.13. CAMPANULA RAPUNCULOIDES **104**, N. Ebudes (Eigg): rough grassland above shore, Runciman's Beach, NM484843, J. Chester, 1998, **E**, det. D.R. McKean. 1st record since Heslop Harrison in 1930s.

129/3.1. WAHLENBERGIA HEDERACEA *‡__52__, Anglesey.: Garden lawn, Rhoscefnhir, SH523763, N.J.A. Aron, 2003. I.R. Bonner & N.H. Brown were invited to confirm the identity of a 1.5m. patch in a close mown lawn. The owner had not noticed it before and had no idea how it had become established here.

[129/5.2. PHYTEUMA ORBICULARE **9**, Dorset: Alter to Casual. Planted]

129/6.1. JASIONE MONTANA *__94__, Banffs.: 42 plants in middle of track, on E bank of river Spey, near Bogmoor, NJ347621, I.P. Green, 2003. Also along track to NJ348622.

‡129/7.2. LOBELIA ERINUS *__85__, Fife & Kinross: Cracks in pavement, Dalgety Bay, NT1683, per RBGE, 1991. Record overlooked until recently.

¢130/6.12. GALIUM SPURIUM *__70__, Cumberland: Flower bed, Wetheral Pasture, NY460533, F. J. Roberts, 2003, **LANC**.

130/7.1. CRUCIATA LAEVIPES **91**, Kincardines.: Abandoned railway, Banchory, NO716962, D. Welch, 2003. 1st recent record.

‡131/3.mic×orb. SYMPHORICARPOS × CHENAULTII (S. MICROPHYLLUS × S. ORBICULATUS) *__42__, Brecs.: Small thicket, probably originating from garden outcast, in scrub on river bank, Cefn Coed, SO030077, M. & C. Porter, 2002.

‡131/6.1. LONICERA PILEATA *__39__, Staffs.: At several paces in lane, Rushton Spencer, SJ935625, J.H. Clarke, 2001.

‡131/6.5. LONICERA HENRYI *__49__, Caerns.: Woodland near gardens, Bryn Euryn, SH834801, J. Phillips & P. Ingham, 2002, **NMW**, det. E.J. Clement..

‡131/6.6. LONICERA JAPONICA *__49__, Caerns.: Well naturalised on cliff above beach, Great Orme, Llandudno, SH759829, W.M. McCarthy, 2002.

‡131/6.8×etr. LONICERA × ITALICA (L. CAPRIFOLIUM × L. ETRUSCA) *__29__, Cambs.: Scrambling in hedges by railway, Paddocks Drive, Newmarket, TL642625, A.C. Leslie, 2003. *__46__, Cards.: Abundantly naturalised in scrub on sea cliffs , W of pier, New Quay, SN388601, A.O. Chater, 2002, **NMW**.

133/1.1. VALERIANELLA LOCUSTA **104**, N. Ebudes (Canna): Above sandy beach, Sanday, NG266047, M.E. & P.F. Braithwaite and C.W. Murray, 2001. 1st record for Canna.

†133/1.3. VALERIANELLA RIMOSA **41**, Glam.: Locally fairly frequent in part of a spring-sown oats field, with *V. dentata*, Hunts Farm, Pennard, SS563873, A. Jones & J.P. Woodman, 2002. 1st record in western Glamorgan since c. 1850.

133/1.5. VALERIANELLA ERIOCARPA. ▣**9**, Dorset: Several patches on castle mound, Corfe Castle, SY960823, D.C. Leadbetter, 2002.

¢134/1.4. DIPSACUS STRIGOSUS *__33__, E. Gloucs.: Small number of previous year's seedheads on side of A419, near Royal Agricultural College, Cirencester, SP002014, M.A.R. & C. Kitchen, 2003.

¢134/1.lac. DIPSACUS LANCINIATIUS *__39__, Staffs.: About four plants plus rosettes in a pile of building waste from new building work, Ounsdale School, Wombourne, SO865931, A. Ferguson, 2003, conf. I.C. Trueman.

‡135/1.2. ECHINOPS EXALTATUS *__81__, Berwicks.: Established on roadside, near East Morriston, NT609419, M.E. Braithwaite, 2002.

135/4.1. SAUSSUREA ALPINA **104**, N. Ebudes (Raasay): 3 plants, 1 in flower, on rock ledge, N end of Beinn na' Leac, NG593374, S.J. Bungard, 2003. 1st record for Raasay.

135/5.3×4. CARDUUS × STANGII (C. CRISPUS × C. NUTANS) *__46__, Cards.: By footpath, Felin-y-mor Road, Aberystwyth, SN580806, A.O. Chater, 2003, **NMW**, det. C.A. Stace.

¢135/6.7. CIRSIUM OLERACEUM *__81__, Berwicks.: Ornamental, Mellerstain Lake, NT651386, M.E. & P.F. Braithwaite, 2001.

¢135/11.3. CENTAUREA CYANUS *__84__, W. Lothian: With *Anthemis arvensis* and *Chrysanthemum segetum* in small fallow patch beside strawberry beds, West Craigie Farm, NT158763, J. Muscott, 2003. Originally sown in wild flower seed mix?

¢135/17.1. PICRIS ECHIOIDES *__109__, Caithness: 1 plant on Thurso riverside, ND115678, R.E.C. Ferreira, 2003.

‡135/19.1a, TRAGOPOGON PRATENSIS subsp. PRATENSIS *__11__, S. Hants.: Priddy's Hard E, SU615012, E.J. Clement & D.R. Allan, 2003.

135/22.2. LACTUCA VIROSA *¢__42__, Brecs.: About 40 plants (casual only) on disturbed road verge, beside A40 at Scethrog, SO107251, M. Porter, 2002. Population cut down by verge trimmer.

‡135/23.2. CICERBITA MACROPHYLLA *__29__, Cambs.: Large patch at base of hedge, beside Lynn Road, Wisbech, TF465101, A.C. Leslie, 2002.

‡135/23.3. CICERBITA PLUMIERI *__39__, Staffs.: Amongst natural vegetation, near footpath, at edge of wood, Dimmingsdale, SK049433, P.B. Knight, 2001.

135/25.3. TARAXACUM ARGUTUM *__46__, Cards.: Mature dune, Ynys-las Dunes NNR, SN608938, A.O. Chater & P.A. Smith, 2003, **NMW**, conf. A.J. Richards.

135/25.23. TARAXACUM SCANICUM *__46__, Cards.: roadside bank, 400m E of Rhoscellan-fawr, Wallog, SN602854, A.O. Chater & P.A. Smith, 2003, **NMW**, det. A.J. Richards.

135/25.84. TARAXACUM ATACTUM *__23__, Oxon: In *Agrostis/Lolium/Phleum* grassland, Port Meadow, SU495085, A.W. McDonald, 2001, conf. A.J. Richards. Also at SU496085.

135/25.103. TARAXACUM ACROGLOSSUM *__23__, Oxon: In former croquet lawn on base-rich clay, Milham Ford School, SP5207, J. Webb, 1999, conf. A.J. Richards.

135/25.187. TARAXACUM PORRIGENS *__35__, Mons.: Path side, Geraig Wood, west of Abergavenny, SO2416, T.G. Evans, 2003, **NMW**, det. A.J. Richards. Very good distinctive material of a very rare British plant.

135/25.217. TARAXACUM UNDULATUM *__23__, Oxon: In long grassland, on wet, base-rich clay, Milham Ford School, SP5207, J. Webb, 1999, conf. A.J. Richards.

135/28.141. HIERACIUM CHLORANTHUM __104__, N. Ebudes (Eigg): Rocky outcrop, Poll Duchaill area, NM4588, J. Bevan, P. Braithwaite & C.W. Murray, 1998, **herb. J.B.**, det. J. Bevan. 1st record for Eigg.

¢135/29.1. GAZANIA RIGENS *__11__, S. Hants.: Honeycombe Chine, SZ1191, E.J. Clement & D. R. Allan, 2003, det. E.J. Clement.

‡135/33.6. GNAPHALIUM LUTEOALBUM *__58__, Cheshire: Gravelly area, Gordale Nursery, Burton, Wirral, SJ335755, R.F. Goodchild, 2003, **herb. G.M. Kay**, det. E.J. Clement.

‡135/43.1. ERIGERON GLAUCUS *__85__, Fife & Kinross: Seaside braes and rocks, Kinghorn Ness and area, NO270862, R.I. Milne, 1998, **E**. Very thoroughly naturalised, probably first in 1970s.

__113(S)__, Channel Is. (Sark): On roadside wall outside derelict garden, West of La Valette, WV471761, R.M. Veall, 2003, **herb. Société Sercquiaise**. 1st record for Sark.

‡135/43.2. ERIGERON PHILADELPHICUS *__29__, Cambs.: Three plants on roadside verge, E side of Crane's Lane, Kingston, TL344548, P.J. Reynolds, 2002, conf. G. Halliday. Garden escape.

‡135/43.4. ERIGERON KARVINSKIANUS *__70__, Cumberland: S-facing stonework, Oxford Street, Workington, NY002286, R.E. Groom, 2003, **LANC**.

‡135/43.5. ERIGERON ANNUUS *__41__, Glam.: About 50 plants along disused railway line, near Port Tennant, Swansea, SS685931, C.R. Hipkin, 2002.

‡135/44.2. CONYZA SUMATRENSIS *__41__, Glam.: Many plants in flower beds and on bare waste, Victoria Gardens, Swansea, SS642923, A.S. Lewis, 2002.

‡135/44.bil. CONYZA BILBAOANA *__29__, Cambs.: Garden weed, 28 Panton Street, Cambridge, TL453575, P.D. Sell & P.H. Oswald, 1999.

¢135/44.bon. CONYZA BONARIENSIS *__1b__, Scilly: c. 8 plants in bulb field, near Watermill, St Mary's, SV924121, E. Sears, 2003, det. E.J. Clement.

‡135/48.2. TANACETUM MACROPHYLLUM *__94__, Banffs.: Established, growing on bank by bridge, Boat o' Brig, NJ318517, I.P. Green, 2000. Still there 2003. Recorded from this location by M. McCallum Webster in 1966 but in v.c. 95. Confusion over county boundary?

‡135/50.6. ARTEMISIA ABROTANUM *¢__44__, Carms.: One plant in rough ground beside cycle-way, Pwll, SN472008, T. & V. Lewis, 2003.

135/54.1. CHAMAEMELUM NOBILE __52__, Anglesey: Patch spreading from a rock outcrop into a damp grassy hollow, Tywyn Trewan, SH320754, I.R. Bonner, 2002, **herb. IRB**. 1st post-1970 record.

¢135/55.2. ANTHEMIS ARVENSIS __84__, W. Lothian: With *Centaurea cyanus* and *Chrysanthemum segetum* in small fallow patch beside strawberry beds, West Craigie Farm, NT158763, J. Muscott, 2003. Originally sown in wild flower seed mix? 1st certain record since 1934.

¢135/57.1. LEUCANTHEMELLA SEROTINA *__46__, Cards.: rubbish tip, Aberystwyth, SN589810, J. H. Salter, 2003, **NMW**, det. E.J. Clement.

‡135/62.1. SENECIO CINERARIA *__85__, Fife & Kinross: 1/2 plants by shore - an escape from nearby garden, Kinghorn, off Pettycur road, NT269862, R.I. Milne, 2003, **herb. G.H.B.**

‡135/62.1×10. SENECIO × ALBESCENS (S. CINERARIA × S. JACOBAEA) *__85__, Fife & Kinross: 2 plants on sea brae, Kinghorn Ness area, NT270862, R.I. Milne, 2003, **E**, det. D.R. McKeen. A natural hybrid (both parents frequent in vicinity).

‡135/62.3. SENECIO INAEQUIDENS *__33__, E. Gloucs.: One plant in new shrubbery, Gloscat New Campus, Princess Elizabeth Way, Cheltenham, SO920225, J.A. Bailey, 2003, conf. E.J. Clement.

*__58__, Cheshire: Waste land, Ellesmere Port, SJ384787, R.F. Goodchild, 2000, conf. G.M. Kay.

135/62.12. SENECIO ERUCIFOLIUS *__42__, Brecs.: Grassy road verge, 0.5km SW of Troed-rhiw-dalar, SN947531, M. & C. Porter, 2002. 1st confirmed record.

135/62.17. SENECIO SYLVATICUS __104__, N. Ebudes (Raasay): 60-80 plants by track in cleared forest, N of Glen Lodge, NG564368, S.J. Bungard, 1996. 1st record for Raasay.

‡135/74.1. AMBROSIA ARTEMISIIFOLIA **33**, E. Gloucs.: Single plant 2 feet high by railings, Pittville Park, Cheltenham, SO9523, A.J. Wake, 2003, det. E.J. Clement. Only post 1970 record. *¢**50**, Denbs.: Edge of lake, Gresford, SJ346536, B. Formestone, 2003, conf. J.A. Green.

‡135/75.1. IVA XANTHIIFOLIA *__6__, N. Somerset: Single plant on stonework of Herriott's Bridge, Chew Valley Lake, A. Stevenson, 2003, det. J. Akeroyd.

‡135/81.3. BIDENS CONNATA *__39__, Staffs.: More than 40 plants in the vicinity of locks 10 and 12, Caldon Canal, Denford, SJ950537, D.W. & S. Emley, 2003.

¢135/CAR.tin. CARTHAMUS TINCTORIUS *__70__, Cumberland: Field edge, bird seed casual, Parton,Wigton, NY278505, M. Ashurst, 2003, **LANC**, det. G. Halliday. *__95__, Moray: rubbish tip, Elgin, NJ2363, I.P. Green, 2003.

¢135/GUI.aby. GUIZOTIA ABYSSINICA *__44__, Carms.: One plant (ex bird seed) in crack in concrete apron of old quay, Carmarthen Quay, SN411198, R.D. Pryce & K.A. Cottingham, 2003. __95__, Moray: rubbish tip, Elgin, NJ237630, I.P. Green, 2003. 1st record since 1970.

¢135/TAG.ere. TAGETES ERECTA *__11__, S. Hants.: W of public carpark, Stanpit, SZ165927, P. A. Budd, 2003, conf. B. Goater.

‡137/1.2. SAGITTARIA LATIFOLIA *__39__, Staffs.: Edge of anglers' pond, adjacent to golf course, near Keele University, SJ818456, I.J. Hopkins, 2000.

[138/1.1. HYDROCHARIS MORSUS-RANAE **9**, Dorset: Extinct pre-1969]

‡138/3.1. EGERIA DENSA *__49__, Caerns.: Small pond in wood off Valley Road, Llanfairfechan, SH697737, W.M. McCarthy, 2002.

‡138/4.1. ELODEA CANADENSIS *__109__, Caithness: Abundant in shallows, Loch of Mey, ND269739, H.S. McHaffie, 2003.

‡138/6.1. LAGAROSIPHON MAJOR *__49__, Caerns.: Small pond in wood off Valley Road, Llanfairfechan, SH697737, W.M. McCarthy, 2002.

143/1.1. RUPPIA MARITIMA **104**, N. Ebudes (Canna): Pool above shore, Dun nam Berbh, NG249052, P.F. Braithwaite, 2001, det. C.D. Preston. 1st record for Canna.

‡147/2.1. LYSICHITON AMERICANUS *__81__, Berwicks.: Established on rocks in burn, below Silverwells, NT885660, M.E. Braithwaite, 2002. *__94__, Banffs.: In and by burn below Inveravon Church, NJ181375, A.G. Amphlett, 2003. Total of 5 plants present, 1 on N edge of burn (v.c. 94), 1 in middle and 3 on v.c 95 side.

‡147/6.1. DRACUNCULUS VULGARIS *__29__, Cambs.: Several plants established in a shallow, dry ditch, Waterbeach, TL495653, A.C. Leslie, 2002. *__45__, Pembs.: Six plants in single patch (10×10m) in rough grassland, St Davids rubbish tip, SM787266, M. Sutton, 2002.

148/2.3. LEMNA TRISCULA **109**, Caithness: Loch of Winless, ND2954, N.F. Stewart, 2002, 1st record since 1947. Previous single record now known to be extinct.

‡148/2.4. LEMNA MINUTA *__48__, Merioneth: In one spot (no other *Lemnas* present) in shallow water of marsh at sea level, near Caerduon, Barmouth, SH6417, P.M. Benoit, 2002, **NMW**.

*__H32__, Monaghan: Frequent at Shankill Lough, H559310, I. McNeill, 2003, det. P. Hackney.

‡149/1.2. TRADESCANTIA FLUMINENSIS *¢__29__, Cambs.: Oil Mill Lane, Wisbech, TF459098, G. M.S. Easy, 2002. *__46__, Cards.: Abundantly naturalised in disused cellar under grating, King Street, Aberystwyth, SN580816, S.P. Chambers, ?2002, **NMW**.

‡151/1.2. JUNCUS TENUIS *__94__, Banffs.: Bogmoor, NJ350638, I.P. Green, 2003. Also at NJ 350640. One plant at each location. **104**, N. Ebudes (Muck): Port Mor, NM4279, J. Bevan, P. Braithwaite & C.W. Murray, 1996. 1st record for Muck.

‡151/1.4. JUNCUS GERARDII *__57__, Derbys.: Disused railway line, Ilkeston, SK461425, B. Gough, 2003, det. C.A. Stace.

151/1.8. JUNCUS AMBIGUUS *__29__, Cambs.: In small quantity in the brackish fringe at base of the S bank of the North Level Main Drain, Foul Anchor, TL464179, A.C. Leslie, 2002, **CGE**, conf. T.A. Cope. ‡__81__, Berwicks.: Dense colony 360m long alongside verge of B6456, Kettleshiel, NT715518, M.E. Braithwaite, 2002, det. T.A. Cope. First inland record.

151/1.13×14. JUNCUS × SURREJANUS (J. ARTICULATUS × J. ACUTIFLORUS) **2**, E. Cornwall: Marsh at eastern end of Colliford Reservoir, Bodmin Moor, SX188739, P.R. Green, 2003, det. C. A. Stace. First post 1970 and only extant record for v.c. 2.

151/1.25×26. JUNCUS × DIFFUSUS (J. INFLEXUS × J. EFFUSUS) *__81__, Berwicks.: With parents, new pond, Greenlaw Dean, NT692475, M.E. Braithwaite & BSBI party, 2002.

151/1.26×27. JUNCUS × KERN-REICHGELTII (J. EFFUSUS × J. CONGLOMERATUS) *__51__, Flints.: Hay field, Coed Duon', Tremeirchion, SJ073715, J.E. Green & A.O. Chater, 2002.

152/1.2. ERIOPHORUM LATIFOLIUM **104**, N. Ebudes (Eigg): Wet moorland below Blar Mor (to S), NM4790, J. Bevan, P. Braithwaite & C.W. Murray, 1995. 1st record for Eigg.

152/2.2a×2b. TRICHOPHORUM CESPITOSUM nothosubsp. FOERSTERI (T. CESPITOSUM subsp. CESPITOSUM × T. CESPITOSUM subsp. GERMANICUM) *__49__, Caerns.: Flush in mire, occasional with abundant subsp. *germanicum*, 400m NE of Llyn Idwal, SH650600, A.O. Chater, 2002, **NMW**.

152/3.6. ELEOCHARIS ACICULARIS **39**, Staffs.: Edge of Chasewater Reservoir, SK034080, G. M. Kay, 2002, conf. C.D. Preston. 1st record since 1901.

152/7.1. SCHOENOPLECTUS LACUSTRIS **104**, N. Ebudes (Raasay): Only a few plants in Loch na Cuilce, NG573474, S.J. Bungard, 2000. 1st record for Raasay.

152/8.2. ISOLEPIS CERNUA *__104__, N. Ebudes (Muck): Croidhean Araich, NM422805, P.F. & M.E. Braithwaite, 2000, **herb. P.F.B.**

152/13.2. RHYNCHOSPORA FUSCA **104**, N. Ebudes (Skye): 3000 shoots, perhaps 10% flowering, on edge of small lochan, Glen Sligachan, NG4828, G.P. Rothero, 1995, **herb. C.W.M.** 1st record for Skye and 2nd for v.c. 104.

152/16.3. CAREX DIANDRA **104**, N. Ebudes (Muck): Boggy hollow S of plantation at centre of island, NM4179, J. Bevan, P. Braithwaite & C.W. Murray, 1995, conf. A.O. Chater. 1st record for Muck.

152/16.22. CAREX CURTA **104**, N. Ebudes (Eigg): E coast, N of Kildoran, NM48, J. Bevan, P. Braithwaite & C.W. Murray, 1996. 1st record for Eigg.

152/16.23. CAREX HIRTA **95**, Moray: Bank of the river Findhorn, Logie, NJ327657, I.P. Green, 2003. 1st record since 1970. **104**, N. Ebudes (Rum): rough grassland, N shore of Loch Scresort, NM4099, J. Bevan, P. Braithwaite & C.W. Murray, 1997. 1st record for Rum.

152/16.24. CAREX LASIOCARPA **91**, Kincardines.: Fen, Annie's Dam, NO801717, D. Welch, 2003, **ABD**. Only extant site.

152/16.42. CAREX PUNCTATA ▮**9**, Dorset: In small flush over a mile from the sea, Turbary Common, SZ064946, R.M. Walls, 2003.

152/16.43. CAREX EXTENSA *‡__23__, Oxon: Introduced into W.D. Campbell's garden, Charlbury, SP3618, W.D. Campbell, 1988. Imported with sedge peat from Somerset.

152/16.52. CAREX FILIFORMIS *__6__, N. Somerset: Damp depression in neutral hay meadow, near Cheddar, ST466512, E. McDonnell, 2003. See SRPG Newsletter No.4 for more information.

153/12.6. FESTUCA ARENARIA *__2__, E. Cornwall: In rough dunes at west end of Par Beach, SX079532, I.J. Bennallick & P. Hunt, 2000, **BM**, det. A.O. Chater. Found again at this site during BSBI meeting, May 2003.

‡153/12.7g. FESTUCA RUBRA subsp. MEGASTACHYS *__39__, Staffs.: Grass verges, Wombourne and nearby, SO876927, C.B. Westall, 2002.

[153/12.8b, FESTUCA OVINA subsp. HIRTULA **9**, Dorset: Delete. Never confirmed and not in Flora]

153/12.10. FESTUCA FILIFORMIS **57**, Derybs.: Wet Withens, SK221792, M. Rand, 2003.1st post 1970 record.

¢153/13.rig. LOLIUM RIGIDUM *__11__, S. Hants.: Priddy's Estate, Gosport 6101, SU613011, E.J. Clement & D.R. Allan, 2003, **herb. E.J. Clement**.

153/17.1. BRIZA MEDIA **104**, N. Ebudes (Raasay): By the path between Fearns and Hallaig, NG53, F. Rose, 1987. 1st record for Raasay.

†153/17.2. BRIZA MINOR ▮**9**, Dorset: Arable, Swanage, SZ003799, E.A. Pratt, 2000.

153/18.1. POA INFIRMA ▮**9**, Dorset: By lamp post in bare area, Poole Park, SZ021909, D.A. Pearman & P.J. Selby, 2002, **herb. P.J. Selby**, det. P.J. Selby.

153/18.9. POA COMPRESSA **49**, Caerns.: Grassland, near disused quarry, Dinorwig, SH587612, W.M. McCarthy, 2002. 1st record as a native.

‡153/18.10. POA PALUSTRIS **104**, N. Ebudes (Canna): Marsh by stream behind shore, Tarbert Bay, NG242054, F.M. Aungier, 1995, det. D.R. McKean.1st record for Canna since 1939, refinding (same area) of record made by Heslop Harrison. N. Ebudes (Skye): Damp grassland, Loch a' Ghlinne, Dalavil, NG5905, C.W. Murray, 1998, **E**, det. D.R. McKean. 1st record for Skye.

153/18.13. POA BULBOSA *__29__, Cambs.: Dominant in a narrow band at edge of Paddocks Drive, Newmarket, TL643626, A.C. Leslie, 2003, **CGE**.

‡153/23.2. PARAPHOLIS INCURVA *__29__, Cambs.: A few plants on bare ground, NW side of A14, SE of Stow cum Quy, TL533600, A.C. Leslie, 2003, **CGE**, conf. T.A. Cope. With other native coastal plants on main road verge.

153/24.4. GLYCERIA NOTATA **94**, Banffs.: Ditch on E side of track, SW of Bridgeton near Boat o' Brig, NJ316507, I.P. Green, 2003. 1st record since 1970.

‡153/28.4a. AVENA STERILIS subsp. LUDOVICIANA *__39__, Staffs.: Edge of grassy waste ground, Hollyhock Way, Branston, SJ222210, M.E. Smith, 2002, conf. T.A. Cope.

153/30.1. TRISETUM FLAVESCENS *__109__, Caithness: Many plants on roof of Thurso East ice-house, ND122687, J.K. Butler, 2003, **herb. J.K.B.**, det. D.R. McKean.

¢153/38.4. PHALARIS MINOR *__58__, Cheshire: Landfill site, Neston, SJ292785, R.F. Goodchild, 2002, det. T.B. Ryves.

‡153/38.5. PHALARIS PARADOXA *__39__, Staffs.: Scattered on disturbed, abandoned arable ground by lake, Wedge's Mill, SJ973082, I.J. Hopkins & M.O. Stead, 2003.

153/39.2 × 4. AGROSTIS GIGANTEA × A. STOLONIFERA *__11__, S. Hants.: Mercury Park NW (12), SU676192, J.A. Norton & D.R. Allan, 2003, det. E.J. Clement.

‡153/39.3. AGROSTIS CASTELLANA **29**, Cambs.: Wall, Potters Lane, Ely, TL5479, R.M. Payne, 2002. 1st localised record.

153/40.1. CALAMAGROSTIS EPIGEJOS *__58__, Cheshire: roadside hedgebank near Leighton Hall Farm, Parkgate, SJ286791, E.F. Greenwood, 2001, **LIV**. Known for some years but plant is closely mown and rarely flowers.

153/40.2. CALAMAGROSTIS CANESCENS **9**, Dorset: In strip of wet woodland, Moors Valley, SU102062, B. Edwards, 2001, det. D.A. Pearman. 1st record since 1927.

¢153/46.1. POLYPOGON MONSPELIENSIS *__45__, Pembs.: About 8 'clumps' casual in disturbed ground W of Slade Lane, North Haverfordwest, SM949162, H. Gravell, 2002. *__81__, Berwicks.: Turnip factory tip, Old Cambus quarry, NT808705, M. Watson & ENHS party, 2003, det. M.E. Braithwaite.

‡153/46.2. POLYPOGON VIRIDIS *__95__, Moray: Decora (Garden Centre), Elgin, NJ216634, I.P. Green, 2003.

153/47.3. ALOPECURUS BULBOSUS *__45__, Pembs.: Many plants in damp mesotrophic upper salt marsh, Radford Pill, Milton, SN041032, M. Prosser & H. Wallace, 2002.

153/50.3. BROMUS RACEMOSUS *__43__, Rads.: Abundant in one corner of wet hay meadow, Crossgates, SO087654, S.P. Chambers, 2002.

153/50.4b. BROMUS HORDEACEUS subsp FERRONII **52**, Anglesey: Short turf, in disused coastal quarry, Rhoscolyn, SH262753, I.R. Bonner, 2003, **herb. IRB**, conf. L.M. Spalton. Probably overlooked, but the first post-1970 record.

153/50.4d. BROMUS HORDEACEUS subsp. LONGIPEDICELLATUS *__52__, Anglesey: Grass verge of new A55 dual-carriageway, Gaerwen, SH490723, I.R. Bonner, 2003, **herb. IRB**, conf. L.M. Spalton. *__81__, Berwicks.: Several, arable edge, Burnmouth Hill, NT957614, M.E. Braithwaite, 1999, det. L.M. Spalton.

†153/50.7. BROMUS SECALINUS **41**, Glam.: Weed in sandy soil of rockery, Victoria Gardens, Swansea, SS642922, A.S. Lewis, 2002, det. T.B. Ryves. 1st record in Glamorgan since 1937. **39**, Staffs.: Near field gateway, Hatherton, SJ956111, D.L. Brookman & T.W.J.D. Dupree, 2003. 1st record since 1930.

‡153/52.1. ANISANTHA DIANDRA **41**, Glam.: Well-established, with *A. madritensis*, on disturbed fixed dunes near Swansea Marina, SS663924, B. Stewart & C.R. Hipkin, 2002. 1st record in western Glamorgan since 1842.

‡153/53.1. CERATOCHLOA CARINATA *__48__, Merioneth: Several plants at edge of car park/ riverside meadow, Y Marian, Dolgellau, SH7217, P.M. Benoit, 2002, **NMW**.

¢153/53.3. CERATOCHLOA CARTHATICA *__69__, Westmorland: rough ground, Kendal, SD523908, A. Boucher, 2003, **LANC**, det. G. Halliday.

153/54.1. BRACHYPODIUM PINNATUM *s.s.* *__29__, Cambs.: Small colony in overgrown chalk pit, Cherry Hinton, TL4856, R.S.R. Fitter, 2002, conf. C.A. Stace.

153/54.1. BRACHYPODIUM PINNATUM *__58__, Cheshire: Under oak tree on E side of road between Wirral Way and Wood Lane, Parkgate, SJ281789, E.F. Greenwood, 2000, **LIV**. Usually close-mown and rarely flowers.

153/56.1×3. ELYTRIGIA × LAXA (E. REPENS × E. JUNCEA) *__104__, N. Ebudes (Raasay): Churchton Bay, NG553357, S.J. Bungard, 1997, det. T. Cope.

153/59/5. HORDEUM MARINUM ‡**29**, Cambs.: Small colony on NE verge of A14, W of Honey Hill, Fen Ditton, TL495603, A.C. Leslie, 2002, **CGE**. First record since 1881.

¢153/59.vul. HORDEUM VULGARE *__81__, Berwicks.: In experimental crop, Fishwick Mains, NT9249, M.E. Braithwaite, 2003.

‡153/62.1. CORTADERIA SELLOANA *__109__, Caithness: One clump, close to but outside garden at Newlands by Haster, ND321497, J.K. Butler, 2003.

¢153/68.1. ECHINOCHLOA CRUS-GALLI **70**, Cumberland: Flowerbed, from bird seed, Wetheral Pasture, NY460533, F.J. Roberts, 2003, **LANC**. 1st record since 1942. *__94__, Banffs.: Under bird table in garden, Bogmoor, NJ355632, I.P. Green, 2003.

¢153/68.esc. ECHINOCHLOA ESCULENTA *__29__, Cambs.: Several plants at edge of allotments car park, Cherry Hinton, TL482567, A.C. Leslie, 2002.

¢153/70.1. SETARIA VIRIDIS *__94__, Banffs.: Under bird table in garden, Bogmoor, NJ355632, I. P. Green, 2003.

¢153/70.pum. SETARIA PUMILA *__70__, Cumberland: Pathside, bird seed casual, Port Carlisle, NY245615, F.J. Roberts, 2003, **LANC**, det. G. Halliday. *__94__, Banffs.: 2 plants from bird seed in garden, Bogmoor, NJ356629, I.P. Green, 2003.

¢153/70.ver. SETARIA VERTICILLATA *__70__, Cumberland: Flowerbed, bird seed casual, Wetheral Pasture, NY460533, F.J. Roberts, 2003, **LANC**, det. G. Halliday.

¢153/BRA.pla. BRACHIARIA PLATYPHYLLA *__11__, S. Hants.: Boscombe Chine, SZ108914, P.A. Budd, 2003, **herb. M.W. Rand**, conf. E.J. Clement.

‡153/FAR.spa. FARGESIA SPATHACEA *__41__, Glam.: Long established in deciduous woodland, Cwm Ivy Wood, Gower, SS483938, Q.O.N. Kay, 2002.

154/1.1d, SPARGANIUM ERECTUN subsp. OOCARPUM *__6__, N. Somerset: Large patch at edge of pond, Dimmer, ST616309, P.R. Green, 2003. *__39__, Staffs.: Edge of Wyrley & Essington Canal and nearby, Leamore, SJ999007, J.E. Hawksford, 2003. *__50__, Denbs.: Farm pond, Cloy Farm, Overton, SJ398431, J. Clark, 2003, conf. A.O. Chater.

155/1.1. TYPHA LATIFOLIA ‡**104**, N. Ebudes (Eigg): In reed bed, Cleadale, NM4789, J. Chester. 2000, **E**, conf. D.R. McKean. 1st record for Eigg and only recent record for v.c. 104.

155/1.1×2. TYPHA × GLAUCA (T. LATIFOLIA × T. ANGUSTIFOLIA) *__5__, S. Somerset: Around edge of pond, Taunton, ST252256, I.P. Green & P.R. Green, 2003. Large patches growing with one parent only – *T. angustifolia*

‡157/1.1. PONTEDERIA CORDATA *__2__, E. Cornwall: One clump at margin of duck pond, near Par, SX076543, P. Hunt, 2003.

‡158/6.1. KNIPHOFIA UVARIA *__70__, Cumberland: Sandy banks, Overby, N of Aikshaw, NY1246, R.E. Groom, 2003.

‡158/6.2. KNIPHOFIA PRAECOX *__69__, Westmorland: roadside bank between Shap and Sleagill, SD566120, R.W.M. Corner, 2003.

‡158/6.Atl. KNIPHOFIA 'ATLANTA' *__29__, Cambs.: One flowering stem in tall herbaceous vegetation on SE facing bank of Grunty Fen Drain, Witchford, TL507789, A.C. Leslie, 2002. Perhaps planted or dumped but apparently now well-established.

‡158/10.3. TULIPA GESNERIANA *__94__, Banffs.: Single (red) plant on grassy edge of woodland between B9138 and burn, Marypark, NJ194384, A.G. Amphlett, 2003.

‡158/14.1×2. POLYGONATUM × HYBRIDUM (P. MULTIFLORUM × P. ODORATUM) *__94__, Banffs.: In woodland by road, Dufftown, NJ323394, A.G. Amphlett, 2003. A single patch with 13 flowering stems. *__107__, E. Sutherland: Doll Ford, NC871044, J.K. & S.I. Butler, 2003. Garden escape. *__109__, Caithness: 1 plant near layby on roadside, Dunnet Head, ND204752, J.K. Butler, 2003.

‡158/19.1. SCILLA BIFOLIA *__29__, Cambs.: Abundantly naturalised beside lane to church and in neighbouring field, Brinkley, TL630548, A.C. Leslie & J.L. Sharman, 2002.

‡158/20.1. HYACINTHOIDES ITALICA *__11__, S. Hants.: Mill Lane East, SU361154, P.A. Budd, 2003, **herb M.W. Rand**, conf. M.W. Rand.

‡158/20.3. HYACINTHOIDES HISPANICA *__109__, Caithness: 6 plants at Stemster House, ND183610, J.K. Butler, 2003, **herb. J.K.B.** Recorded in Plantlife scheme.

‡158/21.1. HYACINTHUS ORIENTALIS *¢__29__, Cambs.: Several flowering plants on soil tip, by Devil's Dyke, beside Newmarket railway, TL630604, J.L. Sharman, 2002.

¢158/22.luc. CHIONODOXA LUCILIAE *__57__, Derbys.: In small quantity on edge of wood in grounds Churchdale Hall, SK203703, G. Wheeldon & D. Dupree, 2003, det. D. Dupree.

‡158/23.1. MUSCARI NEGLECTUM *__81__, Berwicks.: Established on bank, Coldstream, NT845400, M.E. Braithwaite, 2003.

‡158/23.2. MUSCARI ARMENIACUM *__94__, Banffs.: One plant in flower on road verge between B9138 and burn, Marypark, NJ194384, A.G. Amphlett, 2003.

‡158/24.3. ALLIUM ROSEUM *__49__, Caerns.: Naturalised on laneside, Llyn Helig, Llandudno, SH700830, W.M. McCarthy, 2002.

‡158/24.5. ALLIUM SUBHIRSUTUM *__29__, Cambs.: One small clump by layby, NW side of A 14, NE of Newmarket, TL663662, A.C. Leslie, 2003, **CGE**.

‡158/24.7. ALLIUM TRIQUETRUM *__42__, Brecs.: Deciduous woodland on river bank, Hay-on-Wye, SO227423, M. & C. Porter, 2002. *__57__, Derbys.: Bank running up from road towards gardens, just south of Holloway, SK328560, P. Precey, 2003.

‡158/24.12. ALLIUM CARINATUM *__94__, Banffs.: At junction of Burn of Mulben and River Spey, Boat o' Brig, NJ319518, A.G. Amphlett, 2003, det. I.P. Green.

158/24.13. ALLIUM AMPELOPRASUM **113(S)**, Channel Is. (Sark): Roadside verge near Mon Plaisir, Rue du Sermon, WV462760, R.M. Veall, 2001, **herb. Société Sercquiaise**, det. P.R. Green. 1st record for Sark.

[¢158/24.cep. ALLIUM CEPA **113(S)**, Channel Is. (Sark): Has been redetermined as *A. ampeloprasum*.]

‡158/28.1. TRISTAGMA UNIFLORUM *__52__, Anglesey: Clump by stream opposite gardens, unlikely to be planted here, Moelfre, SH512863, I.R. Bonner, 2003.

‡158/31.1. LEUCOJUM AESTIVUM *__42__, Brecs.: Several clumps naturalised on steep wooded bank of River Wye, Hay-on-Wye, SO228424, M. & C. Porter, 2002.

‡158/33.3. NARCISSUS POETICUS *__81__, Berwicks.: Established in policies, Newton Don, NT7137, M.E. Braithwaite & ENHS party, 2002.

‡158/33.3a. NARCISSUS POETICUS subsp. POETICUS *__94__, Banffs.: W side of River Avon, Bridge of Avon, NJ183594, A.G. Amphlett, 2003.

‡158/33.5a. NARCISSUS PSEUDONARCISSUS subsp. PSEUDONARCISSUS *‡__81__, Berwicks.: Naturalised on roadside, Gordon, NT643429, M.E. Braithwaite, 1998.

158/34.1b. ASPARAGUS OFFICINALIS subsp. OFFICINALIS ‡__48__, Merioneth: One large plant in sand dunes, Penrhyn Point, Fairbourne, SH6115, P.M. Benoit, 2002, **NMW**. 2nd, and 1st recent record.

‡158/ERY.den. ERYTHRONIUM DENS-CANIS *__81__, Berwicks.: Naturalised in shaded grassland, Newton Don, NT710368, M.E. Braithaite & ENHS party, 2002.

159/2.1. SISYRINCHIUM BERMUDIANA *__35__, Mons.: More than 60 plants in narrow strip in wet, sloping, little improved meadow, Springdale Farm, west of Llangwm, ST407996, J.S. Winder, 2003, **herb. T.G.E.**, conf. T.G. Evans. At least 500 m from any dwelling. Looked native.

‡159/8.1. CROCUS VERNUS *__58__, Cheshire: Garden escape at bottom of Well Lane, Gayton, SJ272805, E.F. Greenwood, 2001.

‡159/8.6. CROCUS CHRYSANTHUS ▣__39__, Staffs.: roadside passing place, Smestow, SO852913, C.B. Westall, 2003. Long established clump.

‡159/8.8. CROCUS SPECIOSUS *__39__, Staffs.: Naturalised patches on bank around pool and nearby, SJ763369, I.J. Hopkins, 2003.

‡159/8.7 × ang. CROCUS × STELLARIS (C. FLAVUS × C. ANGUSTIFOLIUS) *__58__, Cheshire: Small patch in field/hedge boundary, Wood Lane, Parkgate, SJ282789, E.F. Greenwood, 2001.

‡159/9.2b. GLADIOLUS COMMUNIS subsp. BYZANTINUS *__45__, Pembs.: Thriving and well established on top of sheltered wall beside track, N of the Priory, Caldy Island, SS141966, S.P. Chambers, 2002.

‡159/13.1. CROCOSMIA PANICULATA *__41__, Glam.: Established on margin of Clyne Common, SS599889, A.S. Lewis, 2002. *__44__, Carms.: rank vegetation, waste ground, Trostre, SS522995, T. & V. Lewis, 2003.

‡160/1.1. YUCCA RECURVIFOLIA *__9__, Dorset: Established seedlings on low cliff, Swanage, SZ032798, D.C. Leadbetter, 2000. *__29__, Cambs.: Established on former arable, now waste ground, Milton, TL472630, G.M.S. Easy, 2003, **herb. G.M.S. Easy**.

‡160/3.1. CORDYLINE AUSTRALIS *¢__41__, Glam.: Seedlings frequent on sandy waste near The Slip, Swansea , SS643922, A.S. Lewis, 2002.

‡160/4.1. PHORMIUM TENAX *__57__, Derbys.: Acid laneside bank near Buxworth, SK028819, J. Hawksworth & W.A. Thompson. 2003. Several young plants present, apparently regenerating naturally from planted parents.

[162/2.2. CEPHALANTHERA LONGIFOLIA **9**, Dorset: Delete. No specimen. Misidentification]

162/5.1. NEOTTIA NIDUS-AVIS **104**, N. Ebudes (Skye): One plant under hazel scrub, Scorrybrack, Portree, NG4943, M. Henriksen, 1997, photo M. Henriksen, conf. R. Bateman. 1st record for Skye. Seen by C.W.Murray on 14/6/97. Plant picked a week later.

162/7.3. SPIRANTHES ROMANZOFFIANA **103**, Mid Ebudes: Two flowering spikes and one single leaf, The Reef, Tiree, NM0146, J. Bowler, 2002, conf. L. Farrell. 1st record for Tiree.

162/13.1. PLATANTHERA CHLORANTHA *__52__, Anglesey: Five flower spikes in unimproved grassland (former playing field), Plas Newydd, SH516694, D. & M. Walker, 2002, conf. I.R. Bonner & N. Brown. 1st confirmed record.

162/16.1b×18.1. ×DACTYLODENIA ST-QUINTINII (GYMNADENIA CONOPSEA subsp. DENSIFLORA × DACTYLORHIZA FUCHSII) *__70__, Cumberland: Wet roadside verge, Lamonby, NY339353, A. Gendle, 2003, conf. R. Bateman. Single plant with both parents.

162/16.1c×18.2. ×DACTYLODENIA LEGRANDIANA (GYMNADENIA CONOPSEA subsp. BOREALIS × DACTYLORHIZA MACULATA) *__69__, Westmorland: Steep, wet grassland in open situation, Argill Wood NR, NY845138, A. Gendle, 2003, conf. R. Bateman. Single plant.

162/16.1c×18.3c. ×DACTYLODENIA VOLLMANNII (GYMNADENIA CONOPSEA subsp. BOREALIS × DACTYLORHIZA INCARNATA subsp. PULCHELLA) *__69__, Westmorland: Calcareous bog, Tarn Sike, NY672076, A. Gendle, 2003, conf. R. Bateman. Single plant among *Gymnadenia conopsea* subsp. *borealis*.

162/16.1×18.5. ×DACTYLODENIA VARIA (GYMNADENIA CONOPSEA × DACTYLORHIZA PURPURELLA) *__104__, N. Ebudes (Raasay): Oskaig, NG547377, S.J. Bungard, 1996, det. R. Bateman.

162/16.1c×18.5. ×DACTYLODENIA VARIA (GYMNADENIA CONOPSEA subsp. BOREALIS × DACTYLORHIZA PURPURELLA) *__69__, Westmorland: Wet grassland, Tarn Sike, NY670076, A. Gendle, 2003, conf. R. Bateman. Single plant among *Dactylorhiza purpurella*.

162/17.1×18.1. ×DACTYLOGLOSSUM MIXTUM (COELOGLOSSUM VIRIDE × DACTYLORHIZA FUCHSII) *__23__, Oxon: One plant with parents in chalk grassland, Bald Hill, SU723961, S. Blow, 2002, conf. R. Bateman.

162/18.1×3b. DACTYLORHIZA × KERNERIORUM (D. FUCHSII × D. INCARNATA subsp. COCCINEA) *__70__, Cumberland: Edge of willow scrub on calacreous steelworks waste, Hodbarrow, SD181783, A. Gendle, 2003, conf. R. Bateman. 2 plants.

162/18.1×5. DACTYLORHIZA × VENUSTA (D. FUCHSII × D. PURPURELLA) *__109__, Caithness: A few plants on steep bank of Thurso riverside, ND112672, R.E.C. Ferreira, 2003.

162/18.2×5. DACTYLORHIZA × FORMOSA (D. MACULATA × D. PURPURELLA), **104**, N. Ebudes (Raasay): Oskaig, NG5437, S.J. Bungard, 1996, det. R. Bateman. 1st record for Raasay. Also at Inverarish NG551358 & 553354. *__108__, W. Sutherland: Ungrazed acid grassland in grounds of museum, Unapool, NC237327, L. Tucker, 2003, det. R. Bateman.

162/18.3b. DACTYLORHIZA INCARNATA subsp. COCCINEA **104**, N. Ebudes (Eigg): Boggy meadow, Cleadale, NM4789, J. Bevan, P. Braithwaite & C.W. Murray, 1995, **herb. C.W.M.**, det. S. Clarke & R. Bateman. 1st record for Eigg. N. Ebudes (Muck): Marshy ground, Eilean nan Each, NM3981, J. Bevan, P. Braithwaite & C.W. Murray, 1996, **herb. C.W.M.** det. S. Clarke *et al*. RBGE. 1st record for Muck. N. Ebudes (Raasay): Flushes on slope, South Fearns, NG584353, S.J. Bungard, 1997, det. R. Bateman.1st record since 1951 and close to site where recorded by J.W.Heslop Harrison. N. Ebudes (Canna): c. 15 plants in sandy grassland, SW of Am Malagan, Sanday, NG265046, M.E. & P.F. Braithwaite and C.W. Murray, 2001. 1st record for Canna.

162/18.76. DACTYLORHIZA TRAUNSTEINERI subsp LAPPONICA **104**, N. Ebudes (Raasay): About 50 plants in damp moorland, W of Druim an Aonaich, NG578417, S.J. Bungard & C.W. Murray, 1995. **herb. C.W.M.**, det. S. Clarke & R. Bateman. 1st record for Raasay and 2nd in v.c. 104. N. Ebudes (Skye): Flush above path, An Slugan, S of Strollamus, NG589257, R. Woodall (2000) & S.J. Bungard (2002), 2000, det. R. Bateman. Recorded by R. Woodall (2000) but without voucher. Specimen and photos obtained by S.J. Bungard (2002). 1st record for Skye.

162/23.2. OPHRYS SPHEGODES **9**, Dorset: In chalk turf, Nine Barrow Down, SZ008808, E.A. Pratt, 2002. 1st record for this habitat.

Book Reviews

Dorset Rare Plant Register. An account of the rare, scarce and declining plants of Dorset. B. Edwards & D. A. Pearman. Pp. xviii + 106. Dorset Environmental Records Centre. 2004. Spiral-bound softback. £8·00. ISBN 0-9511394-5-2.

There has been a fair trickle of county *Red Data Books* and rare plant registers in recent years, each one seemingly more ambitious than the last. This one is no exception, and is one of the most useful and informative registers so far produced.

A succinct, and highly readable, introduction explains how the species included in the register were selected, and gives a very useful overview of Dorset's rare plants and their habitats. As is customary, the bulk of the volume is devoted to the species accounts, which are thankfully arranged in alphabetical rather than taxonomic order. Most accounts present details, in tabular form, of all recent (1990 onwards) records – including site name, grid reference (to 6-figures or more), date of most recent record, recorder's name, and population data if available. All useful stuff, but, best of all, for each record we are told whether it occurs within an S.S.S.I. or S.N.C.I. (locally designated, non-statutory 'Site of Nature Conservation Interest').

Each species has a commentary on its life history and habitat in Dorset, and any trends in its abundance are noted. Many species have declined, of course, and reasons for the losses are given where known. The emphasis, however, is not so much about dwelling on past declines (though we must learn from them when we can), but rather on an up-to-date assessment of *current* distribution and status.

The *Register* deals with 263 taxa: 29 listed in the *Red Data Book* (i.e. recorded in Britain in 15 or fewer 10-km squares from 1987 onwards), 92 Nationally Scarce (16–100 10-km squares), 52 'Dorset Rare' (1–3 sites in the county from 1990 onwards), 77 'Dorset Scarce' (4–10 sites), seven hybrids and six aliens. For status, the authors have used the categories given in the *New Atlas*, and so perhaps for the first time in a county register we have species being referred to as 'archaeophyte', 'neophyte' or 'native or alien'. On the whole, recent introductions (neophytes) are omitted – apart from a handful considered native, or possibly so, in the past. R.D.B. taxa believed to be 'alien' in Dorset *are* included, but within square brackets. There is only one glaring inconsistency: *Valerianella eriocarpa*, square-bracketed as an 'alien' (in line with the *New Atlas*), is then listed as 'native'. Which is it to be? One presumes that this apparent error reflects the authors' own views about the species (*Watsonia* **24**: 81–89), coupled with the current uncertainty following its discovery in coastal limestone grassland in Devon and N. Wales. On the face of it, 'native or alien' might have been a fair compromise!

As a botanist working in a conservation agency, I often need to know which rare or scarce species occur within particular S.S.S.I.s; or, for particular species, how well they are represented within the 'protected sites network'. In many counties we don't (yet) have the requisite level of information; but this isn't necessarily because it doesn't exist (indeed quite often the information *does* exist), it's just that it hasn't been pulled together in a readily accessible form. In this respect Dorset, quite clearly, is ahead of the game, and all involved in the B.S.B.I. and Dorset Environmental Records Centre are to be congratulated at the way they have been prepared to publish, not just the full grid references, but also whether or not these fall within protected sites. Botanical 'twitchers' will, I suppose, be delighted at the detail they now have at their fingertips, but the authors are in no doubt that the greatest threat to rare plants is not collecting, but ignorance: "...ignorance of their existence and ignorance of their rarity."

In the conservation agencies we have always argued that it is through the routine protection and 'proper management' of *habitats* that we conserve 99·9% of our *species* – although, frustratingly, it's the 0·1% involving *ex situ* conservation, translocations and re-introductions that tends to raise hackles and hit the headlines. But now, for one county at least, we have a fascinating overview of the value of the S.S.S.I. and S.N.C.I. network for the conservation of rare and scarce species. Choose almost any species you like, and you'll discover the full extent to which it now depends for its survival on the protected sites network: *Carex dioica*, for example, all extant populations in S.S.S.I.s; *Carex humilis*, 58 populations, just one of which has no protection; or *Lycopodiella inundata*, 60 populations, all in S.S.S.I.s, apart from one which is a S.N.C.I.

The picture isn't entirely rosy, and some species (especially those of arable habitats) are poorly represented on protected sites. *Briza minor*, for example, has 12 populations, none of them protected. Also, we must acknowledge that the designation of a plant's habitat as S.S.S.I. or S.N.C.I. doesn't *guarantee* its survival in perpetuity; indeed, it would be interesting to know how many 'old' localities, now gone, were also situated within these protected sites. But the authors are up-beat and cautiously optimistic, arguing that "...the tide has turned, [now that] some real effort is successfully going into the restoration and protection of our habitats and the species on them." Let's hope that the 2nd edition, in five or ten years' time, will prove this optimism to have been well-founded.

This is an essential reference work for anyone concerned with the conservation of the Dorset flora, and there is much of interest too for botanists elsewhere in Britain working on rare and scarce vascular plants. Anyone engaged in the early stages of writing a county rare plant register should make sure they get hold of a copy, and then use it as a model for their own!

S. J. LEACH

From Earth to Art. The Many Aspects of the Plant-World in Anglo-Saxon England. Edited by C. P. Biggam. Pp. 342. Editions Rodopi B.V., Amsterdam – New York (Costerus New Series 148). 2003. Softback. E70/US$83. ISBN 90-420-0807-5.

"This book presents most of the papers from 'Early Medieval Plant Studies', the First Symposium of the Anglo-Saxon Plant-Name Survey (A.S.P.N.S.), held in the University of Glasgow, 5th to 7th April, 2000." So begins the preface to this unusual volume by its editor, C. P. Biggam, Director of A.S.P.N.S., who explains that the Survey was founded in 1999 at Glasgow "to study in depth the linguistic evidence for the plant-names of Anglo-Saxon England, taking account of evidence from other disciplines wherever appropriate".

Although its main emphasis is linguistic, the book can justly claim to be interdisciplinary. The contributions are divided into four sections, "Landscape", "Human sustenance and comfort", "Plant-names: analysis and recording" and "Art and literature". These are followed by no less than 19 lexical indexes, of which "Modern English (c. 1450 to present)" (15 pages), "Old English (5th century to c. 1150)" and "Botanical Latin" are the most substantial; some others, e.g. "Langobardic" and "British Celtic", consist of single entries. I found something of interest in every chapter, but I am probably more linguistically inclined than many B.S.B.I. members.

The book begins with an examination by Della Hooke of references to trees in pre-Conquest charters, especially as boundary landmarks. Surprisingly perhaps, "in both charters and place-names ... the thorn [clearly usually *Crataegus monogyna*] stands paramount". Hooke's study corroborates Oliver Rackham's findings about the incidence of tree species in relation to 'ancient' and 'planned' countryside (*Trees and Woodland in the British Landscape*, 1990: 187). Next, Carole Hough's contribution discusses and lists "plant-names attested uniquely in place-names from the Anglo-Saxon period", drawing on the volumes of the English Place-Name Survey. She makes some new suggestions, including *fûl* (as in Fulwood, Lancs, and Fullwood, Yorks, traditionally interpreted as "foul wood") as referring to *Frangula alnus*, but seems to confuse it with *Alnus glutinosa*, suggesting whole woods of it and describing it as "usually found in wet or marshy places, often beside streams". The third paper is on a topic more familiar to B.S.B.I. members – criteria for assessing native status. It is by Ralph Forbes, a B.S.B.I. Vice-county Recorder, and uses *Stratiotes aloides*, *Hydrocharis morsus-ranae*, *Spergula arvensis* and *Scandix pecten-veneris* as examples, but he provides no evidence from the Anglo-Saxon period.

In the second section, concerned with plant uses in Anglo-Saxon times, Allan Hall provides a clear explanation of how archaeobotanical evidence is preserved and recovered and itemises that stored in the Archaeobotanical Computer Database (A.B.C.D.) from deposits of the sixth to mid eleventh century. Debby Barnham discusses Anglo-Saxon food plants: interestingly, 'leeks' (various *Allium* species) were more important than cabbage, which attained its central role in English cuisine after this period. Maria Amalia D'Aronco explains the influence on plant pharmacy of a group of medical documents in Latin, "the common pharmacopoeia of the early Middle Ages", when they were translated into Old English at the end of the 10th century.

The next section, the longest, contains papers concerned with the central interest of ASPNS, linguistic studies. Peter Bierbaumer's contribution on "not-so-real" plant-names gives some salutary examples of misreadings by modern scholars and misunderstandings by scribes. Hans Sauer provides a detailed technical analysis of the morphological patterns and forms of Old English plant-names, and Philip G. Rusche shows how four glossaries of plant-names all descend from a common source, Dioscorides' *De materia medica*. C. P. Biggam presents "an example of the A.S.P.N.S. methodology", "a full word-study" of the Old English word *æspe* (origin of the modern *aspen*) which he suggests "could indicate any of the poplars growing in Anglo-Saxon England". Anthony Esposito compares the treatment of some sample plant-names in use since medieval times, including *madder* and *marigold*, in existing editions of the *Oxford English Dictionary* and in "the new, completely revised edition now in progress". Mats Rydén writes about "William Turner (c. 1510–68), the pioneer figure in the systematic study of British plants and English plant-names".

It was disappointing to learn from the papers on plant-life in early Christian Anglo-Saxon art by Jane Hawkes and in Old English poetry by Jennifer Neville how little the British flora figures in these and that depictions of and references to plants are usually highly stylised and often derived from Celtic and late Roman models.

P. H. Oswald

PLANTATT. Attributes of British and Irish Plants: Status, Size, Life History, Geography and Habitats for use in connection with the New atlas of the British and Irish flora. M. O. Hill, C. D. Preston & D. B. Roy. Pp. 73. Centre for Ecology and Hydrology, Abbots Ripton. 2004. Softback. Price £6·00. ISBN 1 870393 74 0.

The uninformative main title, *PLANTATT*, may put off many people from looking at what is a very useful compilation. The volume integrates into one place 31 attributes or characteristics such as the growth form, biogeographic element, etc. of 1885 native plants, archaeophytes and well-established aliens in the British and Irish floras. It updates previously published work (e.g. Ellenberg values) and provides new compilations such as those for broad habitat categories.

The introduction describes in detail how the attributes have been compiled and abbreviated. The attributes are grouped under four main headings: (a) Status and taxonomy (taxon name, family, native status, conservation status, rarity status, change index); (b) Size and life form (height, length, perennation, life form, woodiness, clonal spread; (c) Geography and climate (major biome, eastern limit code, continentality in Europe, origin of alien taxa, numbers of 10-km squares in Britain, Ireland and Channel Islands, [averaged] January and July mean temperatures, annual precipitation; and (d) Habitat (coastal, broad habitats, Ellenberg indicator value). The species are then listed alphabetically with abbreviated attributes in tabular form, which forms the bulk of the book. An appendix sets out how the new attributes have been compiled.

The volume will probably be of considerable use to botanists and ecologists wanting to characterise all or parts of the flora, or to analyse changes or causes of change, for which it is invaluable saving many hours work integrating data sets. It would be even more useful if it was also available in electronic form, saving the re-entering of the data required. It will probably be of most use to B.S.B.I. members writing Floras who want a single reference source for characterising, say, their local biogeographic elements.

T. C. G. Rich

Editorial note: The PLANTATT database *is* available in electronic form and can be downloaded from the Biological Records Centre website, www.brc.ac.uk

Interactive Flora of the British Isles. (DVD-ROM). Edited by C. A. Stace, R. van der Meijden & I. De Kort. Expert Center for Taxonomic Identification (ETI). £32·00.

This Flora is based on a revised version of the *New Flora of the British Isles* (Stace, 1997 – see review in *Watsonia* **22** p. 123) and, for the distribution maps, on the *New Atlas of the British and Irish Flora* (Preston *et al.* 2002 – see review in *Watsonia* **24** p. 583). "Two thick, heavy books combined into one light, thin disc, providing the user with more than 6500 colour photographs and more than 2000 line drawings." This is certainly true for Stace's *Flora*, which has been reproduced most elegantly in electronic form with hyperlinks to glossary, keys and literature references. It is less true of the *New Atlas* for although the DVD Flora has access to the same data for its distribution maps, it is not possible to replicate the maps in the *New Atlas* (you cannot view the whole of the British Isles and map at 10-km scale) and the DVD does not include any of the text from the *New Atlas*. Although the *New Atlas* is already available on CD it is a pity that the text was not included on this DVD as it compliments the descriptions from the *New Flora* by providing more detail on distribution, habitats and change.

This is the first time we have reviewed a DVD (as opposed to a CD) product in this journal. It is an interesting publishing venture being a collaborative production involving Cambridge University Press, Oxford University Press, the Centre for Ecology and Hydrology, the Dutch National Herbarium, the University of Amsterdam, BSBI and DEFRA. Despite the large collection of collaborators' logos on the cover there is still room for a few nice plant pictures. Strangely, these appear to all be alien species, with the main picture showing *Geranium endressii*; perhaps this shows the cover designer's preference for garden plants, but it would have been nice to see something typically British on a *Flora of the British Isles*.

If, like me, you already have the *New Flora* and the *New Atlas*, you may be thinking that you do not need the DVD. In fact this *Interactive Flora* is much more than the sum of its parts. The electronic book is cleverly structured so that you can look at glossary entries (all highlighted in the text and many of them illustrated), view information on classification, synonyms, and literature and look at photographs and/or drawings of the species, all without losing your place. It is possible to copy sections of text and pictures and paste them into other applications. Anyone familiar with using the internet will find the way the program works to be familiar and intuitive. As with the *New Atlas* CD, once the software is installed, the program can be run without the disc and everything on the DVD except the photographs can be viewed without the disc in the drive.

The Text key is not very friendly and, being dichotomous, allows users to get a long way down the 'wrong' path before realising their mistake. It does have a decision tree allowing you to review the questions asked so far and to see how many species are still possible and a list of those 'eliminated' by decisions made. There are also a few examples of multi-access keys in the IdentifyIt module. These only cover *Cotoneaster*, *Limonium* and *Sorbus*, but the software allows the user to develop their own matrices of character states against which specimens can be compared. It would be good to have a basic multi-access module for all taxa which would at least enable the user to shortlist all the species with, for instance, blue flowers and five petals. At present this feels like a fun 'add-on' to the program rather than an integral identification guide, but if further matrices are developed and shared, it could become a welcome alternative to the standard keys.

I found the selection of pictures very good – for most common species there are several to choose from including a general habitat shot and a close-up of the flowers. There is more emphasis on flowers than foliage and the photo's do not always show the key diagnostic characters, but they are very good for showing the 'jizz' of a plant. It is very reassuring, having struggled through twenty questions on a dichotomous key, to find that the plant you are trying to identify matches the photograph. In order to keep the file size down the images are at a low resolution (72 dpi) which is fine for viewing on screen but too low for printing. 6500 photo's is still a relatively small number to show all the variation of the British Flora and there are many subspecies and varieties which are not illustrated. The multimedia (pictures) list includes an 'overview' picture, but this is simply the default picture shown, which makes it look as if there is one more picture than there actually is. The name 'multimedia' made me wonder if there were any other types of file that might be attached to a species. A quick search of the disc revealed four 'movie' files although these do not appear to be used by the software; there is also a 'miscellaneous' folder with pictures of Clive

Stace and the Dutch editors out botanising and enjoying a celebratory dinner. Again, these pictures are not used within the program and I cannot tell if they have been put on the DVD by accident or whether this is a little 'Easter Egg' put there to delight those nosy enough to poke around on the disc. Drawings from the *New Flora* and from BSBI handbooks have been scanned in, they are presented on a cream background which does not look too bad on screen but will not help anyone who tries to print them out on a black and white printer. Although you can look at all the pictures for one species at the same time it is not so easy to get up pictures of similar species for comparison. There is no equivalent to the browsing that one can do with a printed book where you often find what you are looking for by chance when looking up a related species which is illustrated on the same page. While this method of flicking through the pictures until you find a match may not be very scientific, it is the preferred (and often the quickest) way to identify an unknown plant for many botanists.

Hybrids are treated separately in the indexes, this is partly to get around the technical difficulties of getting hybrid names to sort correctly (hybrid signs are put in brackets after the names to enable alphabetic sorting). Most are listed and described under one or both of the parent species; the only problems are intergeneric hybrids which are only indexed under the hybrid epithet and not with the parent species. Relatively few hybrids are illustrated. As a test I tried searching for pictures of the hybrids of conservation concern recently listed by Preston (2004) but could not find any of them.

Other features which add to the content of the *New Flora* are tabs linking to Literature and Synonyms. These have been restricted to a bare minimum with many less synonyms included than, for instance, Sell & Murrell (1996). The Literature links were also rather minimal with only 63 entries altogether. Key references to accounts in the *Biological Flora* series or even BSBI abstracts would have been useful.

The mapping software is perhaps the most important add-on to the content of the *New Flora* and yet in some ways it is the least successful part of this venture. When viewing the whole of the British Isles you can only look at distributions at 40-km scale, when looking at Northern or Southern Britain this comes down to 20-km. At both 40-km and 20-km scale there is no information on date-class of the records which can produce some very misleading maps; you would think *Adonis annua* was very common in Britain unless you knew that most of the records shown were in fact pre-1970. It is not until you select one of the detailed maps which show dots at 10-km scale that you are able to select which date classes of records are shown. Welsh users will be annoyed to find there is no way to display all of Wales on one map and view 10-km records and even with Ireland the scale is at 20-km until you zoom in to view half of the island. An odd feature is that the 'map chooser' which allows you to select species for mapping does not use the same index as the rest of the program and instead asks you to choose from three batches of page numbers as if you already knew where the species was cited in the main text. The software also allows the user to call up lists of species for a square (or group of squares), compare species distributions and show species richness. The ability to query which taxa have been found in a square is very useful and when combined with the date-class and native/alien status it enables the user to extract, for instance, a list of native species recorded in a square that have not been recorded between 1987 and 1999. The key calls this 'disappeared 1970–1986' suggesting that you are mapping the diversity of extinctions – this is not strictly true but some of the patterns shown by such maps are quite interesting and warrant further study. I get the feeling that the mapping section was added at a late stage in the process rather than being properly integrated into the book and this is why there is no direct link from a species account to a map for that species. Like the *New Atlas* you can distinguish alien and native records with colours, but instead of the blue (native) and red (alien) of the *Atlas*, the DVD uses purple for alien records. For those of us (like me) who are slightly colour blind this is not an easy colour to distinguish from blue.

The electronic format will not appeal to everyone and, even within the subset of computer-literate botanists, there will be many who have older PCs which lack a DVD drive. There is a further handicap for institutional users as the software will only run fully on a single PC and attempts to access it over a network will result in a lack of pictures. It is never as easy to load up a computer disc as it is to grab a book.

Those computer users who have machines capable of running this software will undoubtedly also have access to that other fount of knowledge – the world wide web. It is worth comparing the availability of photographs on the internet with those on the DVD. Initially the DVD's figure of

6500 photos looks very good but the speed, variety and quality of pictures that can be found on the net give it a good run for its money. There may be a few species pictured on the DVD for which there is nothing available on the net, but I have not found them yet. The DVD does have the advantage that all of the pictures are accurately identified but there are many species on the disc which have no pictures at all. I tried some searches using Altavista's image search facility and was able to get 81 pictures of *Malva parviflora* in less than 1 second where the DVD had only the line drawing of the fruit from the *New Flora*. Most of the species which lack photographs are rare aliens, but even *Viola arvensis* has only one picture on the DVD (222 on the net). If you want the disc to be a 'one-stop-shop' for plant information then inclusion of photos of all the common species can be justified but I expect most purchasers will already have good sources of pictures for these plants. There is a demand for pictures of the critical and obscure species and for pictures that show how to distinguish difficult taxa.

Given the dynamic nature of this sort of information I do wonder if publication in this form is really justified. It would be relatively straightforward to make all this data available on a web site with the added advantage that it could then be updated and added to. The mapping data is already available on the NBN Gateway and you could incorporate links to the BSBI database for other information (e.g. references in Literature from BSBI abstracts).

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M. N. SANFORD

Obituary

STANLEY REGINALD JOHN WOODELL
(1928-2004)

Stan Woodell, the Oxford botanist, has died aged 75. He joined the Botanical Society of the British Isles in 1954, remaining a member until his death, and had been closely involved in work for the Society. For many years he was a member of the B.S.B.I. Conservation Committee, to which he was appointed in 1969 and, except for a rest year, in which he served until 1983. He was B.S.B.I. Representative for 10 years on the Society for the Promotion of Nature Reserves, later the Society for the Promotion of Nature Conservation, and was B.S.B.I. Referee for Primulaceae from 1980 until his death. His research on the genetics of *Primula* was far-reaching. He was a founder member of the Berkshire, Buckinghamshire and Oxfordshire Naturalists' Trust (later the Berkshire, Buckinghamshire and Oxfordshire Wildlife Trust, B.B.O.W.T.) and was very active in local conservation. He was a Governing Body Fellow of Wolfson College, Oxford, playing an active part in college life, and remaining Fellow Librarian until his death.

Stanley Reginald John Woodell was born in London on 15 November 1928 and spent his formative years there, attending the Latymer Schools. He was still living in London during the Second World War and had vivid memories of bombings in the city and of an incendiary bomb that fell on his family home. Succeeding well at school, and after service in the Royal Air Force, he gained a place at Durham University to read Botany, becoming the first member of his family to pursue a university career. He stayed there to do a Ph.D., supervised by Prof. David H. Valentine, on the genetics of Primulas, thus continuing Valentine's earlier research on the genus.

His first academic post was at Queen Mary College, London, and in 1959 he was appointed Lecturer in the Botany School, Oxford University, where he taught ecology and remained until his early retirement in 1988. Stan's main interests were plant ecology and taxonomy, especially the reproductive biology of flowering plants, particularly those of extreme environments such as deserts, saltmarshes and the Arctic. He travelled widely and carried out research not only in Britain but elsewhere, including Australia, Africa, Greenland and California. In Oxford he continued research on *Primula* and also worked on *Armeria* and *Viola*. In the late 70s he was involved with the conservation and management of the Fen Violet, *V. persicifolia*, particularly at Woodwalton Fen.

Stan was closely committed to teaching and enjoyed field trips with his undergraduate students, many of whom remained close friends and colleagues. He regularly ran annual week-long field excursions for students to Gower, Scotland, North Wales, the Algarve, and other places. He supervised many research students who were grateful for his enlightened choice of research topics upon which they embarked; several research papers have appeared through his continued collaboration with them after their careers at Oxford were completed.

One of his major projects was work with John Richards and Roy Perry on a new Flora of Oxfordshire which was started in 1968. Soon afterwards, however, his two co-authors left Oxford and the project took much longer than was first envisaged. But through the cooperation of many devoted field recorders and the later arrival of John Killick, a new third author (John Richards having retired from the Flora project), the work was finally published 30 years after its inception (Killick, Perry & Woodell, 1998).

Perhaps his greatest academic achievement was his forward-looking research on hybridization in the Primrose (*Primula vulgaris*), Oxlip (*P. elatior*) and Cowslip (*P. veris*). The significance of this work (for example, Woodell 1960a; 1960b) – in many ways four decades ahead of its time – is only now becoming apparent as molecular genetics develops. He showed that the genes which entered the incipient hybrid seed behaved differently, depending on whether they came from the 'father' or the 'mother' plant. Belated follow-up work now in progress at the University of Bath shows how important Dr Woodell's work in the 1950s has been in understanding plant evolution and the potential for hybridization.

His interest in conservation and man's damaging impact on the environment became increasingly important to him. For B.B.O.W.T. he served on many Trust committees and was Chairman of its local Vale of Aylesbury Regional Committee from 1976 until his death. Stan was



Stan Woodell, c. 1978.

among those who took the Trust forward, from its early years in the 1960s when it was entirely volunteer-led, through to its present membership of 18,000 and a permanent staffing. Locally he was involved in the acquisition and management of Rushbeds Wood and Lapland Farm for the Trust, places he loved very much. In 1985 Stan organised a lecture series at Wolfson College on 'The English Landscape'. In his Editor's Epilogue of the publication that resulted, he wrote "We are all custodians of our landscape. Will our descendants, in a few hundred years or less, praise us for the care we gave to our landscape, or condemn us for the damage we did to it? It is up to all of us to ensure that it is praise, rather than condemnation that we receive." In 1987 he was awarded a grant by the British Ecological Society to work on the vegetation of Cape St Vincent and the Sagres Peninsula in Portugal. This is an area – the most westerly point of Europe – that has a notable vascular flora but was under threat from development. Stan's intervention, which involved the Portuguese President, caused the authorities to re-consider their development plans.

Stan lived the last ten years of his life with a transplanted kidney. Then in 2003 he underwent a heart operation. As a result of this and a declining kidney his health deteriorated. But his long spells in hospital were eased by his love of his books (he had amassed a considerable library by then) and music. His funeral and burial in Oakley churchyard were attended by many of his friends and colleagues. But Stan had agreed to this site only when he was sure that the vegetation surrounding his grave would not be too closely cropped. He had previously warned in a letter to *The Oxford Times* of the excessive zeal in keeping churchyards well mown and tidy, arguing that they are often the last refuges for species that have vanished from the surrounding areas.

A King George VI Fellowship to the United States was awarded to Stan in 1956. One of its requirements was "to meet and get to know Americans". Stan fulfilled this admirably, returning home at the end of the year with an American wife, Becky. They settled down in Oakley near Aylesbury where he lived for the rest of his life.

We extend our sympathy to Becky, their two sons, Vivian and Julian, and their families in their sad loss.

I am grateful to Becky Woodell, Mary Briggs, Richard Fitter and Rachel Hamilton for information used in this account. Dr Alison McDonald kindly supplied the photograph.

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A. ROY PERRY

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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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The cover illustration of *Euphorbia hyberna* L.. (Irish Spurge) was drawn by Rosemary Wise.

Re-appearance of the rare intergeneric hybrid fern ×*Asplenophyllitis jacksonii* Alston (Aspleniaceae) in the flora of Cornwall

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ABSTRACT

The extremely rare fern ×*Asplenophyllitis jacksonii*, the natural hybrid between *Asplenium adiantum-nigrum* and *Phyllitis scolopendrium,* has been found in the wild in Cornwall after an absence of records of it in mainland Britain as a whole for nearly one and a half centuries. Here, the occurrence, field-appearance, habitat, origins and onward progress of the plant are described and discussed in relation to the habitat and ecology of this striking intergeneric hybrid fern.

INTRODUCTION

A single plant of the extremely rare fern ×*Asplenophyllitis jacksonii*, the natural intergeneric hybrid between *Asplenium adiantum-nigrum* and *Phyllitis scolopendrium,* has been found by the author in the wild in West Cornwall (v.-c. 1), after an absence of native records of it in mainland Britain as a whole for nearly one-and-a-half centuries.

In the British flora in Victorian times, this hybrid was reportedly known in the wild from widely scattered stations in the Channel Islands (Guernsey in 1856, Jersey 1863), Cornwall (c. 1860) and Devon (1872) (McClintock 1975; Ivimey-Cook 1984; Le Sueur 1984; French *et al.* 1999). According to Alston (1940) and Lovis (1975), no further wild sightings of this plant had up to then been made anywhere on the British mainland or in the Channel Islands since 1872. More recently, F. J. Rumsey (pers. comm., 2004) reports the discovery of a small plant demonstrated to be this hybrid in Guernsey in 1996, but that this plant could not be refound. Apart from this, the only other known record for this hybrid anywhere in the intervening century has been that of a single plant also found in the 1990s in western France (Brittany - Prelli 1996).

Details of the reputed earlier Cornish locality are given as a 'dot' for the District of Penwith, west Cornwall in Jermy *et al.* (1978), but no further locality details are known locally (French *et al.* 1999; R. J. Murphy pers. comm. 2004). Furthermore, F. J. Rumsey (pers. comm. 2004) states that the only previous Cornish record of ×*Asplenophyllitis jacksonii* backed by a specimen is incorrect, the specimen being ×*Asplenophyllitis microdon*, and that it is therefore likely that this present find constitutes the first record of the hybrid from Cornwall – certainly the first unequivocal one.

OCCURRENCE AND INITIAL RECOGNITION OF THIS HYBRID

A single plant of this hybrid was found by the author in September 2002, and, since its first encounter, its subsequent progress has been carefully and continuously monitored.

The plant grows in the old mortar of a west-south-west facing wall of a dilapidated farmstead outbuilding. This locality is within the extensive former mine-working region of west Cornwall between Truro and Redruth at an altitude of c. 75 m. The plant occurs at the side of a rough farm track used mainly by farm tractors and agricultural machinery, and is an inland but nevertheless somewhat maritime-influenced Cornish site.

First impression of the plant was of a fern of unusual appearance, resembling in size and colour, but not in form, a small and rather pointed-fronded polypody of non-colonial habit and hence

worthy of further investigation. On closer approach, it appeared to have coarsely-lobed and rather fleshy fronds, in texture and colour more like *Asplenium marinum*. But the fronds were more spreading away from the wall and with longer, darker stipes to each frond than this species, and the blades, although fleshy, were each wider at the base and the whole of each blade more undulate. It thus became rapidly clear that this was an even more unusual plant - an ×*Asplenophyllitis* - the intergeneric hybrid between *Asplenium* (the Spleenworts) and *Phyllitis scolopendrium* (Hart's Tongue Fern). The occurrence of any fern of intergeneric origins is rare in any combination.

But this plant was not the very local ×*Asplenophyllitis microdon* that I had previously seen in Guernsey (which has the parents *Asplenium obovatum* (=*billotii*) × *Phyllitis scolopendrium* - silhouetted in Hegi 1984 and Page 1997). For ×*A. microdon* has somewhat slender, tapering, less triangular and more ovate-outlined fronds, although its fronds can also be undulate (see photo in Page 1988). However, in this Cornish plant, the parental involvement of a different *Asplenium* seemed indicated; the wide and spreading basal pinnae and overall triangular outline of each of the fronds in the hybrid suggested that this parent was *Asplenium adiantum-nigrum*. This new mainland Cornish fern find is thus of ×*Asplenophyllitis jacksonii* ('Jackson's Fern'). This diagnosis is further supported by the presence of the two parent species *Asplenium adiantum-nigrum* and *Phyllitis scolopendrium* on the same wall (and only these two members of the Aspleniaceae in the locality). Both the latter are also much more abundant on adjacent hedgebanks (built of stone faces with an earth infill and turf capping - see Page 1988, 2005) in the general vicinity.

STRUCTURAL DETAILS OF THIS HYBRID

The following structural details of the fern are mainly as recorded directly from this plant in the field at the time of first finding. The plant has six main intact or semi-intact fronds c. 9·5–15·5 cm long (including stipes) with blades c. 7·5–11·0 long and 3·5–5·8 cm broad across the basal pinnae. The fronds spread away variously from the wall as they adopt more-or-less horizontal to slightly ascending orientations. The stipes are somewhat thicker and shorter than those of comparably-sized *A. adiantum-nigrum*, while the overall plant has fronds considerably larger than those of *A. adiantum-nigrum* in the same site. Compared with this parent, pinnae throughout all fronds of the hybrid are clearly much more entire and congested, slightly overlapping in the lower half of the blade, becoming more so and progressively more confluent in the upper half of the blade. The widest pinnae are the lowest in nearly all fronds, giving the blades a notably triangular outline, and individual pinnae are also each broadest at the base and typically taper rapidly to bluntly-rounded tips. The lowermost 3–5 pinnae bear conspicuous small acroscopic or basiscopic lobes (often both), the basiscopic of which is especially developed on the lowermost one or two pinna-pairs on most fronds, reflecting the shape of the largely auricled cordate base of the *Phyllitis* parent. The lower pinnae are also in life somewhat forwardly-inclined and themselves waved slightly along their length, giving the whole blade the slightly undulate surface so apparent in the field.

On the underside, all fronds (at first finding and also those subsequently appearing) bear copious long sori, which include a mixture of ones of 'single' (i.e. *Asplenium*-like) and 'twinned' structure (opening towards each other, i.e. *Phyllitis*-like) in approximately equal numbers. The latter character in particular, together with the unusually bright green colour of the upper surface of each blade, confirm the involvement of *Phyllitis scolopendrium* in its parentage.

To authenticate and affirm the scientific record in case the plant failed to survive, the plant was photographed and, at the end of the growing-season of 2002, when a blade was starting to discolour naturally, this single frond was collected by careful removal with fine scissors from the stipe base without disturbance to the rest of the plant. Pressed to form a voucher specimen (see silhouette, Fig. 1), this has been temporarily retained for collective study by local botanists in order to calibrate memories in case of independent location of further specimens. It will in due course be deposited at the **BM**.



FIGURE 1. ×*Asplenophyllitis jacksonii*. Single typical frond from the new Cornish site. Natural size.

HABITAT AND KNOWN HABITAT HISTORY

The hybrid grows on a west-south-west facing wall of a somewhat dilapidated farmstead outbuilding, which otherwise (at the time of finding) carries mainly only scattered ivy and *Cymbalaria muralis* plants. The short length of wall is typical of local rural construction: built a few centuries ago of a small number of large squared granite 'quoins' (cornerstones) with smaller pieces of more irregularly shaped 'killas' rocks (partly-metamorphosed shaly-mudstones of Upper Devonian/Lower Carboniferous age) forming the main 'run' of the wall, among which are also further smaller scattered granite inclusions. The hybrid fern itself lies at a point in the wall forming a junction of granite quoin and killas stone beneath. The original mortar is probably based on local granite sand with added lime, and the wall itself, with the rest of the farmstead, is believed to date originally from the 1700s with some rebuilding work in the 1800s. Most of the stonework appears to have received little structural attention since.

The killas rocks are almost certainly native to the immediately surrounding area, which was formerly heavily mined for metal ores. Only the granite quoins would have been brought in, probably from quarries a few miles away. The presence of numerous nearby old mineworkings suggests that the majority of the killas rocks were those outcast from these sources, and which themselves could be variably metalliferously influenced (here with copper, tin and arsenic). In this light, it seems significant that, unlike the nearby lanebanks, the immediate wall is scarcely rich in ferns: there are merely two stunted plants of *Phyllitis scolopendrium*, also on the immediate wall-face, less than a metre from the hybrid and a singe specimen of rather stunted *A. adiantum-nigrum* more than a metre in the opposite direction, with further specimens of *Phyllitis* more abundantly round an adjacent corner. Apart from scattered buildings, the remainder of the farm track is defined largely by traditional (and probably old) Cornish 'hedges' of earth-and-stone construction, carrying populations especially of *Polypodium interjectum*, *Polystichum setiferum*, *Asplenium adiantum-nigrum* and *Phyllitis scolopendrium.* Close searching both in the immediate vicinity and in other similar habitats nearby have, however, so far failed to reveal any further specimens of ×*A. jacksonii*.

Following initial finding of this hybrid (Page 2003), the plant has continued to be monitored by the author. It continues to thrive now nearly three years on. Throughout 2003 the hybrid fern

persisted successfully even through a relatively prolonged late summer drought (when it was monitored frequently, but without interference). During this time it appeared to suffer less from temporary flagging of the fronds than did adjacent specimens of either parent in the same habitat. The plant now has a considerably increased number of fronds (twelve produced by the end of 2003 – all of which are soriferous and continue to follow the soral structural patterns described above). It has become noteworthy that the hybrid appears to remain much larger on the immediate wall than are either of the parent species, suggesting an innate vigour to this particular hybrid plant.

I am told by the owner of the site that this particular wall was cleared of much ivy growth about six years prior to my finding this fern. The hybrid fern appeared clearly at least several years old when initially found. However, the subsequent observations showing it to continue to increase in size and frond number indicate that the plant was not fully-grown when originally found, and this suggests that its origin might well date from immediately after the time of clearance of the ivy mantle. If so, its formation may indeed have been stimulated by the surface disturbance of the mortar-courses during the process of this removal event.

COMPARISONS WITH THE ORIGINAL GUERNSEY MATERIAL AND WITH THE RECENT FRENCH (BRETON) MATERIAL

The first known record of this plant recorded anywhere was in Guernsey, Channel Islands, where it was originally found by C. Jackson in June 1856 (McClintock 1975). In comparison with the actual fronds from the plant recorded in Guernsey, almost all of the details seen in this new Cornish plant are virtually identical, though the Cornish plant is still of a slightly smaller maximum frond size (15 5 cm compared with 10–16 cm but up to 20 cm long for the original Guernsey material). However, the overall variation in size and form between the fronds of this plant and those of the total of seven fronds I have seen preserved from Guernsey is remarkably similar. No exact habitat details of the Guernsey plant are known to me, although it was probably originally from a lanebank. Literature suggests that it was dug up and thereafter seems to have been successfully maintained in cultivation for over the next half a century, becoming propagated and listed by at least four fern nurseries between 1865 and 1928 (McClintock 1975). This does seem to suggest that, like the present Cornish plant, that from Guernsey may too have had a reasonable degree of individual vigour.

The recent record for this hybrid found in Brittany in September 1994 was regarded by Prelli (1996) also as 'extremely rare'. This plant possessed 5 small fronds, measuring 6–11 cm long, with only a few sori, and a further three 15–20+ cm in length, which were more fertile. Cytological analysis confirmed the plant to be triploid, with n = c. 108 chromosomes, thus according with its ascribed parentage. Nearly all of the morphological details of the fronds described and illustrated by Prelli compare closely with those of the present plant, the exception being that about half of the sori of the present plant are 'twinned' in a *Phyllitis*-like fashion. In terms of habitat, however, the French one is, as with this Cornish one, associated with the ferns *Polystichum setiferum, Asplenium adiantum-nigrum* and *Phyllitis scolopendrium,* within a sub-coastal wood, but rooted into the ground at the edge of a small footpath where 'the earth has been disturbed'.

EVIDENCE OF THE INTERGENERIC STATUS OF ×*ASPLENOPHYLLITIS*

The occurrence of this and other hybrids involving *Phyllitis scolopendrium* as one parent, and a species of *Asplenium* as the other, immediately begs the question of whether we are dealing here with a pteridophyte hybrid which is truly intergeneric in origin, or whether it is the result of a cross between species of the same genus which happen to look very different.

My reasons for maintaining generic distinction of *Phyllitis* from *Asplenium*, and thus for regarding this present plant as of intergeneric status include:

- differences in vegetative morphology [with the blade of *Phyllitis* not just entire, but also having a distinctively auricled, cordate base],
- differences in reproductive structure [in which the sori of *Phyllitis* are consistently large, long and run along almost the entire length of the available veins of the lamina, and are always 'twinned'],

- the known experimental difficulty in artificial synthesis of ×*Asplenophyllitis* hybridity (Lovis & Vida, 1969) [which contrasts with the far larger number and frequency of hybrids occurring naturally in the wild between many but not all species of typical *Asplenium* (in Europe see for example Lovis & Reichstein 1981; Jalas & Suominen 1972; Hegi 1984; Vogel *et al.* 1996, and in North America, Wagner 1954)],
- distinctiveness of chromosomal morphology [in which the whole chromosome set of *Phyllitis scolopendrium* is consistently larger than are those of typical *Asplenium* (Vida 1963; Lovis 1973), which has been interpreted as a fundamental distinction of *Phyllitis* (Vida 1970; Lovis 1975; Wagner & Hagenah 1989],
- recent molecular comparisons [which either identify *Phyllitis* as basal within the whole family Aspleniaceae forming a clade which is the sister-group of true *Asplenium* (Murakami *et al.* 1999) or identify *Phyllitis* as sister-group to *Ceterach*, the two together forming a single clade (Pinter *et al.* 2002)].

Some of the above lines of evidence for considering *Phyllitis* generically distinct, when taken separately are indeed not unique in the family: for entire fronds (though not necessarily with cordate auricled bases) have probably evolved several times in the family, as have, I presume, twinned sori. Yet it is the consistency of these in *Phyllitis* that remains notable, while it is also the constant combination of these with the other characters (and especially the distinctiveness of chromosomal morphology) which, in the author's view, continues to justify generic recognition of *Phyllitis* in a global fern taxonomy*.

DISCUSSION

BIOGEOGRAPHIC AND ECOLOGICAL IMPLICATIONS OF THIS FIND

In Britain (as also in the Channel Islands and in north-western France), both parent fern species, *Asplenium adiantum-nigrum* and *Phyllitis scolopendrium*, are common and widespread, especially on old earth-and-stone 'hedges', as well as on a wide variety of old mortared walls. In such hedges within Cornwall, *A. adiantum-nigrum* shows a particularly wide variation in frond form with locality, and sometimes within individual hedges, and a similar picture emerges in Devon. Such hedges in south-west England have themselves been cited as important habitats both for preservation of ancient fern diversity and for presenting sites in which new fern diversity can actively arise (Page 2005). *Phyllitis scolopendrium* is present throughout essentially the same range of habitat types, but when growing in the widespread man-made earth-and-stone hedges of the region becomes abundant, successful and luxuriant (with fronds to 60–85 cm or more in length). No doubt it is the particularly moist climate of this region (with a rainfall of c. 40+ inches (c. 100+ cm) per annum in the area of the hybrid) and frequent high humidity as well as the long (nearly year-round) growing season, that is particularly conducive to the success of both of these parental evergreen ferns, and clearly too of their hybrid, when formed.

Under these conditions it might well be expected that opportunities for hybridisation between the parental frequently-occurring ferns ought to be very high. In this light, the scarcity and clear infrequency of records of the hybrid is probably realistic, considering the degree of close botanical attention which the region has always enjoyed (e.g. Davey 1909; Thurston & Vigurs 1922; McClintock 1975; Margetts & David 1980; Le Sueur 1984; Ivimey-Cook 1984; Jee 1994; French, Murphy & Atkinson 1999) and the interest which the occurrence of natural hybrids in our flora has always aroused (e.g. Manton 1950; Stace 1975 *et seq.*). Were this hybrid to be of genuinely wider occurrence, it might thus well be expected that it would have been recorded before now. One can

*The concept of *Phyllitis* as an independent genus has been widely accepted, especially where the plant is most frequent, both locally (e.g. Girard & Lovis 1968; Lovis 1973, 1975; McClintock 1975; Hyde & Wade 1978; Le Sueur 1984; Ivimey-Cook 1984; Jee 1994; Page 1988, 1997; Stace 1997; French *et al.* 1999; Preston *et al.* 2002), and within its national and disjunct international range (e.g. Pichi-Sermolli 1953, 1977; Vida 1963; Emmott 1964; Jalas & Suominen 1972; Lovis 1975; Lovis & Reichstein 1981; Hegi 1984; Lellinger 1985; Hulten & Fries 1986; Mickel & Beitel 1988; Wagner & Hagenah 1989; Bir 1998; Cody & Britton 1989; Gureyeva, 2001). Encompassing its whole range, Mickel & Beitel (1988) recognise *Phyllitis* as a genus of 3–5 species of Europe, Asia, North America and some of the neotropics of southern Mexico and Hispaniola.

only conclude that reasons for the scarcity of this hybrid are a natural consequence of the parents being not generally successful at crossing with one another. Certainly, even ×*Asplenophyllitis microdon* (the hybrid between *Asplenium obovatum* and *Phyllitis scolopendrium*) is only modestly more widely known in the wild, with a particular focus of occurrence on the island of Guernsey (Page 1991; Jee 1994).

It is interesting that this plant of ×*Asplenophyllitis jacksonii* may have originated in its wall-mortar site following a surface disturbance event when the former ivy mantle was removed. In comparison, the account of Prelli (1996) describes the Breton site, though by a path, as being, significantly, where the earth had been disturbed. In Guernsey, it is suggested that statutory obligations on landowners to regularly cut back lanebank vegetation may promote the occurrence of appropriately disturbed sites (A. C. Jermy, pers. comm., April 2004) as new nuclei for fern and potentially hybrid occurrence. Indeed, the possible role of disturbance in enabling prothalli to grow synchronously in close enough proximity to cross would certainly accord with the view I have put forward separately that disturbance processes across a whole range of scales are vitally important in promotion of the re-establishment process of many (and possibly all) pteridophytes via prothalli, and are particularly vital in permitting unusual but successful hybrid formation (Page 2002).

CONSERVATIONAL IMPLICATIONS OF THIS FIND

The presence of this fern, as a single individual plant, and so far as is known, the only plant of its kind extant anywhere in the British Isles, immediately raises some conservational issues. Its site is one which is already clearly actively used in a practical sense by the workers on the particular farm. Yet it may well be some elements of this active use that have created the habitat which has brought this plant into being in the first place and which has clearly promoted it to survive thus far. If there are any conservation generalisations to be drawn from this, it is perhaps that there needs to be a plea for non-remortaring of old walls wherever possible or at least not without prior botanical survey, and for continued botanical surveying to include ones such as this which appear, at least at first, to be pteridologically unpromising.

I estimate that in this case the natural persistence of this hybrid fern does not appear to be unduly threatened, unless interfered with, or unless the plant comes into accidental physical conflict with passing agricultural machinery. However, because such a single plant could be far more vulnerable to wanton destruction, its exact locality has not been revealed other than to the landowner, who has been asked to ensure that the particular wall is not deliberately destroyed, cleared or re-mortared. The habitat details provided above are thus purely for the scientific record. Being on private land in daily use well away from public access, its location seems reasonably well protected. With the owner's continuing permission (a requirement of which is that I do not reveal the exact location to anyone), its further progress and survival seem likely, and are being carefully onwardly recorded by the author.

CONCLUSIONS

This find of ×*Asplenophyllitis jacksonii* from west Cornwall, that from Brittany by Prelli (1996) and that reported from Guernsey by Rumsey clearly achieve a matching trio of records of similar rare crosses, appearing initially probably within the same decade and perhaps even closer in time than this. The occurrence at all, anywhere, of this particular cross is clearly extremely rare and infrequent. Yet there would seem to have been apparent geographic and temporal clusters of its occurrence in our Atlantic periphery around the middle of the 19th century, and again over much the same geographic area around the mid 1990s. I think I can largely rule out lack of vigilance amongst botanists in observing their occurrence, for such plants have the recording-advantage of being distinctive. Hence I am tempted to ask, after such a long period of absence of records, has the last decade of the 20th century itself produced any special circumstances by which the re-occurrence of this rare hybrid could have been similarly stimulated at these discrete Channel-separated but highly Atlantic-influenced sites? Further, are there any similarities of climatic patterns to those occurring in the mid-1800s? Clearly Brittany, the Channel Islands and Cornwall have much in common climatically as well as geologically. The past decade has also been one of unusual winter mildness, coupled also with some exceptionally hot summers, and also

characterised by significant (and sometimes unseasonal) periods of enhanced storm conditions. Could the greater number of occurrences of this hybrid, together with other ×*Asplenophyllitis* hybrids, as well as other unusual pteridophyte hybrids occurring recently (as has already been found with *Equisetum* – Duckett & Page 1975; Page & Barker 1985; Page 1988, 1997 and subsequent observations) correspond with the occurrence of certain specific climatic combinations, coupled with perhaps increased surface-disturbance of sites, by which unusual hybrid combinations in pteridophytes have been especially stimulated to form and succeed?

Finally, evidence at least from this Cornish plant would clearly suggest that the resulting hybrid can be vigorous, and to have every potential to ecologically persist, once successfully formed. The occurrence of such unusual hybrid ferns, whether they may prove to be evolutionary dead-ends or the very beginnings of new lines, are always of interest. For, besides being potentially valuable environmental indicators, they are also especially important in practically illustrating, under field conditions, how details of micro-evolutionary processes in pteridophytes can take place and under what circumstances these may be achieved. I thus echo the comments recently made by Chater (2003) about the importance of including information on infraspecific taxa (to which I also add here hybrid taxa) within floras, if we are going to be able to best understand more exact details of cause-and-effect between ecological stimuli and our constantly-changing micro-evolutionary floristic dynamics, as illustrated particularly well by those of Pteridophyta.

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Chiltern Gentian, *Gentianella germanica* (Willd.) Börner (Gentianaceae) in Britain: distribution and current status

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ABSTRACT

The distribution and current status of *Gentianella germanica* and its hybrid with *G. amarella* (=*G.* ×*pamplinii*) in Britain have been assessed from existing records and seven years of field work. *Gentianella germanica* is largely restricted to the Chilterns in England and has been recorded from 174 sites, but is currently known in 83 sites (44% decline). The decline has occurred mainly since the 1940s, throughout its range, equally across all habitats, and is on-going. *Gentianella* ×*pamplinii* is recorded in 44 sites and has shown a similar pattern of decline to *G. germanica*. The main causes of the decline of *G. germanica* are agricultural improvement and development of scrub woodland and there is little evidence of hybridisation causing loss of populations. Many populations of *G. germanica* are small with less than 100 plants, but some have populations over 1000. Appropriate habitat management is urgently required for its conservation.

KEYWORDS: conservation, *Gentianella amarella*, *Gentianella* ×*pamplinii*, hybridisation, rare species.

INTRODUCTION

Gentianella germanica (Willd.) Börner (*Gentiana germanica* Willd.), Chiltern Gentian or German Gentian, is an annual or biennial herb of chalk grassland and scrub edges with a British distribution centred on the Chilterns in Buckinghamshire. It is a Nationally Scarce species which is becoming close to qualifying as a Red Data Book species; Stewart *et al.* (1994) reported that it had only been recorded from 21/32 hectads (10 km × 10 km squares) since 1970 (34% decrease), and it was thought to be declining due to loss of habitat and hybridisation, especially at the margins of its range. Preston *et al.* (2002) mapped it as present in 20/34 native hectads since 1987, but noted that although some populations had been lost, the distribution had remained stable since the 1962 *Atlas* (Perring & Walters 1962).

Gentianella germanica has a Local Biodiversity Action Plan in Buckinghamshire (BBONT 1997). As relatively little recent information was available about its distribution and status, we decided to gather detailed information for its conservation and for the restoration and management of its chalk grassland sites in Buckinghamshire. *Gentianella amarella* (L.) Börner and its hybrid with *G. germanica* (=*G.* ×*pamplinii* (Druce) E. F. Warb.) were also investigated to provide additional data.

There are two main identification problems relating to *G. germanica* in Britain. First, *G. germanica* hybridises with *G. amarella* and some populations show introgression (Pritchard 1961). Second, in some *Gentianella* species which occur as both annuals and biennials (Pritchard 1959, 1961), the annual plants often look very different to the more prevalent robust biennials. Small annual plants may be responsible for some erroneous *Gentianella* records, especially of *G. anglica* Pugsl. These two problems were investigated using comparative morphology to ensure the records were as reliable as possible.

W. Pamplin had possibly found *G. germanica* prior to 1841 growing near Tring (Anon 1841) but it was first confirmed as present in Britain by the outstanding Hertfordshire botanist W. H. Coleman (we do not agree with Edgington (2003) that the W. Pamplin record is more likely to relate to *G. ciliata* (L.) Borkh.). Coleman's identification stimulated much debate about the identity of the plants (e.g. Brown 1844; Babington 1864), which continued until the issue was finally clarified by Pritchard (1961). The earliest record traced is a herbarium specimen from St Albans, collected sometime before 1743 (Dony 1967). We agree with Webb & Coleman (1849) that the reference by Gerard (1597, 1633) to Bastard Felwort plants growing 'upon a chalkie banke in the high way betweene Saint Albons and Goramberrie' could refer to *G. germanica* but the illustration shows a plant with a low corolla:calyx ratio and a high leaf length:width ratio, which is more likely to be *G. amarella*. Britten (1909) also argued that the plant described by Ray (1690, 1696) as '*Gentiana fugax Autumnalis elatior*, etc.' was *G. germanica*.

METHODS

IDENTIFICATION

After an initial screening of the characters used to separate *G. germanica* from *G. amarella* (cf. Pritchard 1961), those best suited for measurement and distinguishing the taxa were narrowed down to five for the field identification:

1. Number of internodes above the basal rosette. It was not always easy to distinguish between the basal rosette and the lowest node; the first obvious gap was taken as the lowest internode. A number of plants had an extra solitary, small leaf above the terminal node; this leaf was ignored.
2. Leaf length and width (mm). The length and width of the largest stem leaf from about the middle of the stem was measured. From these measurements, the leaf length:width ratio was calculated.
3. Corolla shape.
4. Corolla length (mm), measured from the base of the calyx to the tip of the lobes on the terminal flower or the largest flower if the terminal one was unavailable.
5. Calyx length (mm), measured from the base of the calyx to the tip of the longest calyx lobe on the same flower as the corolla was measured. The corolla:calyx length ratio was calculated from these measurements.

Plants were separated into *G. germanica*, *G. amarella* and *G. ×pamplinii* as appropriate using these characters.

DISTRIBUTION AND HABITATS

Historical information was abstracted from the literature, herbaria (**ABD**, **AYBY**, **BEL**, **BIRA**, **BIRM**, **BM**, **BON**, **BRISTM**, **CGE**, **DBN**, **DZS**, **E**, **HDD**, **K**, **LTN**, **LTR**, **MANCH**, **MBH**, **NMW**, **OXF** and **RNG**; herbaria abbreviations follow Kent & Allen (1984)), the Biological Records Centre at Monks Wood (BRC), the Threatened Plants Database (TPDB), local biological records centres and correspondence with botanists. Requests for information were also circulated in newsletters and magazines. Some data from record centres were questionable, especially where grid references referred to the centre of sites or tetrads, and were rejected or queried if they appeared suspect.

A conservative approach was taken when analysing the records. Localities with the same name were assumed to refer to the same site unless other evidence indicated to the contrary. Erroneous records and introduced sites were excluded from all analyses. Some historical records were assigned to the most likely tetrad (2 km × 2 km square).

The historical records were used to direct searches for extant populations, and other likely sites were also searched. Field surveys were carried out from 1998 to 2004. For each population discovered, the number of plants was estimated, notes made on the condition of the habitat and associated species, and morphological measurements made to investigate possible hybridisation. If populations could not be refound, possible reasons for loss were considered.

Habitat types were compiled for each site from the information associated with each historical record, or from field work. For some old sites where no specific habitat was mentioned, the habitats were allocated by comparison with the current habitat (e.g. the presence of species-rich calcareous grassland was a good indicator that the site had been grassland for many years). The vegetation was visually allocated to national vegetation types (Rodwell *et al.* 1991–2000) but no detailed quadrats were recorded.

CAUSES OF CHANGE

To indicate when major changes might have occurred, the number of sites known per decade was calculated. Due to the variation in recording of sites through time, the species was assumed to have been present at the site until it was last recorded. It is likely to have been present continuously at most sites on species-rich grasslands, but is less likely to have been present in quarries though it would probably have been present on the adjacent grasslands. Some sites in disturbed places such as quarries could be new sites. Also, it is rarely known exactly when a site went extinct, so the last record is a proxy measure only. To determine whether decline in *G. germanica* has occurred randomly throughout its range or has been greater at the margins (cf. Stewart *et al.* 1994), two methods were used. First, the proportion of extant records in each hectad was plotted as a function of distance from the centre of distribution for a series of timescales (pre/post 1900, pre/post 1950, pre/post 1970, pre/post 1987). The centre of distribution was calculated as the 'average' hectad at the approximate centre of the range (SU78). If decline has occurred more at the margins than throughout the range, the proportion of extant sites would be expected to decrease with increasing distance from the centre of the distribution. Second, the proportion of extant sites in the 50% of hectads at the edge of the range (selected by eye) were compared with those in the 50% of squares in centre of the range for the same series of date classes. If it has declined more at the edge of the range than at the centre there would be expected to be a significance difference between these two set of squares.

To determine whether loss has occurred selectively from one habitat type more than others, the frequencies of *G. germanica* and *G. ×pamplinii* in each habitat were compared for all records with recent (post-1987) records. Repeat records from the same habitat for each site were not included. Different habitats listed within each site were counted separately.

RESULTS

IDENTIFICATION

Gentianella germanica was relatively easy to recognise, characterised by its large numbers of internodes, large corollas with a narrowly funnel-shaped tube and its broad leaves (Fig. 1). The two main variants from typical plants (Fig. 1a) were dwarf, squat plants on dry chalky banks (sometimes only a few cm tall; Fig. 1b) and some plants in Bedfordshire which had characteristic open inflorescences with flowers on long pedicels (Fig. 1c); this variation also occurs on the continent. Occasional annual *G. germanica* plants occurred which differed in being generally smaller in all their parts, lacking a basal rosette and often having cotyledons still present (Fig. 1d).

Gentianella amarella had consistently small, cylindrical, much less showy corollas, and narrow leaves (Fig. 1f). Tall, robust specimens of both *G. germanica* and *G. amarella* can be found in denser grassland swards; they look superficially similar and could be misidentified unless examined carefully. In general plants intermediate between these two distinct species were recorded as the hybrid *G. ×pamplinii* (Fig. 1e). Table 1 summarises the measurements used for identification of fresh material.

DISTRIBUTION AND HABITATS

The historical records were often incomplete, poorly documented and vague. It was difficult to be certain where some sites were, or whether different locality names were used for the same site. Some records are errors or are suspect (there is a tendency for any large *Gentianella* plants in the Chilterns to be named *G. germanica*), some may have resulted from mislabelled specimens and some had incorrect grid references. Details about records published in floras with tetrad maps were often lacking.

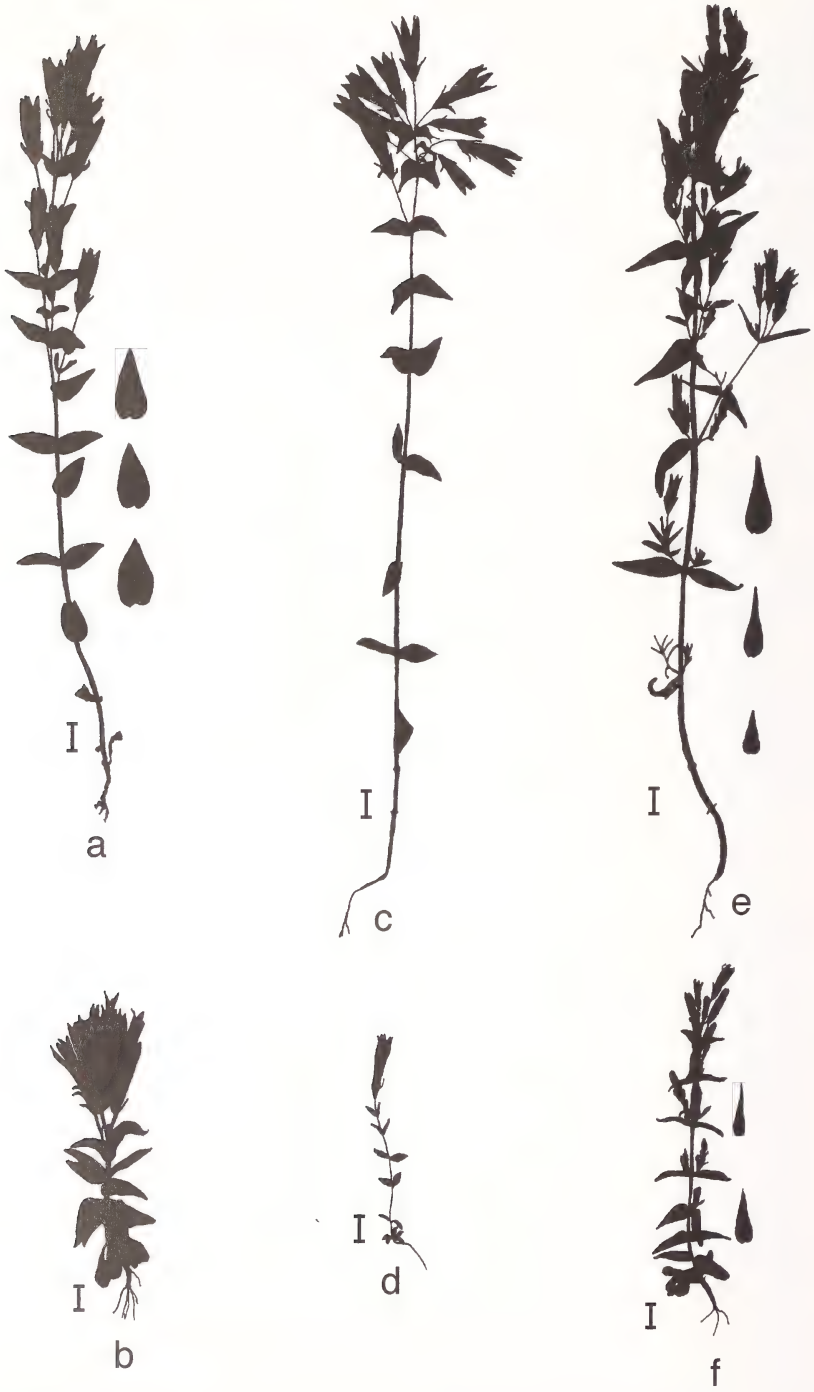


FIGURE 1. Silhouettes of *Gentianella* specimens. a, *G. germanica* typical biennial (**NMW**). b, *G. germanica* dwarf biennial (**NMW**). c, *G. germanica* with lax inflorescence (**BEL**). d, *G. germanica* annual (**NMW**). e, *G.* ×*pamplinii* (**NMW**). f, *G. amarella* (**NMW**). Scale bars all 1 cm.

TABLE 1. SUMMARY OF CHARACTERS USED TO IDENTIFY FRESH FIELD MATERIAL OF *GENTIANELLA GERMANICA, G. AMARELLA* AND THEIR HYBRID *G. ×PAMPLINII*

Character	*G. germanica*	*G. ×pamplinii*	*G. amarella*
Height	Robust, (3·5–)12–36(–54) cm, often branched above only	Robust, (7·3–)13–35(–44) cm tall, often branched above and below	Smaller, (2–)3–15(–24) cm tall, often branched above and below
No. of internodes above rosette	(5–)8–13(–16), usually long	(5–)8–11(–12), usually long	(3–)5–9(–11), usually short
Middle stem leaves	(6–)14–32(–43) mm long × (2·5–)7–17(–22) mm wide, ovate-lanceolate to triangular-ovate	(13–)20–38(–49) mm long × (5–)8–14(–18) mm wide, ovate-lanceolate,	(6–)9–26(–40) mm long × (2–)3–10(–18) mm wide, lanceolate to ovate-lanceolate
Leaf length:width ratio	(1·0–)1·6–2·0(–3·8)	(1·7–)2·2–3·0(–3·7)	(1·5–)2·2–3·6(–5·0)
Corolla	(11·5–)25–32(–37) mm, tube narrowly funnel-shaped	(15–)18–21(–23) mm, tube intermediate	(10–)13–19(–21) mm, tube cylindrical
Calyx	(5–)12–20(–24) mm	(9–)11–16(–18) mm	(5 5–)7–12(–14) mm
Corolla: calyx ratio	(1·2–)1·5–2·2(–3·2)	(1·0–)1·2–1·7(–1·8)	(1·2–)1·5–2·3(–2·9)

Figures are given as (minimum–) 10th percentile – 90th percentile (–maximum).

We have visited virtually every site that was practical to do so. In some instances it was difficult to find extant populations in the field, or to be sure the populations found were actually the same as those recorded previously. Access permission to some private land could not be obtained.

GENTIANELLA GERMANICA

A total of 793 records for *G. germanica* were traced (of which 40 were errors). The native records are summarised in Table 2 at various scales (see Appendix 1 for fuller details). The species has been recorded in nine vice-counties, in 27 hectads, in 115 tetrads and in 174 sites. It is currently known in only 18 hectads and nearly qualifies for inclusion in the Red Data Book (Wigginton 1999). There are four introduced sites.

The records are mapped at the tetrad level in Figure 2, which reveals more detail than the hectad map in Preston *et al.* (2002). The main cluster of records is in the Chilterns, with smaller groups in north Hampshire, Berkshire and Bedfordshire, and outlying records in Wiltshire, mid Hampshire and Essex, and a doubtful record from north Buckinghamshire. This tightly clustered distribution could have arisen from one initial colonisation event followed by local spread with secondary dispersal events.

TABLE 2. SUMMARY OF STATUS OF NATIVE *GENTIANELLA GERMANICA* AND *G. ×PAMPLINII* IN BRITAIN AT FOUR SCALES

	Vice-counties	Hectads	Tetrads	Sites
G. germanica				
Present 1987+	7	18	56	83
Extinct 1987+	2	9	54	65
Not investigated/exact site unknown	-	-	5	26
Estimated decline	22%	33%	49%	44%
G. ×pamplinii				
Present 1987+	7	11	20	18
Extinct 1987+	3	8	18	18
Not investigated/exact site unknown	-	1	2	8
Estimated decline	30%	42%	47%	50%



FIGURE 2. Distribution of *Gentianella germanica* in tetrads.
● 1987–2004, ○ pre-1987, ? doubtful record, × error, ✳ deliberate introduction.

The Wiltshire (all v.c. 8, South Wilts) records have recently been reviewed by Rich & McVeigh (2002). It was first reported in Wiltshire from Mere Down by E. F. Linton (Tatum 1893; Grose 1957), and a small population with hybrids was refound in 2001 (**NMW**). It was also recorded in a chalk pit near Shalbourne Church up to 1919, but by 1999 (and probably long before) the pit had been filled with spoil. Another site reported beyond Ham/Reivar (Grose 1957) is in Berkshire. In Hampshire (all v.c. 12, North Hants), it has been recorded in seven sites on the chalk escarpment between Kingsclere and the Berkshire border, and in one isolated site to the south at Worthy Down; it is currently only known from the verges of the A34 and at Ashmansworth. It was recorded prior to 1849 in a meadow in North Essex (v.c. 19); this record does not fit the pattern of the other records but is supported by a voucher in **BM**; the area has heavy clays and no suitable habitat remains. It has been recorded in 19 localities scattered along the Chiltern escarpment in west Hertfordshire (v.c. 20) and is currently present in 12 sites, and has been deliberately introduced to three other sites to the east. There are no details available for two tetrad records in Dony (1967). In Middlesex (v.c. 21) it was recorded from 1883 onwards in one area centred on Springwell chalk pit, but was last recorded in 1977 and is now extinct (Kent 2001). In Berkshire (v.c. 22) it has been recorded in 15 localities, some on the small section of escarpment south of Inkpen, the south, top and northern escarpment of the Lambourn Downs, and in the Thames valley at Streatley, with a couple of records elsewhere; it is currently known in four sites. In Oxfordshire

TABLE 3. TOTAL NUMBER OF RECORDS FOR EACH HABITAT OF *GENTIANELLA GERMANICA* AND *G. ×PAMPLINII* IN BRITAIN, WITH PERCENTAGE OF KNOWN HABITATS

Habitat	*G. germanica*	*G. ×pamplinii*
Calcareous grassland, including recolonised superficial workings, grassy scrub and lynchets	108 (70%)	21 (55%)
Chalk pits/quarries	23 (15%)	11 (29%)
Scrub/wood	8 (5%)	2 (5%)
Railway	7 (4%)	1 (3%)
Road verge	4 (3%)	2 (5%)
Disturbed ground	3 (2%)	1 (3%)
Orchard	1 (0·6%)	-
Heath/Common	1 (0·6%)	-
Unknown	19	6
Total	174	44

Duplicate records for the same site are excluded.

(v.c. 23) it has been recorded from 26 localities, mostly associated with Chiltern escarpment between Aston Rowant and Swyncombe and associated valleys and plateaux to the south-east; it is still locally plentiful and has been recorded in at least 15 sites recently. There is one tetrad record in Killick *et al.* (1998) for which no details have been traced. There are at least 93 recorded localities in Buckinghamshire (v.c. 24), mostly on the Chiltern escarpment and associated valleys. It has been recorded recently in at least 44 sites. In Bedfordshire (v.c. 30) it has been recorded in a group of nine sites north of Luton, especially associated with chalk quarries and workings; it has only been seen in five sites recently.

Pritchard (1961, 1972) refers to signs of introgression from *G. germanica* into *G. amarella* in Kent and Surrey and, like him, we have seen no *G. germanica* material from these areas (but see *G. ×pamplinii* below). Other *G. germanica* records for v.cc. 5, 7, 45, 51, 57 and 64 (cf. Luxford 1844; Druce 1932) have not been accepted (cf. Pritchard 1961 and Appendix 1).

The habitats of *G. germanica* are predominantly unimproved, open, chalk grassland with various degrees of light scrub, and less frequently in open quarries or chalk pits where it may have colonised from adjacent grasslands (Table 3). Currently, most grassland sites are either grazed by cattle and/or sheep, or are ungrazed except by rabbits and deer. It occasionally occurs in mown sites such as on roadside banks, but only where these are either infrequently mown, or mown once early in the year. The main grassland types (*sensu* Rodwell *et al.* 1991–2000) are the CG2 *Festuca-Avenula*, CG3 *Bromus,* CG6 *Avenula* and MG1 *Arrhenatherum* grasslands. The main scrub type is open W21 *Crataegus-Hedera* scrub. It is found rarely in dense, closed scrub or woodland, or by railways and road sides. The vast bulk of the sites are on calcareous soils, usually derived from chalk.

Assessment of the decline depends at which scale it is analysed (Table 2). The crudest scales of vice-counties and hectads show smaller declines than at the finer scales of tetrads and sites; the latter gives the best indication of decline, showing it has been lost from nearly half of its sites. A comparison of current habitats (Table 4) with all habitats (Table 3) indicates that the main losses have been from calcareous grassland (56% decline) and chalk pits (48% decline). It has been lost from improved or re-seeded grasslands, grasslands which have changed to rank *Arrhenatherum* swards, and where dense scrub or woodland have developed. Some sites have also been lost to development or in-filling of quarries. A comparison of the proportions of all and current records show that the losses have been proportional across all habitats ($\chi^2 = 0{\cdot}917$, $P>0{\cdot}9$).

GENTIANELLA ×PAMPLINII

A total of 68 records for *G. ×pamplinii* were traced and are summarised in Table 2. It has been recorded in ten vice-counties, in 20 hectads, in 40 tetrads and 44 sites. The records are mapped at the tetrad level in Figure 3. The maps shows a more restricted distribution than *G. germanica* and suggests it is most characteristic of the Chiltern escarpment. There are only four tetrads with *G. ×pamplinii* where *G. germanica* has not been recorded.



FIGURE 3. Distribution of *Gentianella ×pamplinii* in tetrads, ● 1987–2004, ○ pre-1987.

Gentianella ×pamplinii has been recorded at two sites in Wiltshire (both v.c. 8, South Wilts) and still persists in small quantity at Mere Down. In Hampshire (v.c. 12, North Hants) it has been recorded in eight sites associated with *G. germanica* on the chalk escarpment between Kingsclere and the Berkshire border; it still occurs in four sites. There are interesting reports of *G. ×pamplinii* in Kent and Surrey outside the area in which *G. germanica* currently grows (Pritchard 1961, 1972; specimens in **K**). Convincing hybrid material was found at Deal and Lyminge (both v.c. 15; **BM**, **LTR**), both close to the Channel opposite Calais where *G. germanica* occurs today. Occasionally in south-east England there are plants with long corollas (*c.* 20–21 mm) which may show some relict of introgression from *G. germanica* (cf. Pritchard 1961) but they cannot be definitely identified from corolla size alone, and no material supporting records for Surrey (v.c. 17) has been seen (cf. Salmon 1931). *Gentianella ×pamplinii* is still present in one of its two Hertfordshire (v.c. 20) sites. It was first described from Letcombe Castle by Druce (1896), and is still present in low numbers but has gone from five other sites in Berkshire (v.c. 22). It has been recorded in eight sites on the Chiltern escarpment in Oxfordshire (v.c. 23), and two to the south-west; it is currently known in three sites. It has been recorded in ten sites on the Chiltern escarpment in Buckinghamshire (v.c. 24), surprisingly few given the large number of localities for which both *G. germanica* and *G. amarella* occur, and has been seen recently in five sites. In Bedfordshire (v.c. 30), there are four localities of which it is still present in three. There is also an interesting specimen for Clipsham Quarry (v.c. 55, Leicestershire) which it outside the range of *G. germanica;* investigations in 2003 only revealed *G. amarella*.

TABLE 4. NUMBER OF CURRENT (1987–2004) RECORDS FOR EACH HABITAT OF *GENTIANELLA GERMANICA* AND *G. ×PAMPLINII* IN BRITAIN, WITH PERCENTAGE OF KNOWN HABITATS

Habitat	*G. germanica*	*G. ×pamplinii*
Present 1987 onwards		
Calcareous grassland, including recolonised superficial workings, grassy scrub and lynchets	60 (72%)	11 (55%)
Chalk pits/quarries	11 (13%)	5 (25%)
Scrub/wood	4 (5%)	1 (5%)
Railway	2 (2%)	1 (5%)
Road verge	2 (2%)	1 (5%)
Disturbed ground	3 (4%)	1 (5%)
Orchard	1 (1%)	-
Heath/Common	0 (0%)	-
Total present	83	20
Taxon no longer present	65	17
Site not visited/no suitable habitat traced	26	7
Total	174	44

Duplicate records for the same site are excluded.

The pattern of decline of *G. ×pamplinii* is very similar to that of *G. germanica* (cf. above), and it occurs in similar habitats (Tables 3 and 4). As with *G. germanica*, the bulk of the *G. ×pamplinii* records are from calcareous grasslands, but there are relatively fewer from scrub/woods (perhaps because the other parent *G. amarella* is rarely present in scrub). There are higher percentages for disturbed habitats (e.g. quarries, verges) than for *G. germanica* as might be expected for a hybrid as hybridisation is often more frequent following disturbance, but the differences are not statistically significant ($\chi^2 = 0{\cdot}18$, $P>0{\cdot}9$). Like *G. germanica*, *G. ×pamplinii* has also declined proportionally across all habitats.

CAUSES OF CHANGE

Analysis of the number of sites recorded in each decade gives some indication of when the major declines in *G. germanica* have occurred (Fig. 4). There was a minor gradual loss of sites until the 1940s, and then an increased rate of loss, possibly resulting from the ploughing during the Second

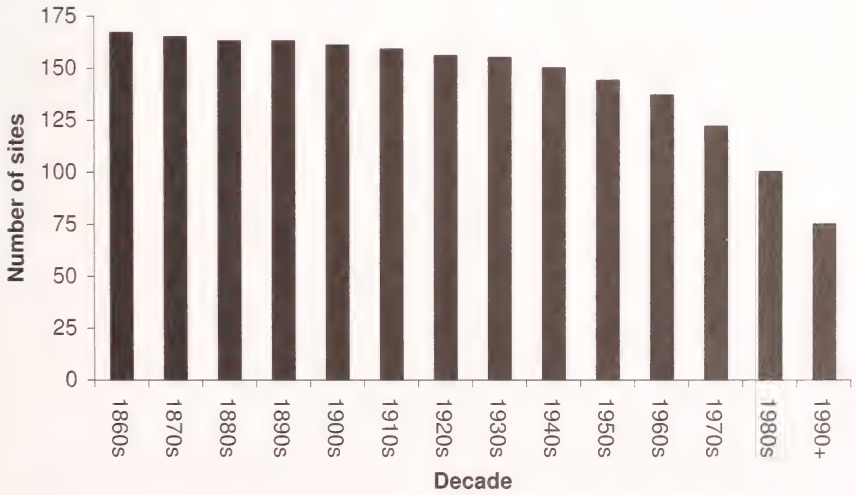


FIGURE 4. Changes in the number of sites of *Gentianella germanica* per decade with time, assuming present at all sites prior to the last record. The last date class includes records from 1990–2004.

World War and the loss of traditional extensive grazing, followed by increasingly steeper rates of decline to the present day. The decline is on-going; if it continues at the same rate as for the last 50 years, *G. germanica* could become extinct in Britain by 2050 assuming no recruitment of new sites.

The *G. germanica* pre/post 1970 map in *Scarce Plants of Britain* (Stewart *et al.* 1994) was interpreted as showing decline at the edges of its range, as there were more hectads at the edges where it had not been seen since 1970 than there were in the middle of the range. The tetrad distribution map (Fig. 2) shows more sites per square in the middle of the range than at the edge, and thus it could also have declined throughout its range to the same extent as at the edges, but this would be hidden in a hectad map as one extant site in a hectad would mask the loss of lots of sites. Figure 5 shows the relationship between the proportion of extant sites and the distance from the centre of the distribution for four date classes; the data are summarised in Table 5. If *G. germanica* was declining more at the edges of its range, an increasingly lower proportion of extant sites would be expected further away from the centre of the distribution. No significant correlations were found between distance from the centre and number of extant sites for the four date classes, suggesting *G. germanica* is declining as much at the centre of its range as at the edges. (To test if the two distant hectads SU83 and TL52 might be having a disproportionate effect on the correlation coefficients, the analysis was repeated excluding them and similar results were obtained with the exception of the pre/post 1987 date class where a correlation was found at the 0 05 level of significance.) Similar results were also obtained for an analysis of the proportions of extant tetrads with increasing distance from the centre of the distribution (data not presented).

TABLE 5. PROPORTION OF EXTANT SITES OF *GENTIANELLA GERMANICA* FOR EACH HECTAD FOR FOUR DATE CLASSES

Hectad	% extant sites pre/post 1900	% extant sites pre/post 1950	% extant sites pre/post 1970	% extant sites pre/post 1987
SP70	86	71	57	29
SP80	77	77	15	15
SP81*	50	50	0	0
SP90	100	100	100	100
SP91	75	75	63	63
ST83*	100	100	100	100
SU35*	100	100	0	0
SU36*	100	33	0	0
SU37	100	100	50	50
SU38*	100	100	40	60
SU43	100	0	0	0
SU45*	100	80	40	40
SU55*	100	0	0	0
SU57	100	50	50	0
SU58	67	33	0	0
SU69	67	67	67	67
SU78	100	92	50	50
SU79	100	100	57	57
SU88	100	60	40	30
SU89	92	88	58	54
SU99*	100	100	50	50
TL00	100	100	50	50
TL01*	100	100	50	50
TL02*	100	83	50	50
TL10*	0	0	0	0
TL52*	0	0	0	0
TQ09*	80	80	20	20
Average	85%	68%	37%	35%

* Hectads at the edge of the range.

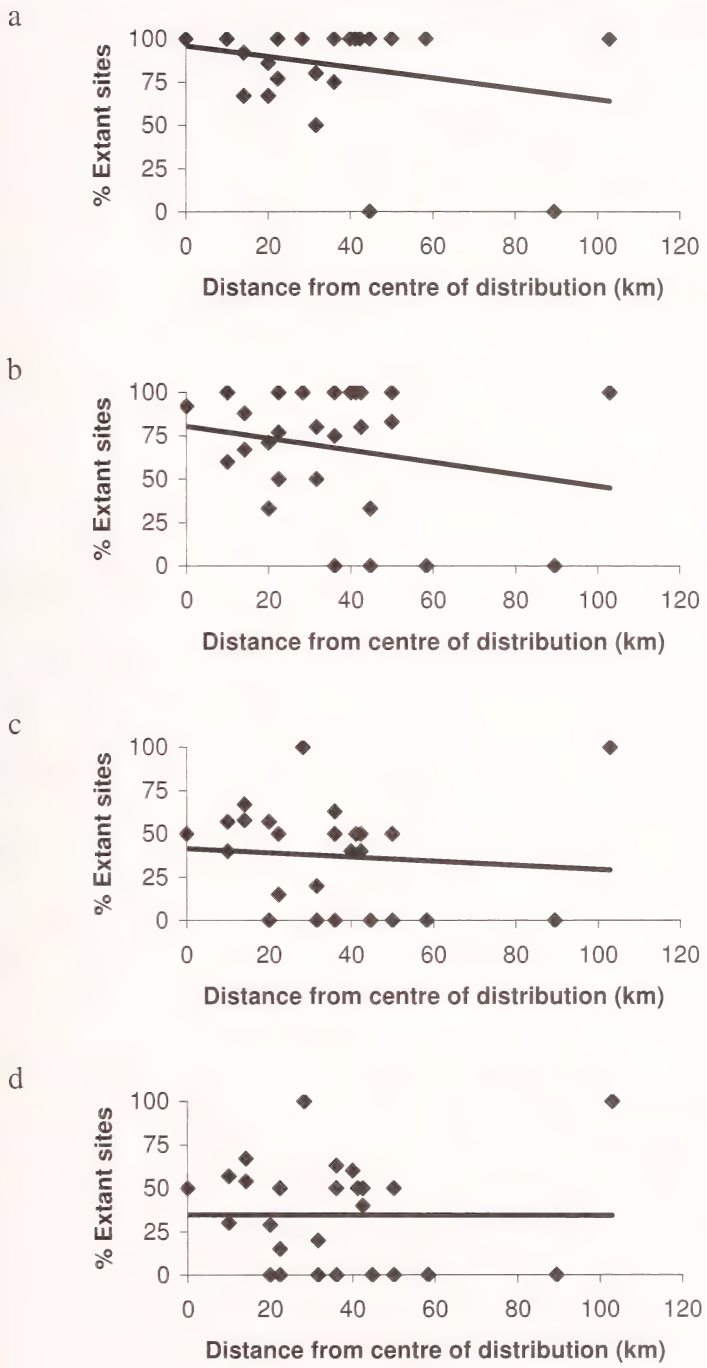


FIGURE 5. Percentage of extinct sites per hectad of *Gentianella germanica* plotted as a function of the distance from the centre of its distribution. a, pre/post 1900 (r = –0·25, P>0·1). b, pre/post 1950 (r = –0·221, P>0·1). c, pre/post 1970 (r = –0·09, P>0·1). d, pre/post 1987 (r = 0 004, P>0·1).

TABLE 6. PROBABLE REASONS FOR LOSS OF *GENTIANELLA GERMANICA* AND *G. ×PAMPLINII* BY HABITAT (PERCENTAGE OF KNOWN LOSSES)

Probable reason for loss	*G. germanica*	*G. ×pamplinii*
Calcareous grassland semi-improved or improved or converted to arable	24 (35%)	3 (19%)
Calcareous grassland neglect becoming tall and rank	7 (10%)	-
Calcareous grassland converted to plantation	4 (6%)	-
Calcareous grassland scrubbed over	2 (3%)	-
Chalk pit scrubbed/wooded over	5 (7%)	2 (13%)
Chalk pit filled in	1 (1%)	1 (6%)
Scrub succession to woodland	5 (7%)	1 (6%)
Development (building)	4 (6%)	-
Railway line scrubbed over	3 (4%)	-
Possible introgression with *G. amarella*	3 (4%)	-
Taxon gone but suitable habitat still present	10 (15%)	9 (56%)
Unknown reason for loss	23	10
Total	91	26

A problem with this proportion-distance analysis is that it assumes the distribution as circular (it is more of an ellipse). A second method of dividing the hectads into half from the edge of the range and half from the centre was used (hectads marked in Table 5) and the differences in the proportions of extant sites were tested using T-tests. There were no significant differences between these two sets of squares for any date classes ($t = 0{\cdot}41$ for pre/post 1900, $t = 0{\cdot}16$ for pre/post 1950, $t = 0{\cdot}02$ for pre/post 1970, $t = 0{\cdot}15$ for pre/post 1987; all $p > 0{\cdot}5$ with 25 degrees of freedom). This also suggests *G. germanica* is declining as much at the centre as at the edges of its range. Again, similar results were obtained for an analysis of the proportions of extant tetrads at the edge or centre of the range (data not presented).

An analysis of the probable reasons for losses (Table 6) shows that in most cases apparently suitable habitat is still present and there is no obvious reason for loss. Where the reasons for loss can be inferred, the main explanations are improvement and neglect of calcareous grasslands (resulting in long rank grass) and scrub development. Successional development of scrub and woodland has also contributed to the decline from chalk pits and partly-scrubbed sites. Interestingly, although introgression with *G. amarella* has often been suggested as a reason for loss (e.g. Pritchard 1972; Stewart *et al.* 1994), it may only have accounted for loss of *G. germanica* at three sites. This is in direct contrast to the conclusion of Pritchard (1972) who suggested introgression was the major cause of decline. The hybrid also seems to disappear from sites for no apparent reason. Many sites were found where *G. germanica* and *G. amarella* grow together with no obvious hybrids.

POPULATION SIZES

Population estimates for 64 of the 83 sites of *G. germanica* seen since 1987 are given in Table 7. The average maximum population size for the 64 populations counted was 876 plants. About half of the sites had fewer than 200 plants, and 11 of these had less than ten plants. These small populations are the most susceptible to further loss, and they typically occur at the edges of scrub or wood, on the narrow unimproved margins and banks around improved fields and in rank, unmanaged grasslands. Seventeen sites have more than 1000 plants, often on extensive areas of species-rich grassland and extensive quarry workings which have partially revegetated.

Due to time constraints few comparable population data for *G. ×pamplinii*, and virtually none for *G. amarella*, were collected.

DISCUSSION

The collection of morphological data was helpful in clarifying the identification of the taxa present in *Gentianella* populations. Only in a few cases where hybridisation was present were there any real difficulties with identification and, even then, it was usually clear when good *G. germanica* was present. It was more difficult to decide whether some variation in *G. amarella* was the result

TABLE 7. MAXIMUM POPULATION SIZES COUNTED FOR 64 POPULATIONS OF *GENTIANELLA GERMANICA* SINCE 1987 (% OF SITES)

Number of plants	Number of sites	Number of plants	Number of sites
1–19	13 (20%)	500–999	7 (11%)
20–49	8 (13%)	1000–1999	4 (6%)
50–99	6 (9%)	2000–4999	11 (17%)
100–199	4 (6%)	5000+	2 (3%)
200–499	9 (14%)		

of introgression from *G. germanica* or simply variation within *G. amarella*. Pritchard (1972) also noted it was easier to find hybrid populations that were closer to *G. amarella* than to *G. germanica*.

Despite the difficulties associated with collation of historical records and the field work, the large number of sites investigated during seven years of field work can be used to generalise about the current status and causes of decline. The systematic collection of data has allowed much more detailed analysis of the causes of change than is usually feasible. The tetrad map (Fig. 2) significantly updates the maps in Stewart *et al.* (1994) and the hectad map in Preston *et al.* (2002). There is little doubt that there are still new localities to be found, and the authors would welcome details of any further sites.

Gentianella germanica is restricted to a relatively small range of chalk grassland types and scrub in southern Britain. Elsewhere in Europe it occurs in a wider range of grasslands from lowland to alpine regions of west and central Europe and in the mountains of the Balkans, where its typical habitats are south-facing, nutrient poor, calcareous grasslands, especially *Mesobromium* communities (Meusel *et al.* 1978; Ellenberg 1988). This may either indicate that *G. germanica* is a late post-glacial arrival in Britain and has not, as yet, managed to colonise other geological formations, or that only a limited range of genotypes are present which can only survive in these habitats; morphologically it is certainly more uniform in Britain than the *G. germanica* group is in Europe (cf. Pritchard & Tutin 1972). Pritchard (1961) suggested that *G. germanica* colonised the Chilterns via the North Downs, but the pattern of distribution is more indicative of one longer range dispersal event with secondary colonisation, despite the 'relict' hybrids on the Kent coast. Other examples of species especially frequent in the Chilterns and rare or absent from much of the North Downs are *Cardamine bulbifera* (L.) Crantz, *Fumaria vaillantii* Loisel., *Hordelymus europaeus* (L.) Jess ex Harz and *Iberis amara* L.

The field work shows clearly that *G. germanica* is declining, and the finer the scale investigated generally the larger the decline (Table 2). The number of sites gives the most direct estimate of the status of the species. With the detail associated with many modern records it is usually possible to determine the number of sites reasonably easily, but it is less easy for older records where sites may have been noted, and different recorders may define sites differently. Frequency estimates based on tetrads or hectads give a poorer measure of the number of populations, and the *G. germanica* decline does not show on summary hectad maps where there is a concentration of sites in a small area, as one extant site can mask loss of any number of other sites. Analysis of distribution data at the hectad level (e.g. Preston *et al.* 2002) may thus indicate little decline except at the grossest of levels, and finer scale data are required to monitor the status of many rare plants. The false generalisation that decline has occurred mostly at the edge of the range (Stewart *et al.* 1994) is also a consequence of visual analysis of hectad data. The site-based information collected for this study will form a baseline for more effective monitoring in the future.

There are few comparable data for declines in other *Gentianella* taxa in Britain to compare with the 44% decline in *G. germanica* (Table 2). *Gentianella ×pamplinii* has declined to a similar extent as *G. germanica* (Table 2). In a study of 21 vice-counties, Rich *et al.* (1996a, 1996b) found that *G. anglica* had disappeared from 71/99 sites (71% decline) although this excluded the core populations in Hampshire, the Isle of Wight and Wiltshire. *Gentianella ciliata* is currently only known in one of its two sites, and *G. uliginosa* in four of its eight sites (both 50% decline). To judge from the hectad data in Preston *et al.* (2002), *G. campestris* (L.) Börner has also declined dramatically in lowland England and Wales, and to a lesser extent so has *G. amarella*. Pritchard (1972) noted all British *Gentianella* taxa except possibly *G. amarella* were declining for a variety

of reasons. Declines in the number of sites of eight other Red Data Book or Nationally Scarce species we have studied in southern England are as follows for comparison: *Cardamine bulbifera*, 22% decline (Showler & Rich 1993; Nicholson *et al.* 2004), *Cyperus fuscus* L., 54% decline (Rich 1999a), *Thlaspi perfoliatum* L., 80% decline (Rich *et al.* 1998), *Carex depauperata* Curtis ex With., 86% decline (Rich & Birkinshaw 2001), *Filago lutescens* Jord., 93% decline (Rich 1999b), *F. pyramidata* L., 97% decline (Rich 1999c), and *Bromus interruptus* (Hack.) Druce and *Filago gallica* L. both 100% decline (Rich *et al.* 1999, Rich & Lockton 2002).

There are no comparable site-based data on declines of *G. germanica* in Europe. Fischer & Matthies (1998) noted *G. germanica* has become endangered in many parts of central Europe such as Switzerland and Germany, and that the remaining populations were often small and isolated. Lennartsson & Svensson (1996) found marked declines in *G. amarella, G. campestris* and *G. uliginosa* in Sweden. It is likely that many *Gentianella* species are declining throughout their ranges across Europe.

The major causes of change are loss of unimproved calcareous grassland to agriculture, especially by 'improvement' through addition of fertilisers and/or herbicides (Table 6). Some loss has also occurred through neglect of grassland management, resulting in a dense, tall, closed sward unsuitable for germination and survival in the first year. Some sites have developed into scrub and woodland. The change from widespread, small-scale, intermittent quarrying to fewer major quarries in recent decades has also severely limited the potential for local patchwork colonisation of such sites, as occurred with several *Gentianella* taxa in the last century. The timing of the increased rates of loss from the 1950s onwards is probably linked to the agricultural revolution resulting in 'improvement' and ploughing of grasslands. It is possible that the myxomatosis plagues in the 1950s reduced rabbit grazing pressure on some sites which allowed development of rank grasslands and scrub (Prichard 1961), though *G. germanica* seems to persist in more rank sites than *G. amarella*.

Hybridisation does not seem to be a significant cause of loss. Hybridisation might only occur where specific pollinators which visit both species are present, but this has not yet been studied. *Gentianella germanica* is usually pollinated by Diptera and solitary bees, but self-pollination rates are high (Fischer & Matthies 1997). Both *G. germanica* and *G. amarella* are self-compatible and the amount of seed produced depends strongly on the extent of self- or cross-pollination (Fischer & Matthies 1997).

Many of the populations found were very small (Table 7). At sites where the available habitat is limited, such populations are likely to be vulnerable to loss from both environmental and genetic effects. Where large populations are present over extensive areas of habitat, they are likely to be more persistent. In a study of *G. germanica* at a range of sites in the Jura Mountains, Fischer & Matthies (1997, 1998) found that reduced reproductive performance of plants from small populations was best explained by genetic effects (inbreeding depression) rather than environmental quality, but they also found that out-breeding depression occurred suggesting plants were locally adapted to their sites. They pointed out that use of artificial inter-population gene flow as a conservation management tool to counter genetic erosion should be used with caution. Given the greater homogeneity of sites in England, this latter phenomenon may be less of a problem but should be investigated experimentally before different populations are crossed with each other in the field.

As populations of *Gentianella* taxa are known to vary dramatically from year to year (e.g. Runge 1963, 1968; Dierschke 1986), it is difficult to draw firm conclusions about the longer term viability of individual sites from our limited population data. A preliminary analysis of data from one north-facing site in Berkshire showed an increase in *G. germanica* over a twenty year period might be linked to increased summer temperature (Osmond *et al.* 2005). Runge (1968) noted that in Westphalia, Germany, *G. germanica* decreased markedly after dry periods in spring and summer, but increased again after wet summers.

The 44% decline in the number of sites of *G. germanica* is cause for concern and indicates that *in situ* conservation action is needed throughout its range in Britain. 40% of the sites are protected as Sites of Special Scientific Interest or nature reserves or are in sympathetic ownership (e.g. National Trust) and 37% are County Wildlife Sites, but 27% of the sites have no designation or protection. The designations may help to protect the sites from development or agricultural improvement, but they do not always ensure appropriate management for *G. germanica*. As the

micro-structure of the grassland is important in determining growth and hence reproductive output of individual plants, especially during the second year when plants flower (Verkaar *et al.* 1983b), the key requirement is to ensure appropriate management of the vegetation to maximise reproductive success. Our provisional thoughts on best management are that sites should be lightly grazed with cattle and/or sheep all year, or heavily grazed for short periods only in late autumn to open up the sward for seed germination, which occurs during December to March (Schenkeveld & Verkaar 1984). *Gentianella* taxa are not selectively eaten by stock due to the bitter chemicals they contain. The sward should be 2–10 cm tall with many small gaps 1–5 cm across (Grubb 1976), although *G. germanica* is noted for its ability to persist in taller turf. For sites where grazing is not practical, physical disturbance with machinery may be required to maintain open ground, or mowing, the timing of which is again crucial (Van Tooren *et al.* 1987).

Restoration of extinct sites through habitat management may not be practical as *G. germanica* has been reported to have a non-persistent, or only short-lived, seed bank (Schenkeveld & Verkaar 1984, Pons 1991). Conservation work should be directed towards maintaining the existing sites before restoration of old sites is attempted. Seed dispersal by shaking out of the capsules is also very limited, mostly within 1 m of the parent plant (Verkaar *et al.* 1983a), though it may be dispersed further by cattle and horses as has been reported for *G. amarella* and *G. campestris* (Ridley 1930). *Gentianella germanica* is currently unlikely to have a meta-population with dynamic colonisation and loss of individual sites within the range in Britain due to habitat fragmentation, and this limited dispersal also means that recolonization from adjacent sites is likely to be low.

Gentianella taxa are notoriously difficult to grow in cultivation, and ex situ collections are likely to be difficult to maintain. One British *G. germanica* seed collection from the Warburg Nature Reserve, Nettlebed is currently held in the Millennium Seedbank (S. Flynn, pers. comm. 2005).

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APPENDIX 1

RECORDS OF *GENTIANELLA GERMANICA*

Records are ordered by vice-county, locality name, and date. Tetrad letters follow standard B.S.B.I. nomenclature. Unsourced records are field records held at the Biological Records Centre, Monks Wood. Erroneous records are given in square brackets at the end of each vice-county. Sites labelled * are deliberate introductions. Our records are listed with our initials only. Full details are held by AM & JC and are available on request.

[SOUTH SOMERSET (V.C. 5)
Listed in Druce (1932), probably in error.]

[NORTH WILTS (V.C. 7)
Listed in Druce (1932) and rejected by Grose (1957).]

SOUTH WILTS (V.C. 8)
Mere Down, ST83G: 1891, E. F. Linton (Tatum 1893; Grose 1957). 5 plants, hybrids also present, 12 September 2001, TR.
Shalbourne, old chalk pit north of, SU36B: 23 September 1910, C. P. Hurst (**BM**, **OXF**). 30 September 1910, C. P. Hurst (**OXF**). 1913, G. C. Druce (**OXF**). 1919, C. P. Hurst (Grose 1957). Not refound, 22 August 1999, AM & JC.
[The Pitton record for *G. germanica* queried by Grose (1957) is *G. ciliata.*]

NORTH HANTS (V.C. 12)
Ashmansworth (Privet Copse, sometimes erroneously called Pilot Hill), SU45D & E: 9 September 1914, 15 September 1915 & September 1924, W. C. Barton (**BEL**, **BIRM**, **BM**, **BRISTM**, **CGE**, **LTR**, **MANCH**, **MBH**, **NMW**, **OXF**). Chalk grassland, 3 October 1939, E. C. Wallace (**RNG**). Very few plants dried up by drought, 4 October 1955, N. M. Pritchard (**ABD**). Scrubby ground at edge of plough, 25 September 1956 (annuals), N. M. Pritchard (**ABD**, **OXF**; Brewis *et al.* 1996). 3 plants, open chalk scrub, 6 September 1969, R. P. Bowman (Brewis *et al.* 1996). 1973, F. Rose. 1979, R. A. Boniface (**NMW**). Chalk grassland, 24 September 1979, E. C. Wallace (**RNG**). 700+ plants, 1982, R. P. Bowman. 1985, Hampshire County Council. 19 August 1987, NCC England Field Unit. Brewis *et al.* (1996) reported site 'now ploughed' [second site survived]. 4 plants and 30 hybrids in one site, the other lost to scrub encroachment, 24 August 2004, A. R. G. Mundell.
Ecchinswell, chalk pit near (= Nothing Hill), SU55E: Specimens here varied a great deal, 21 September 1895, 10 September 1896, 22 September 1897 & 27 August 1923, A. B. Jackson (**BM**, **K**, **NMW**). Small chalk pit, 15 September 1935, J. E. Lousley (**BM**, **RNG**). 19 September 1937, P. M. Hall (**BM**; Brewis *et al.* 1996). Not refound, chalk pit overgrown, 21 August 1999 & 4 September 2001, AM & JC.
Faccombe, south of, SU35Y & 45D: 2 September 1958, F. Partridge (Brewis *et al.* 1996). Not refound but areas of relict calcareous grassland had *G. amarella* and *G.* ×*pamplinii*, 22 August 1999 & 4 September 2001, AM & JC.
Great Litchfield Down, disused railway, SU45S: Thousands of plants, 1969, R. P. Bowman (Brewis *et al.* 1996). Not refound, the population now appears to be entirely comprised of *G. amarella* and hybrids, 21 August 1999, AM & JC.
Highclere-Old Burghclere, old railway line, SU45T & U: 1976, M. Boniface (Brewis *et al.* 1996). 1977, M. Boniface. 1986, W. M. Keens. Not refound, 21 August 1999 or 24 August 2002, AM & JC.
Seven Barrows, A34, SU45S: 31 August 1964, R. P. Bowman. New A34 verge, numerous, 1980, P. R. Brough (Brewis *et al.* 1996). 1987, W. M. Keens. *c.* 10,000 plants – very diverse population, much evidence of introgression, 21 August 1999, AM & JC. Many hundreds, 10 August 2001, A. R. G. Mundell.
Sydmonton (Watership chalk pit, including North Sydmonton?) SU45Y: 1895, G. C. Druce (**OXF**). 21 September 1895 & September 1896, A. B. Jackson (**BIRM**, **K**). 19 September 1937, E. C. Wallace (**RNG**). Not refound, 24 August 2002, AM & JC.
Worthy Down, SU43M: 1940, Lady J. C. Davy, since ploughed (Brewis *et al.* 1996). Not refound but suitable habitat still occurs, 21 August 1999, AM & JC.

[SURREY (V.C. 17)
No material supporting the J. S. Mill *G. germanica* record from between Banstead and Chipstead (Brewer 1863) have been seen; Salmon (1931) suggested the record might be of hybrids but we have seen no evidence of these either, despite much field work in the area and numerous herbarium specimens.]

NORTH ESSEX (V.C. 19)
Chickney – Henham, meadow near a wood, TL52U: pre-1849, E. Forster (**BM**; Gibson 1862). No suitable habitat remaining and not refound, 15 September 2001, AM & JC.

HERTS (V.C. 20).
Aldbury Downs, SP91R: September 1872, H. Groves (**BM**). September 1913, E. J. Salisbury (**K**). 19 August 1921, A. W. Graveson (**HTN**, **NMW**). Chalky field, September 1923, P. W. Richards (**OXF**, **NMW**). 2 October 1929, C. E. Salmon (**BM**). 1956, F. Rose. Undated (Dony 1967). 100+ plants, 1970, C. M. & J. G. Dony (NCC Rare Plant forms). 1980, R. M. Bateman. Small field containing 500+ plants including annuals, but gone from another sub-population, 11 September 2001, AM & JC (**NMW**).
Aldbury Nowers, wood, SP91L: 1863, W. H. Coleman (Webb & Coleman 1849, Pryor 1887). Not refound but suitable habitat present, 11 September 2001, AM & JC.
Aldbury, Cootswold House Bank, SP91R: 1984, N. M. Pritchard (**HTN**). 261 plants, 29 August 1998, AM & JC.
Beechengrove Wood, below, TQ09N: 27 May 1979, J. G. Dony & P. Tate. 1991, G. Salisbury & J. Saunders (T. J. James database). 58 plants, 24 August 2001, AM & JC.
*Essendon, Howe Green (Bedwell) chalk pit, TL20Z: Believed to have been deliberately introduced to this site in the early 1970s (pers. comm. T. J. James, 2003). Several hundred plants, 1970, C. M. & J. G. Dony (NCC Rare Plant forms). 1971, J. Reid. Old chalk pit, quarter of a mile E of village. 10,000 plants on semi-open grassy vegetation on bare chalk or very thin, sand-rich soil, 19 August 1972, H. J. Killick (NCC Rare Plant forms). 1973, T. J. James. 15 August 1974, H. J. Killick. In great abundance, 4 September 1974, J. E. Lousley (**RNG**). 1981, C. David, C. M. & T. J. James. 1990, T. J. James & G. J. White. Dead stems frequent, 19 April 1991, T. J. James & G. White (T. J. James database). Site bulldozed but 50 + plants still present, June 2004, T. J. James (T. J. James, pers. comm. 2004).
Flamstead, Jacks Dell, TL01W: August 1902, H. J. Riddelsdell (**BM**). 1967, J. G. Dony. *c.* 20 plants – diminishing because of scrub invasion, 1970, C. M. & J. G. Dony (NCC Rare Plant forms). Not refound, quarry overgrown, 11 August 2001, AM & JC.
Flaunden Bottom-Hanging Croft, TL00A & TQ09E: 1958, E. W. B. H. Milne-Redhead. 1967, J. G. Dony (Dony 1967). Several hundred plants, 1970, C. M. & J. G. Dony (NCC Rare Plant forms). Not refound, 24 August 2001, AM & JC.
Flaunden Quarry, TL00A: August 1989, G. Salisbury & J. Saunders. Not refound, quarry infilled, 20 September 2004, AM & JC.
Great Gaddesden, Hoo Wood, TL01G: pre-1820, W. Blake (**OXF**). August 1822 (**LTN**). 1962, J. G. Dony (Dony 1967). Slope below Hoo Wood, rabbit grazed north facing slope, 10 September 1962, C. M. & J. G. Dony (Dony 1967). Several hundred plants, 1970, C. M. & J. G. Dony (NCC Rare Plant forms). 1979, R. M. Bateman. 1985, P. Collins. 18 June 1998, F. Hall & B. Harold (T. J. James database). Eight plants, 29 August 1998, AM & JC.
*Little Hadham, chalk pit, TL42L: A deliberate introduction in about 1980 (pers. comm. T. J. James, 2003). 1988, S. Watson. Not refound, no access, 15 September 2001, AM & JC.
Oddy Hill, Wigginton (including Holloway Down), SP91F: pre-1841, W. Pamplin (Webb & Coleman 1849; Pryor 1887). 1846, herb. E. Forster (**BM**). 'In a hilly wood near', 1846, R. A. Pryor (Pryor 1887). 1956 & 1957, F. Rose (**NMW**). North facing slope, in short turf with hybrids, 11 August 1962, J. G. & C. M. Dony & D. E. Allen (Dony 1967). October 1962, F. Rose (**NMW**). 12 September 1964, E. C. Wallace (**RNG**). 1967, J. G. Dony. 1968, F. Rose (**RNG**). 100+ plants, 1970, C. M. & J. G. Dony. 19 September 1975, S. L. Jury (**RNG**). 1979, R. M. Bateman. 1984, N. M. Pritchard. 6 August 1988, M. Demidecki & T. J. James. *c.* 2000 plants, *G. amarella* and hybrids also present, 29 August 1998, AM & JC.
Pitstone Quarry, SO91L: 1998, G. Salisbury (T. J. James database).

Ravensdell, TL01C: 1951–1966 (Dony 1967). 1000+ plants, 1970, C. M. & J. G. Dony (NCC Rare Plant forms). 1980, C. M. & J. G. Dony. 21 September 1987, NCC England Field Unit. 17 September 1997, P. Baker (C. R. Boon Database). 13 plants, 31 August 2003, AM & JC.
Sarratt, under Blunts Wood, TQ09N: Undated (Pryor 1887). Not refound, area now arable, 24 August 2001, AM & JC.
St Albans (Verulamium), TL10I: Near the walls of, pre-1743, R. Tilden (**BM**; Dony 1967). Assumed lost to development.
Studham, Greencroft Barn, TL01G: In rough pasture, 1895, D. M. Higgins (Dony 1953). 29 August 1943, J. G. Dony (**LTN**, Dony 1946, 1953). 17 August 1946, P. Taylor (**K**). Slope below barn, *c.* 50 plants, 1970, C. M. & J. G. Dony (NCC Rare Plant forms). Not refound, habitat improved, 28 August 2004, AM & JC.
Tring, nr (including Tring Park), SP91F: 1812, W. Anderson & J. Dickson (Pryor 1887, Druce 1926). 4 September 1846, C. C. Babington (**CGE**). In a wood, 1846 (Pryor 1887). 1864, A.G. More (Druce 1926 incorrectly as Aston Abbots). Undated, C. Conway (**NMW**). 20 September 1850, F. Y. Brocas (**K**). August 1871, J. Cunnack (**BM**, **DBN**). In a fir wood, 29 June 1872, F. J. Hanbury (**BM**). August 1874, E. A. Lomax (**MANCH**). September 1874, J. Cunnack (**BM**). 17 September 1922, A. W. Graveson (**HTN**). 27 September 1931, A. N. Galston (**BM**). 10 plants, 17 October 1990, T. J. James *et al.* (T. J. James database). 12 plants, August 2001, AM & JC.
*Ware, Chadwell chalk banks, TL31L: A deliberate introduction in about 1980 (pers. comm. T. J. James, 2003). 1984, J. C. Doyle. 19 August 1984, T. J. James. 13 June 1989, A. Boucher & T. J. James. Not refound, 15 September 2001, AM & JC.
SP90U: Undated (Dony 1967). Not refound, area improved, 30 August 2004, AM & JC.
SP91Q: Undated (Dony 1967). Not refound, area improved, 30 August 2004, AM & JC.

MIDDLESEX (V.C. 21)
Harefield, Garett Wood (including Springwell chalk pit), TQ09L: 1883, E. de Crespigny (**MANCH**). 1884, field below, 22 August 1892, J. Benbow (**BM**; Kent 1975). 17 September 1904 (**BM**). 17 & 19 September 1910, H. W. Pugsley (**BIRM**, **BM**). 6 September 1913, J. E. Cooper (**BM**). 11 August 1945, B. Welch (**NMW**). 17 August 1945 (**BM**). 1 September 1945, J. E. Lousley (**NMW**, **RNG**). 25 August 1946 (**BM**). 15 August 1947, B. Welch (**NMW**). 21 August 1949, R. A. Boniface (**NMW**). 3 October 1954, E. B. Bangerter and LNHS (**BM**). 2 small seedlings only, 1965, B. P. Pickess (Kent 1975). 1977 (Kent 2001). Not refound, 13 September 2002, AM.

BERKS (V.C. 22)
Cleeve Hill, SU37I: 1966, H. J. M. Bowen (Bowen 1968). 1973, N. E. King & L. F. Durrell. 1974, J. Buchanan. 27 September 2004, G. Osmond, TR & AM (**NMW**); for detailed population counts 1985–2004 by G. Osmond, see Osmond *et al.* (2005).
Coombe Hill (Combe Hill), SU36Q: Undated (Druce 1918). Not refound, area improved, 27 September 2004, AM & TR.
Gramp's Hill, Wantage, SU38S: 1000+ plants in high quality grassland, 1991, M. Reed & P. H. Wilson.
Hurley Pit, SU88A: 1964, V. N. Paul (Bowen 1968). Not refound, 10 September 2001, AM & JC.
Inholmes, SU37G: 1965, H. J. M. Bowen (Bowen 1968). Not refound, 23 August 2001, AM, JC & TR.
Inkpen Hill, Rivar Copse (Reiver Wood, including near Ham), SU36L: August & September 1910, C. P. Hurst (**OXF**, Bowen 1968). 22 September 1937, J. D. Grose (card index held at **DZS**). 3 October 1937, B. Welch (**NMW**). Undated, C. P. Hurst & J. D. Grose (Grose 1957). 1955, F. C. Partridge (Bowen 1968). 1956, J. D. Grose (Bowen 1968). In rough chalk grassland, 13 October 1957, N. Y. Sandwith & F. Partridge (**K**). Not refound, 7 October 2001, AM & JC.
Letcombe Castle (= Segsbury Camp), SU38X: Abundant, 1890, Mr Bellamy & G. C. Druce (**OXF**; Druce 1897, Bowen 1968). September 1892, B. Taylor (**OXF**). September 1892 & September 1894, G. C. Druce (**BIRM**, **BM**, **BRISTM**, **CGE**, **DBN**, **E**, **MANCH**, **NMW**, **OXF**). September 1903 & 13 September 1905, W. H. Griffin (**BM**, **K**, **NMW**, **RNG**). September 1908, G. C. Druce (**E**). September 1917, R. C. McLean (**NMW**). Grassy bank, 16 September 1934, J. D. Grose (**DZS**). 1950, W. L. Theobald (Bowen 1968). 1956. 13 September 1959, J. E. Lousley (**NMW**). 1960, H. J. M. Bowen. August 1978 & 1982, H. J. Killick. 1986, G. Hawker. Ramparts, 1 plant, 28 August 1991, M. Reed. Ramparts, 2 plants with hybrids, 2000, P. H. Wilson. Mixed population with *G. amarella* NW of hill fort but no hybrids, 23 August 2001, AM, JC & TR (**NMW**).

Letcombe Regis/Letcombe Bassett, SU38S: November 1954, E. F. Warburg. Short turf in scrub and along path in *Chamerion,* 19 September 1956, N. M. Pritchard (**ABD**). September 1960, P. Williams. 25 plants, 23 August 2001, AM, JC & TR.
Park Wood, old railway, SU57H: 1980, W. M. Keens. Not refound, 30 September 2001, AM.
Pit Down, SU38G: 1951, 1953, J. W. Gough (Bowen 1968). Not refound, 23 August 2001, AM, JC & TR.
St Mary, chalky bank, woodland (possibly same as Inholmes), SU37M: 10 September 1965, H. J. M. Bowen (**OXF**).
Streatley – Basildon, hill by wood (assumed to be The Holies), SU57Z: 11 August 1937, H. J. Riddelsdell (**K**). Not refound, 4 September 2001, AM & JC.
Streatley, near, SU58K: 20 September 1937, H. J. Riddelsdell (**OXF**, Bowen 1968). 1962. Not refound, 14 September 2002, AM.
Streatley, near (assumed Lough Down), SU58V: Undated, W. Pamplin (Druce 1897). September 1917, Todd & T. G. Parry (**OXF**, Druce 1918). Great quantity, 13 August 1937, H. J. Riddelsdell (**K**, Bowen 1968). Not refound, 14 September 2002, AM.
Upton, near, SU58D: 1890, Miss Fry (Druce 1897). October 1891, G. C. Druce (**OXF**, Bowen 1968). Not refound, 23 August 2001, AM & JC.
Wether Down, SU38F: September 1969, H. J. M. Bowen. Not refound, 23 August 2001, AM, JC & TR.
[Records for Crog Hill & Scar BBOWT Reserve refer to *G. amarella*; *G. germanica* has never been seen there by G. Osmond (pers. comm. 2004).]

OXON (V.C. 23)
Assendon, SU78H: September 1930, G. C. Druce & Lady J. C. Davy (**K**, **OXF**). In profusion on bank, 10 September 1930, E. Vachell, E. Knowling & Lady J. C. Davy (**NMW**). 22 September 1931, G. C. Druce (**BM**, **OXF**).
Aston Rowant NNR – N of M40, SU79I: 22 August 1990, T. H. Fowler. 19 plants, grassland below old visitor centre, 7 September 1998, AM & JC.
Aston Rowant NNR – Beacon Hill, SU79I: Foot of hill, 18 July 1954, R. S. R. Fitter. Post-1970 (Porley 1996). Foot of hill, 1981, M. R. Hughes. Foot of hill, 1986, B. Marcan. Gone by 1991, H. J. Killick and 21 August 2003, AM & JC.
Aston Rowant NNR – Bald Hill, SU79H & I: August 1903, H. J. Riddelsdell (**BM**). 13 September 1953, J. E. Lousley (**CGE**, **NMW**, **RNG**). Open chalk grassland reverting to scrub, 24 August 1958, R. F. Norris (**RNG**). 16 September 1961 (**AYBY**). 14 August 1964, M. W. (Ambrose & Marcan 1964). 28 August 1965, E. J. Byrne (Ambrose & Marcan 1965). 1966. 9 September 1966, T. C. E. Wells (**ABRN**). 1967, G. Glover. August 1967, A. J. Richards (**OXF**; Killick *et al.*1998). Foot of hill, 1968, D. B. Eyres. 2 September 1980, P. J. Grubb (**CGE**). 1986. 30 July 1987, NCC. 18 March 1988, H. J. M. Bowen. 720+ plants scattered over hill, 15 September 1991, H. J. Killick. Many 1000s of plants, 7 September 1998, AM & JC. 1 September 2001, B. Laney.
Bix Bottom, SU78J: 1984, S. Webster (Killick *et al.* 1998).
Bledlow Cross, SP70Q: 4 September 1935, E. C. Wallace (**BM**, **E**, **RNG**). Two plants, 4 September 1998, AM & JC.
Bledlow-Chinnor, roadside between, SP70Q: 1886, G. C. Druce (Druce 1886, 1927). Not refound, 20 August 2004, AM & JC.
Buckingham Bottom, SU79H: 2002, R. Barber & N. Snell.
Chinnor Chalk Pit, SP70K & SU79P: Tetrad K, 1970, R. S. R. Fitter (Killick *et al.* 1998). Tetrad P, 21 August 2003, J. M. Campbell.
Chinnor Hill, SU79Q & U: 23 September 1883 & September 1884, G. C. Druce (**E**, **OXF**). 1921, Lady J. C. Davy & G. C. Druce (**OXF**; Druce 1927). Rough hillside, October 1922, E. Vachell & G. C. Druce (E. Vachell diaries, held at **NMW**). 4 September 1935, E. C. Wallace (**BIRM**, **RNG**). chalk grassland, 16 October 1954, F. Rose (**NMW**). 20 September 1954, H. J. M. Bowen (**RNG**). On grassy path, 15 September 1956, E. C. Wallace (**RNG**). 1965, H. J. M. Bowen (TPDB). 1968, H. J. M. Bowen (TPDB). 1969, R. S. R. Fitter (TPDB). 1971, R. S. R. Fitter (TPDB). 1981, H. J. M. Bowen. 14 September 1986, H. J. M. Bowen. 1989, D. J. Dunlop (TPDB). A few small *G. germanica*, plus hybrid swarm, 21 September 1991, H. J. Killick. 5 plants, plus one further up the hill, 21 October 1991, H. J. Killick. 5 plants, 4 September 1998, AM & JC.

Crowell Hill, chalky banks, SU79P, 23 September 1883 & September 1886, G. C. Druce (**ABD**, **BEL**, **BIRM**, **BRISTM**, **BM**, **CGE**, **DBN**, **E**, **MANCH**, **OXF**, **RNG**, Druce 1927). 14 September 1893, D. C. O. Adams (**BM**). September 1896, G. C. Druce (**NMW**). Growing on steep chalky banks on the lower slopes, 16 August 1913, E. M. Reynolds (**BIRA**). 4 September 1919, T. J. Foggit (**BM**, **HDD**). September 1921, M. L. Wedgwood & G. C. Druce (**MBH**, Wedgwood 1945). September 1927, D. M. Heath & R. Butcher (**BIRM**). September 1927 & September 1928, G. C. Druce (**BM**, **K**, **MBH**, **OXF**, **NMW**). 10 September 1933, J. E. Lousley (**BIRM**, **E**, **NMW**, **RNG**). 12 September 1946, N. D. Simpson (**BM**). Not refound, 4 September 1998, AM & JC.

Dame Alice [Alys] Farm, SU69W: 1895, J. Rose (Druce 1927).

Earlswood, near Rotherfield Greys, SU78H: 1963, V. N. Paul. Not refound, 27 August 2001, AM & JC.

Eversdown Valley, Middle Assendon, SU78M: 1970–1979, V. N. Paul. 1979, G. Bellamy. 1980, R. S. R. Fitter (BBONT 1997). 1980, J. P. Verge. 1992, NCC. 91 plants, 20 August 1998, AM & JC.

Harpsden, grassland on chalk/Henley golf course, SU78K: September 1954, A. Arrett (**RNG**). 1961, B. Kemp. 1973, V. N. Paul. Not refound, 27 August 2001, AM & JC.

Howe Hill/Howe Wood, SU69V: Plentiful, undated, G. C. Druce (Druce 1927). 13 August 1949, E. F. Warburg (**LTR**, **OXF**). 13 September 1953, J. E. Lousley (**RNG**). June 1955, E. F. Warburg. 28 September 1955 and long grass on open scrubby hillside, 9 September 1956, N. M. Pritchard (**ABD**, **OXF**). Undated (Killick *et al.* 1998). *c.* 100 plants, 17 September 2001, AM & TR (**NMW**).

Kingston Blount ('Kingston Hill' of Syme 1872–1893), SU79P: 14 September 1842 (**BM**). 76 plants, 23 August 2004, AM & TR (**NMW**).

Nettlebed, Warburg Reserve, SU78E & I: 4 September 1983 & 1985, T. H. Fowler. Both tetrads, 1992, NCC. 1000+ plants, 27 August 2001, AM & JC (**NMW**). Not refound in Tetrad I, 21 August 2003, AM.

Oakley Hill, SU79P: 1968–69, and 1986–1988, R. S. R. Fitter. 5000+ plants, much introgression, 17 September 2001, AM (**NMW**).

Pyrton Hill, SU79C: 1986, D. Ferguson. Not refound, 23 August 2004, AM & TR.

Shirburn Hill, SU79C: 1986, A. Brickstock. 1986. 22 September 1991, H. J. Killick. Not refound, 17 September 2001, AM & TR.

Swyncombe Downs, SU69Q & V: 1961, J. A. Cole. 1970. 1971, L. E. Cobb. Undated (Killick *et al.* 1998). 205 plants and possibly hybrids, 18 August 1998, AM & JC. Possibly with hybrids, 1 September 1999, H. J. Killick.

Watlington Hill, SU79B: 1858, R. F. Norris. September 1897, G. C. Druce & J. Bull (**BIRM**, **BM**, **CGE**, **K**, **NMW**, **OXF**). 13 September 1953, J. E. Lousley (**RNG**). 1961, J. A. Cole. 1968, D. B. Eyre. 32 flowering plants, 27 August 2001, B. Laney & C. Cody. *c.* 700 plants, 17 September 2001, AM & TR (**NMW**).

Whitehill Shaw, SU79F: 1986, D. Ferguson. 151 plants, 23 August 2004, AM & TR (**NMW**).

Wormsley, SU79H: 1961, E. Nelmes. Undated, Mrs Coker Beck (Druce 1927).

SU68A: A record for Battle House, 1979, is unconfirmed and maybe the source of the Killick *et al.* record. Not refound, improved pasture, 24 August 2004, AM & TR.

SU78D: No details traced and undated (Killick *et al.* 1998).

SU79M: Near Wellground Farm, undated (Killick *et al.* 1998). No access, 2004, AM & TR.

SU79N: Stokenchurch, NW of, undated (Killick *et al.* 1998). Details not traced, access restricted and not refound, 2004, AM & TR.

SU79L & R: Ibstone, undated (Killick *et al.* 1998). Details not traced, access restricted and not refound, 2004, AM & TR.

[Records for Bozedown (SU67N), Fiddle Hill (SU68A), Hungry Hill Wood (SU79G), Queen Wood, Priors Grove (SU79B & G), Swan Wood (SU68X), Warren Bank (SU68M), and SP70F from Oxon BRC are unconfirmed, not refound and not accepted, 2004, AM & TR. The record for near Finstock SP31: 1954, C. C. Townsend mapped in Preston *et al.* 2002 is a data extraction error (pers. comm. C. C. Townsend, 2002). A record for 'Cotswolds', 18 September 1955, O. Buckle (**K**) is assumed to be an error for the Chilterns.]

BUCKS (V.C. 24).

Ashfield Barn, near Turville (including Ibstone House Wood), SU79Q: 1967, NCC. Grassland, 27 September 1972, M. T. Horwood, (BBONT 1997). Not refound, 7 September 1998, AM & JC and 23 August 2004, AM & TR.

Aston Clinton (Ragpits), SP81V: 1872, H. Harpur-Crewe (Britten 1872; Druce 1926). September 1898, G. C. Druce (**OXF**). 1966–1981, Godwin (BBONT 1997). 1000s of plants, 27 September 1977, J. Martin & R. J. Pankhurst (BBONT 1997). Not refound, 26 August 1998, AM & JC.

Aston Hill, SP81V: 1848 (**OXF**, Druce 1926).

Bacombe Hill, near Wendover, SP80T: 12 October 1904, A. Wallis (**BM**). Not refound, 6 September 2003, AM & JC.

Beacon Farm Field, SU88J, 9 October 1986, J. Simons (BBONT 1997). 4000+ plants, 21 August 1998, AM & JC (**NMW**).

Beacon Hill, Ellesborough, SP80I: 1897, G. C. Druce (**OXF**). In abundance, August 1913, G. C. Druce (**OXF**, Druce 1926). Chalk pasture at the foot of, 26 August 1913, F. L. Foord-Kelcey (**CGE**, **K**, **NMW**, **OXF**). Not refound, 25 August 1998, AM & JC.

Bellows Hill, SU79Z: Undated (BBONT 1997).

Bennett End, Radnage, SU79Y: 1976, C. Hole. Not refound, 2004, AM.

Bledlow Great Wood, SP70Q: 1981, English Nature (BBONT 1997). 1986, H. J. M. Bowen (BBONT 1997). No suitable habitat remains, 2002, AM.

Bledlow, SP70Q: Undated, H. Wallis, also seen by G. C. Druce (Druce 1926).

Bloom Wood, S of, SU88U: 10 October 1941, H. Wallis (**OXF**). Not refound, 28 August 2002, AM.

Bolter End, near, calcareous grassland, SU79W: 1966 (**AYBY**).

Bradenham, road verge, SU89I: 1967. Not refound, 6 September 2004, AM.

Buckland, SP81W: 1863, H. Harpur-Crewe (**BM**; Britten 1872, Druce 1926). 8 August 1864, H. Harpur-Crewe (**BIRM**, **BM**, **BON**, **CGE**, **OXF**).

Bufflers Holt near Buckingham (also known as Stonepit Hill), SP63S: Disused limestone quarry, undated, W. Walker (Britten 1872; Druce 1926). Not refound, 26 August 2001, AM & JC.

Buttler's Hangings, SU89D: 1970–73, J. Buchanan. 1973, M. T. Horwood. 1978, R. S. R. Fitter (BBONT 1997). 1979, T. Williams. 1980, J. Roberts. 1981, C. Smith & K. Ibberson. 1983, M. Young (BBONT 1997). 1987, M. Young. 3 September 1988, E. Britnell & B. Marcan. 1988 & 1989, A. Lack (BBONT 1997). Population estimated in the 100s, 1996, M. Young & R. Maycock (BBONT 1997). 2000+ plants, 22 September 2001, AM (**NMW**).

Cadmore End Common, small chalk pit, SU79W: 29 September 1957, R. A. Boniface (**NMW**). Not refound, 2 September 1998, AM & JC.

Cheddington, SP91D: Chalk Pit, 25 August 1963, Lady Barlow, J. Easton & V. G. Scott. 1965, R. S. R. Fitter (BBONT 1997). August 1965, S. Cowdy (Ambrose & Marcan 1965). 29 July 1981, English Nature (BBONT 1997). 25 August 1986, V. G. Scott (BBONT 1997). 3000+ plants, 11 September 2001, AM & JC (**NMW**).

Chequers, SP80H: 9 July 1985, H. Smith (BBONT 1997). Along Cradle footpath, undated, J. Green. Only *G. amarella* and hybrids, September 1997, R. S. R. Fitter. Not refound, 30 August 2003, AM & JC.

Cock Lane Cemetery, SU89W: 1986, M. Young (BBONT 1997). Population estimated in the 100s, 1996, M. Young (BBONT 1997). Not refound, *c.* 250 plants of hybrid swarm only, 2 September 2001, AM & JC.

Commonhill Wood SSSI, SU79L: 10 September 1986, D. Webb & J. R. Simons. 9 September 1987, D. W. Soden & S. J. Leach. 7 plants, 23 August 2004, AM & TR.

Concord (including Barn Wood/Boswells/Steep Blackmores/The Lee/The Patch/Whitefields, possibly more than one site), SP80Y: 22 September 1957 (**AYBY**). July 1963, S. Cowdy. 28 July 1964, S. Cowdy (Ambrose & Marcan 1964). 14 August 1965, Buckinghamshire Archaeological Society, August 1965, S. Cowdy (Ambrose & Marcan 1965). Poor year, 8 August 1966, S. Cowdy (Marcan 1966a). 8 September 1968, G. Glover. 1973, S. Cowdy. July 1975, A. Swaine. Not refound, 25 August 2001 & 25 August 2004, AM & JC.

Dancersend Waterworks, SP90E: 1980, S. Cowdy. 1986, H. Smith *et al. c.* 500 plants, 8 September 1998, AM & JC.

Dancersend, SP90E: 29 July 1943, J. E. Dandy (**BM**). Plentiful vegetative rosettes, 14 June 1944, J. E. Lousley (**RNG**). 1951, M. Rothschild. 17 August 1952, G. Taylor (**BM**). 1958, R. S. R. Fitter (BBONT 1997). Rides in new plantation on former chalk scrub, 17 September 1960 (**BM**). August 1965, S. Cowdy (Ambrose & Marcan 1965). 1968, H. J. M. Bowen. 1973 & 1974, A. Mount. 27 September 1977, J. Martin & R. J. Pankhurst. 1980 & 22 August 1982, R. M. Bateman. 1986 & 1987, M. T. Horwood (BBONT 1997). 1 September 1987, D. W. Soden. Population numbers in 100s at both main sites, 1996, M. Jones (BBONT 1997). *c.* 750 plants, 8 September 1998, AM & JC.

Danesfield/Medmenham, SU88C: Undated, J. C. Melvill (Britten 1872; Druce 1926). 11 August 1945, E. F. Warburg (**LTR**, possibly introgressed). Not refound, 1 October 2004, AM & JC.

Daws Hill/Janes Field, SU79Z: 1973, M. T. Horwood. 1000+ plants, 26 August 2004, AM & JC (**NMW**).

Drayton Beauchamp, SP91B: 1863, August 1869 & 30 August 1873, H. Harpur-Crewe (**BM**, **DBN**, **K**, Britten 1872, Druce 1926).

Eversdown Valley, Woodend Cottage, SU78N: 1980, R. S. R. Fitter (BBONT 1997). 1984, M. T. Horwood *et al.* Good patch by footpath, 1997, W. Gray. 9 plants, 20 August 1998, AM & JC.

Fawley, SU78N: October 1972, M. T. Horwood. No access.

Fawley Bottom Farm Orchard, SU78N: 27 July 1981, S. Scoggins. 1985, A. Brickstock. 1995, R. D'Ayala (BBONT 1997). Masses, 1997, W. Gray. *c.* 2000 plants, 20 August 1998, AM & JC.

Fawley Bottom Wood, SU78N: 10 September 1991, R. Maycock & A. Woods. 11 plants, 1 October 2004, AM & JC.

Fawley Church, near, SU78N: 9 August 1961, U. K. Duncan (**E**). Not refound though two other populations known nearby, 21 August 2003, AM.

Fingest, SU79Q & V: 20 September 1931, C. R. Metcalfe (**K**). Grass bank, 1942, H. Wallis (**OXF**). 11 September 1954, D. H. Kent. September 1955, E. Bull (**AYBY**). 1966, A. Wootton 1968, A. Woodward. Chalk downland turf slope, 15 September 1973, E. C. Wallace (**RNG**). 2 October 1976, S. R. Diserens. Chalk roadside, 18 September 1980, R. P. Libbey (**LTR**). 1980, Cunningham. 1980, J. Roberts. 1980 (BBONT 1997). 1982, A. J. Byfield. 1986, T. H. Fowler (BBONT 1997). 1986, A. Brooks & D. Ferguson. 24 September 1989, E. Norman (BBONT 1997). 21 plants, 18 August 1998, AM & JC.

Fingest, scrub above, SU79Q: 31 August 1968, D. B. Eyres. 5 September 1986, D. Webb & A. Brooks. 200 plants, 23 August 2004, AM & TR (**NMW**).

Flowery Field, SU88P: 1980, English Nature (BBONT 1997). 1986, N. Goldsmith & M. M. Dahl. Not refound, 20 August 1998, AM & JC.

Forty Green, railway embankment, SU99F: 1969, W. Langham (Marcan 1970). Not refound, 20 September 2004, AM & JC.

Further Bellows Hill, SU79Z:1971, J. Buchanan. Not refound, 26 August 2004, AM & JC.

Gillfield Wood, SU89Q: 20 September 1986, T. & V. Marshall (Marcan 1987). July 1991, (BBONT 1997). Not refound, 1997, A. J. Showler (BBONT 1997).

Gomm Valley, SU89W: 1992, M. Young (BBONT 1997). Not refound, 2 September 2001, AM & JC.

Gray's Lane Bank, Wormsley/Ibstone Common, SU79L: 1 August 1971 & 30 August 1972, J. Buchanan. 2000+ plants, 6 August 2004, AM & JC.

Hale Wood, SU79L: 1966, S. Cowdy. 1986 (BBONT 1997). 1987, NCC (BBONT 1997). Not refound, 18 August 1998, AM & JC.

Hale Wood, Wendover, SP80Y: 1957, R. S. R. Fitter (BBONT 1997). August 1965, S. Cowdy (Ambrose & Marcan 1965). Poor year, 8 August 1966, S. Cowdy (Marcan 1966a). 1967. Not refound, 25 August 1998, AM & JC.

Hanover Hill Farm, opposite Mousells Wood, SU79V: 1982, Hammerton. 3 September 1986, A. Brooks & D. Ferguson (BBONT 1997). Not refound, site improved, 23 August 2004, AM & TR.

Hartmoor Wood, Ibstone, SU79M: 6 plants in a small glade, 22 September 2001, AM.

Hatches Bank/Juniper Hill Plantation, Great Kingshill, SU89T & U: 1960, E. J. Byrne (Hyde 1961). Extremely abundant, 26 August 1966, E. J. Byrne (Marcan 1966b). 1986, J. Buchanan. 40 plants in scrubby glade (SU89U), and 300 plants in second glade (SU89T), 6 September 2004, AM (**NMW**).

High Heavens, meadow, SU88J: 1986–87, N. Goldsmith. 6 August 1987, C. Catling. 90 plants, 21 August 1998, AM & JC.

High Heavens, site 2, SU88P: 84 plants, 21 August 1998, AM & JC.
High Wycombe – Little Marlow, SU88U: 7 October 1944, D. E. Kummins (**RNG**).
High Wycombe, Carver Hill/Desborough Fields, SU89L: 1986, E. Britnell (Marcan 1987). 15 October 1986, B. Marcan. 4 September 1988, B. Marcan. 2 October 1996, W. Gray (BBONT 1997). Not refound, 28 August 2002, AM.
High Wycombe, Green Street, SU89L: 'On the many of the chalky commons around High Wycombe as on Keep Hill, Green Street, etc,' (Britten 1872; Druce 1926). Not refound, 2 September 2001, AM & JC.
High Wycombe, Keep Hill, SU89Q: August 1868, E. Chandler (**CGE**). September 1868 (**BM**). 'On the many of the chalky commons around High Wycombe as on Keep Hill, Green Street, etc.' (Britten 1872; Druce 1926). August 1908, J. Britten (**BM**). 10 October 1941, H. Wallis (**OXF**). Not refound, 2 September 2001, AM & JC.
High Wycombe, SU89: 1878, Miss Giles (**OXF**).
High Wycombe – Lane End, rough chalk slope, SU89G: 30 August 1953, N. Y. Sandwith (**K**).
Holtspur Bottom/Holtspur Bank, SU99A: 1893, W. H. Summers (Druce 1926). 8 October 1941, H. Wallis (**OXF**). 1968, S. Cowdy. 1969. 20 August 1986, D. Webb. 80–100 plants, 21 August 1998, AM & JC.
Homefield Wood, SU88D: 22 August 1948, J. E. Lousley (**RNG**). 1950, R. A. H. Graham. 1977, E. Byrne. 18 May 1984, T. Williams (BBONT 1997). 1988, K. R. Stevenson. 1997, N. Smith. 1998. *c.* 500 plants, 20 August 1998, AM & JC.
Hughenden Valley, Friars Garden, SU89T: 1971, K. J. Lunnon (Marcan 1972). Not refound, 8 October 2004, AM.
Ibstone, SU79R: 1967. 1971, P. Burrows (Marcan 1972).
Kits Wood scrub, West Wycombe, SU89H: 1954, F. Ambrose (Hyde 1954). 1973, M. T. Horwood. 1977, B. Marcan. 28 June 1978, T. Marshall. 1986, B. Marcan (BBONT 1997). 1987, D. W. Soden. 19 August 1987, E. Britnell, R. Hatch & B. Marcan. 25 September 1987, D. W. Soden. 1996 (BBONT 1997). 2000–3000 plants, 11 September 1997, A. J. Showler (BBONT 1997). 1999, W. Gray. 1000+ plants, 27 August 2001, B. Laney. *c.*2000 plants, and second population *c.* 200 plants, 22 September 2001, AM (**NMW**) .
Kop Hill Quarries, SP80B: 20 August 1985, D. Ferguson. Not refound but hybrids present, 24 August 1998, AM & JC.
Little Kimble, SP80I: 20 September 1916, M. L. Wedgwood (**MBH**, Wedgwood 1945).
Lodge Hill, near Bledlow, SP70V: 4 September 1979, A. Colmer. Not refound, only hybrids, 4 September 1998, AM & JC.
Lower Barn SSSI, SU79L: 9 September 1987, NCC England Field Unit.
Lydalls Wood, SU79H: 27 August 1981. Not refound, no access, 7 September 1998, AM & JC.
Manor Farm, SU79L: 27 September 1972, M. T. Horwood (BBONT 1997). Not refound, 18 September 1998, AM & JC.
Marlow Chalk Pit, SU88N: 1926, Wallis (Druce 1926). Not refound, 26 August 2004, AM & JC.
New House Farm, SU89P: 1973, M. T. Horwood.
Newlands Park, Shire Lane, TQ09C: In some profusion, known to me for many years on slope of old grassland among blackthorn and hawthorn bushes, 1950 & 7 September 1957, R. F. Turney (**K**). Not refound, 24 August 2001, AM & JC.
Old Hill, SU79V: October 1986, B. North. 1000+ plants, 23 August 2004, AM & TR.
Paradise Wood, by, SU78I: 400 plants in small area of scrub, 30 August 2004, AM & JC (**NMW**).
Parkwood, Bradenham Bank (Small Dean Lane), SU89I & J: Undated, G. C. Druce (Druce 1926). 26 August 1964, M. Humphrey (Ambrose & Marcan 1964). 1966, A. Wootton. 1967. 18 June 1967, J. Humphrey. 1968, B. Marcan. 15 July 1970, J. Buchanan. 1970–75, C. Hendry. 1981. 27 October 1984, H. J. M. Bowen. 1986, A. Mayled. 1986, B. Marcan & R. Hatch. 1987, M. Young. 29 August 1987, A. J. & J. M. Showler. 1996, M. Young (BBONT 1997). 500–600 large plants, 1997, A. J. Showler (BBONT 1997). *c.*100 plants, 25 August 2001, AM & JC. 120 plants, 25 August 2004, AM (**NMW**). Second population not refound, 6 August 2004, A. McVeigh & J. Hodgkins.
Parkwood, SW of, Bradenham, SU89E & J: October 2001, A. J. Showler. *c.*100 plants, 15 September 2002, AM.
Penley Wood, SU79S: September 1902 (**BM**). September 1904, G. C. Druce (**BM**, **BRISTM**, **CGE**, **NMW**, **OXF**; Druce 1926). 5 September 1939, H. Wallis (**RNG**). *c.* 40 plants, 22 September 2001, AM (**NMW**).

Perks Lane Corner, SU89U: 1973, M. T. Horwood. Not refound, 25 August 2001, AM & JC.
Piper's Hanging Wood, below, SU89D: 3 July 2004, J. Buchanan. No access 2004.
Pitstone Hill, SP91M: 27 August 1977, J. A. Colmer. 1980, R. M. Bateman (BBONT 1997). Not refound, 27 August 1998, AM & JC.
Pound Wood, Cadmore End, SU79W: In chalk scrub, 1966, B. North (**AYBY**). Both sides of M40, October 1986, B. North (BBONT 1997). Not refound, 2 September 1998, AM & JC.
Prestwood Picnic Site, SU89U: 6 September 1987, A. J. & J. M. Showler (BBONT 1997). 10 small plants, 11 September 1997, A. J. Showler (BBONT 1997). 25 October 1990, A. J. Showler & R. Maycock. 32 plants, 30 August 1998, AM & JC.
Richmore Hill Bank, Wormsley, SU79L: 9 September 1987, D. W. Soden & S. J. Leach.
Sands Bank, SU89G: 1974, E. Britnell. 7 September 1985, B. Marcan. 1986, J. W. G. Gutch. 1986 & 1987, E. Britnell. 1993, A. Idle (BBONT 1997). 121 plants, 1997, A. J. Showler (BBONT 1997). c. 250 plants, 2 September 2001, AM & JC (**NMW**).
Seerhill Plantation/Clappins Lane, SU89P: 1971, K. J. Lunnon (Marcan 1972). 1977, E. J. Byrne. Not refound, 2 September 2001, AM & JC.
Slough Bottom Farm, SU89D: 1973, M. T. Horwood. 1986, (BBONT 1997). Not refound, 25 August 2001, AM & JC.
Spencers Green, Crong Meadow, SP90E: 30 September 1987, D. W. Soden. 50 plants, 8 September 1998, AM & JC.
Stokenchurch, SU79N: 1968.
Swains Wood, SU79G & L: 23 August 1970, M. T. Horwood. 12 August 1979, C. R. Huxley. 1979, T. Williams. 16 July 1987, D. W. Soden. Between 100 and 1000 plants, 1996, R. D'Ayala (BBONT 1997). c. 2000 plants, 18 August 1998, AM & JC.
The Hale, near, SP80Y: 28 September 1987, D. W. Soden. 27 plants on chalk bank, 25 August 1998, AM & JC.
Turville Hanging, SU79L: 1979, J. Buchanan & T. Williams. One plant, 23 August 2004, AM & TR.
Turville Heath, SU79K: 1961, J. A. Cole. Not refound, 17 September 2001, AM & TR.
Turville Hill, SU79Q: 1963, I. M. Walker (Ambrose 1964). 29 August 1977, J. Roberts. August 1979. 1981 (Marcan 1982). 1982, Hammerton. 1983, A. Beddow. 1984, M. R. Hughes. 30 August 1986, T. H. Fowler. 22 August 1987, J. Roberts. 11 & 14 September 1987, D. W. Soden. 1987 (BBONT 1997). 24 August 1988, L. Adams & G. Yeoman. 1996, R. D'Ayala & N. Snell (BBONT 1997). 100s present in the horse grazed paddock, 1997 (BBONT 1997). 750+ plants, 7 September 1998, AM & JC.
Vickery's Field/Upper Aston Hill, Aston Clinton, SP80Z: 1967. 30 May 1980, S. Cowdy & M. Richard. Not refound, 25 August 2004, AM.
Wendover, Steep Hill near (assume Bacombe Hill), SP80: 12 October 1904, A. Wallis (**BM**).
West Wycombe, N of, SU89H: 25 September 1987, D. W. Soden. No access, not refound, 30 August 2003, AM & JC.
West Wycombe, railway line, SU89H: 21 plants, 28 September 2001, A. J. Showler.
Whiteleaf Cross, S of, SP80H: 20 September 1985, D. Ferguson (BBONT 1997). Not refound, 24 August 1998, AM & JC.
Winchbottom Bank, SU89Q: 1967. 1971, P. Knipe. 1973, M. T. Horwood. September 1986, B. Marcan. 9 July 1987, R. Hatch & B. Marcan. 1995, M. Young (BBONT 1997). 100s of plants, 1997, A. J. Showler (BBONT 1997). No access, 10 September 2001, AM & JC.
Windsor Hill, SP80G: 1967, S. Cowdy. 1979 & 1987, M. T. Horwood (BBONT 1997). 1991 (BBONT 1997). 1995, M. Young. Not refound, possible misidentification of *G. amarella* suspected, 30 August 1998, AM & JC.
Windsor Hill (Risborough Cop North), SP80G: 1973, M. T. Horwood. Not refound, 25 August 2004, AM.
Yoesden Bank, SU79Y & Z: 1971, J. Buchanan. 1973, M. T. Horwood. 1985–86, D. Ferguson. 18 September 1986, J. Buchanan. 1996, D. Ferguson (BBONT 1997). 11 September 1996, W. Gray. Two populations with 500+ plants and 1000s of plants, 6 September 1998, AM & JC.
[The Aston Abbots, 1864, A.G. More record in Druce (1926) refers to Tring; see *Thirsk Botanical Exchange Club* 10, 1864. Brimmers Lane Reservoir, SP80G: 5 plants, 16 August 1998, W. Gray. Not refound, probable misidentification, 25 August 1998, AM & JC. Ivinghoe Hills, SP91T: 1973, 1978 & 1987 (BBONT 1997). Not refound, 26 August 1998, AM & JC; almost certainly an error from this very well known site. Lacey Green Churchyard, SU89J: 1987 (BBONT 1997). Not

refound and likely to have been an error, 25 August 2001, AM & JC. Rivenoak Farm, SU79Y: 50 plants, 14 October 1997, W. Gray. Not refound, probable misidentification, 2 September 1998, AM & JC. Upper Wardrobes & Pink Hill, SP80A: 1 plant, 1996, W. Gray. Not refound, probable misidentification, 25 August 1998, AM & JC.]

BEDS (V.C. 30)

Chalton Cross, chalk pit, TL02I: 24 August 1889, J. Saunders (**LTN**; Dony 1953). 20 August 1891 & 5 August 1893, D. M. Higgins (**BM**, **BRISTM**, **CGE**, **DBN**). Old chalk pit, 1970, C. M. & J. G. Dony (NCC Rare Plant forms). 15 September 1984, C. R. Boon. 1987, J. G. Dony. 8 plants, 31 August 2003, AM (**NMW**).

Dog Kennel Downs, Dunstable, TL02G: 2004, confirmed G. Bellamy. Not refound, 8 October 2004, AM.

Dyers Hall, TL02P: 100+ plants, 1970, C. M. & J. G. Dony (NCC Rare Plant forms). c. 750 plants with hybrid, 16 September 2001, AM & JC (**NMW**).

Harlington (including old chalk pit), TL02P: 17 & 19 August 1894, 7 August 1895, 17 August 1901, 6 August 1903, 8 August 1903, 14 August 1906, August 1907, 25 & 30 August 1909 & August 1911, D. M. Higgins (**BIRM**, **BM**, **BRISTM**, **CGE**, **DBN**, **E**, **LTR**, **K**, **MANCH**, **OXF**, **RNG**). 31 August 1949, J. G. Dony & R. H. Goode (**LTR**). 29 August 1959, D. P. Young (**BM**). 100+ plants, 1970, J. G. Dony (NCC Rare Plant forms). 1985. Not refound, 16 September 2001, AM & JC.

Houghton Regis, chalk pit near, TL02B: 1977–1978, J. G. Dony (C. R. Boon Database). 1986, J. G. Dony. 30 plants, 24 September 2004, AM & JC.

Streatley, TL02U: 1970, J. G. Dony. Not refound but hybrids present, 16 September 2001, AM & JC.

Sundon, near (including old chalk workings), TL02I, N & P: 10 August 1901, D. M. Higgins (**CGE**, as near Luton). 19 August 1905, D. M. Higgins (**E**). 1923, Lady J. C. Davy (**OXF**). September 1941, G. K. Long & J. G. Dony (**LTN**). Locally plentiful in a few old chalk pits near Sundon, 1943, J. G. Dony (**LTN**, Dony 1946, 1953). 1 September 1946, P. Taylor & J. E. Lousley (**K**, **RNG**). 24 August 1946, J. G. Dony (**BM**). 1968, J. G. Dony. Many thousands of plants extending over a system of spoil heaps, 1970, C. M. & J. G. Dony (NCC Rare Plant forms). 18 September 1977, C. R. Boon. 24 July 1982, O. M. Stewart (**E**). 5 August 1986, A. N. Gagg. 1987, J. G. Dony. 430,304 plants, 18 August 1988, J. Plumridge (NCC Rare Plant forms). Population by sewage works not refound, 16 September 2001, AM & JC. Thousands of plants in chalk workings, 17 September 2001, AM & JC. Tetrads TL02I & N, 8 October 2004. AM.

[Ravensden Hill, TL05X: c. *1*906, E. M. Langley, rejected by Dony (1953)].

[PEMBROKE (V.C. 45)

Recorded in error in Druce (1932).]

[FLINTS (V.C. 51).

As Wynne (1993) pointed out, the following three records should be viewed with suspicion, and are not accepted in the absence of vouchers: Glol, limestone common skirting the road east of, September 1907, T. J. Walshe & A. A. Dallman (Dallman 1908). The Graig, Tremeirchion (Dallman 1910). The Marian, Cwm, Mrs MacDonald (Dallman 1908).]

[DERBY (V.C. 57)

No material has been traced to support the Castleton, Fallgate, *c.* 1909–1910 record of Drabble & Drabble (1911) and it is rejected.]

[NORTH-WEST YORKS (V.C. 64)

Records for Ripon on the authority of Grisebach (e.g. Luxford 1844, Brown 1844) are based on an ambiguously labelled herbarium sheet in **K** with both *G. amarella* and *G. germanica*; the only clearly labelled plant from Ripon is *G. amarella*.]

[ARGYLL (V.C. 101)

A specimen labelled Kilberry, September 1931, E. M. Macalister-Hall (**E**) is assumed to be a labelling error.]

APPENDIX 2

RECORDS OF *GENTIANELLA ×PAMPLINII*

[NORTH WILTS (V.C. 7)
Stace *et al.* (2003) in error for v.c. 8 South Wilts.]

SOUTH WILTS (V.C. 8)
Mere Down, ST83G: 8 September 1891, E. F. Linton (**BM**; Grose 1957). 12 September 2001, TR (**NMW**).
Shalbourne, chalk pit, SU36B: October 1910, August & September 1913, C. P. Hurst (**CGE**, **MANCH**, **OXF**; Grose 1957). Not refound – two pits located during search both filled in or in alternative use, 22 August 1999, AM & JC.

NORTH HANTS (V.C. 12)
Ashmansworth, SU45E: 9 September 1914, 15 June & 15 September 1915, 15 September 1918, W. C. Barton (**BIRM**, **BM**, **BRISTM**, **CGE**, **K**, **LTR**, **MANCH**, **OXF**, **RNG**). 30 plants, 24 August 2004, A. R. G. Mundell.
Ashmansworth, chalk quarry, SU45E: On steep slopes of quarry, 4 October 1955, N. M. Pritchard (**ABD**). Site unknown, not investigated.
East Woodhay, in a deep grazed field and on side of road on chalk, 4 October 1955, N. M. Pritchard (**ABD**; Brewis *et al.* 1996). Site unknown, not investigated.
Ecchinswell, chalk pit near, SU55E: 10 & 21 September 1896, 22 September 1897, A. B. Jackson (**BIRM**, **BM**, **CGE**, **OXF**). Not refound, 21 August 1999, AM & JC.
Faccombe, south of, SU35Y: Introgressed population of *G. ×pamplinii* and *G. amarella*, 22 August 1999 & 4 September 2001, AM & JC. Second subpopulation not refound 4 September 2001, AM.
Great Litchfield Down, disused railway, SU45S: 1980, R. P. Bowman (Brewis *et al.* 1996). 21 August 1999, AM & JC.
Seven Barrows A34 verge, SU45S: Abundant, 22 August 1999, AM & JC.
Sydmonton, chalk pit (North Sydmonton, Watership chalk pit), SU46W: 21 September 1895, A. B. Jackson (**BM**, **CGE**, **MANCH**, **OXF**; Brewis *et al.* 1996). Not refound, 24 August 2002, AM & JC.

EAST KENT (V.C. 15)
Deal, TR35Q: Dry, grassy, chalk bank, ex herb. N. D. Simpson, 1902 (**BM**). Not refound in general search around Deal, 9 September 2001, AM & JC.
Lyminge, chalk bank, TR14Q: August 1885 (**LTR**). Site unknown, not investigated.

HERTS (V.C. 20).
Aldbury Downs, SP91R: 2 October 1929, C. E. Salmon (**BM**). September 1913, E. J. Salisbury (**K**). 1923, P. Richards (**OXF**). Not refound, 11 September 2001, AM & JC.
Oddy Hill, Wigginton, SP91F: Undated, W. H. Coleman (**BON**). 29 August 1988, M. Demidecki (T. J. James database). 29 August 1998, AM & JC.

MIDDLESEX (V.C. 21)
Harefield, Garett Wood (including Springwell chalk pit), TQ09L: 1950 (Burton 1983; Kent 2001). Listed as extinct by Kent (2001) and not refound, 13 September 2002, AM.

BERKS (V.C. 22)
Coombe Hill, SU36Q: Undated (Druce 1918). Not refound, area improved, 27 September 2004, AM & TR.
Letcombe Basset, SU38S: In short turf, mostly *Brachypodium*, 19 September 1956, N. M. Pritchard (**OXF**, Bowen 1968). Not refound, 23 August 2001, AM, JC & TR.
Letcombe Castle, SU38X: September 1892, G. C. Druce & B. Taylor (**OXF**; Druce 1893, 1896, 1897). 9 plants with 2 *G. amarella*, 5 September 1998, AM & JC. Ramparts, *G. germanica* with hybrids, 2000, P. Wilson. 3 intermediates, with *G. amarella*, 23 August 2001, AM, JC & TR.

Rivar Copse, base of, SU36L: September 1913, C. P. Hurst (**OXF**; Bowen 1968). Not refound, 7 October 2001, AM & JC.
Streatley, chalky hillside near, SU58K & V: In great quantity, 13 August 1937, H. J. Riddelsdell (**K**, **MANCH**). Not refound at Lough Down (Lardon Chase) or The Holies, 14 September 2002, AM.
Walbury Hill, SU36Q: 1975, M. Boniface & V. Field (Brewis *et al.* 1996). Not refound, 22 August 1999, AM & JC or 27 September 2004, AM & TR

OXON (V.C. 23)
Bald Hill, SU79H: 1972, A. J. Richards (Killick *et al.* 1998). Not refound 7 September 1998, AM & JC.
Beacon Hill, SU79I: Scrubby long grass, only 3 plants found, 9 September 1956, N. M. Pritchard (**ABD**, **OXF**; Killick *et al.* 1998). Not refound, 7 September 1999, AM & JC.
Bix Bottom, Nettlebed, SU78J: 19 September 1960, W. S. Catling (**RNG**). Site unknown, not investigated.
Chinnor, SP70Q: Undated, G. C. Druce (**OXF**). 25 September 1889, J. Curtis (**OXF**). 1954, H. J. M. Bowen. A few hundred plants with parents, 21 September 1991, H. J. Killick (Killick *et al.* 1998). Not refound, 4 September 1998, AM & JC.
Crowell Hill, SU79P: 16 August 1913, E. M. Reynolds (**BIRA**). Undated (Druce 1927). September 1927, G. C. Druce (Wedgwood 1945). 12 September 1946, H. W. Pugsley, N. D. Simpson & J. P. M. Brennan (**BM**, **OXF**). 1946, J. F. G. Chappel (Killick *et al.* 1998). 9 September 1956, N. M. Pritchard (**ABD**; Killick *et al.* 1998). Not refound, 4 September 1998, AM & JC.
Ibstone, SU79L: Undated (Killick *et al.* 1998). Site unknown, not investigated.
Oakley Hill, SU79P: Undated, BBONT (Killick *et al.* 1998). Much introgression, 17 September 2001, AM.
Warburg Reserve – Big Ashes Plantation, SU78E: c. 50 plants introgressed with *G. amarella*, 27 August 2001, AM & JC.

BUCKS (V.C. 24)
Aston Hill, SP81V: Undated (Druce 1926). Site unknown, not investigated.
Chequers, SP80M: September 1997, R. S. R. Fitter (BBONT 1997). No access; not refound, 30 August 2003, AM & JC.
Cock Lane Cemetery, SU89W: Hybrid swarm, c. 250 plants, 2 September 2001, AM & JC.
Eddlesborough, SP91U: September 1917, G. C. Druce (**OXF**). Not refound, 28 August 2004, AM & JC.
Ellesborough, SP80I: in a rough field nearly opposite Ellesborough Church just at the foot of Beacon Hill, 26 August 1913, F. L. Foord-Kelcey (**BM**, **OXF**; Druce 1926). Not refound, 25 August 1998, AM & JC.
Great Kimble (Kimble), SP80H: September 1904, 1919, G. C. Druce (**BM**; Druce 1926). September 1919, S. Redgrove (**BM**). Site unknown, not investigated.
Kop Hill Quarries, near Princes Risborough, SP80B: Introgressed population, c. 1000+ plants, 24 August 1998, AM & JC (**NMW**).
Lodge Hill, near Bledlow, SP70V: *c.* 75 plants, 4 September 1998, AM & JC.
Whiteleaf Cross, S of, SP80H: 24 August 1998, AM & JC.

BEDS (V.C. 30)
Dyer's Hall, TL02P: Hybrid with both parents, 16 September 2001, AM & JC.
Harlington, TL02P: 6 August 1903, D. M. Higgins (**MANCH**). Not refound, 16 September 2001, AM & JC.
Houghton Regis, chalk pit near, TL02B: With both parents, 24 September 2004, AM & JC.
Streatley, TL02U: Hybrid swarm, no good *G. germanica* present, 16 September 2001, AM & JC.
Sundon, TL02I, J, N and P: 25 September 1926, T. J. Foggitt (**BM**). 1 September 1946, P. Taylor & J. E. Lousley (**K**). Large chalk working, with both parents, 16 September 2001 and 8 October 2004, AM & JC.

LEICS (V.C. 55).
Clipsham Quarry, SK91S: October 1978, C. A. Stace (**LTR**; det. TR, non C. A. Stace). Not refound 14 September 2003, AM & JC.

Distribution of the Irish Whitebeam, *Sorbus hibernica* E. F. Warb. (Rosaceae)

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ABSTRACT

The distribution of the Irish endemic *Sorbus hibernica* E. F. Warb., Irish Whitebeam, is reviewed. Some 230 records were compiled from herbaria, the literature, correspondence and field work. It has been recorded in about 150 localities in 76 hectads in 29 vice-counties, mainly across central Ireland, and is rarely planted. Fewer than half of these records are in common with the *S. hibernica* map in the *New Atlas of the British and Irish flora,* which has a large degree of uncertainty associated with it. Limited data on population sizes suggest that most populations are very small (half of the sites have only one tree), and are too fragmentary to allow conclusions to be drawn about long-term population trends. It grows in a range of habitats occurring on acid and calcareous soils, in natural and man-made habitats (especially linear boundary features), in open and semi-open conditions, and with a broad range of other woody species.

KEYWORDS: Conservation, ecology, endemic, Ireland, *Sorbus aria*.

INTRODUCTION

Sorbus hibernica E. F. Warb., Irish Whitebeam, is one of the relatively few vascular plants endemic to Ireland. Its history dates from a botanical excursion to Galway by the two great botanists R. L. Praeger and H. W. Pugsley in May 1933. Praeger and Pugsley found a tree at Garryland, near Gort, which Pugsley referred to *S. porrigens* Hedl., a species he knew from Britain (Pugsley 1934; British plants are now referred to *S. porrigentiformis* E. F. Warb.). Subsequent investigation by Praeger indicated that this taxon was the most widespread of the *S. aria* (L.) Crantz group in Ireland, *S. aria* sensu stricto being uncommon and probably introduced, and *S. rupicola* (Syme) Hedl. being rare and scattered in the north and west (Praeger 1934). Praeger also collected further material which was sent to A. J. Wilmott at the British Museum (Natural History) in London, who at that time was working on a revision of British *Sorbus*. Wilmott recognised that it differed from other known *Sorbus* taxa and coined the epithet '*hibernica*', but left it to Warburg to formally describe (Warburg 1952, formalised in Warburg 1957).

Surprisingly, for an endemic tree, *S. hibernica* has been relatively little studied since, the only study being that of Parnell & Needham (1998) who investigated its morphological variation and its distinction from *S. aria* and other Irish *Sorbus* species. They showed that *S. hibernica* was as morphologically variable in Ireland as *S. aria*, and noted that further work was needed to confirm its apomictic nature and also to look more closely at its relationship with other taxa.

Praeger (1934) listed the records of *S. hibernica* he had confirmed from nine vice-counties, and listed another four more doubtful ones. The first distribution map of *S. hibernica* was given in Perring (1968), which showed that it was relatively widespread across central Ireland, with outlying localities in v.c. H12 Wexford and v.c. H38 Co. Down, in 44 hectads (10 km × 10 km squares). The most recent distribution map in the *New Atlas of the British and Irish flora* (Preston *et al.* 2002) showed records for 63 hectads where it was considered native and three hectads where it had been planted, but the distribution pattern was somewhat different from that of Perring (1968) (a direct comparison is difficult partly due to the change to the Irish grid). Furthermore, some well-known records such as those from v.c. H21 Wicklow (Brunker 1950) and v.c. H16 West Galway (Webb & Scannell 1983) were not included in the *New Atlas* map, and there were some records from areas in which it had not been previously reported and from where no vouchers had been seen. The *New Atlas* map of *S. aria* similarly is incomplete lacking a significant number of Irish records, especially from the west (D. L. Kelly, pers. comm. 2004). These problems led us to review the distribution of *S. hibernica*, and in this paper we summarise its distribution with an updated distribution map and ecological notes. In an attempt to avoid further confusion, we have presented the records in full so that they can be used in future studies.

METHODS

Locality and habitat information in the literature and on herbarium sheets at **BEL**, **BIRM**, **BM**, **BRISTM**, **CGE**, **DBN**, **LIV**, **MANCH**, **NMW**, **OXF**, **RNG** and **TCD** were compiled with some additional information from the Biological Records Centre, Monks Wood, field surveys and correspondence with the BSBI vice-county recorders (the provisional data were circulated in May 2002). The herbarium material cited has all been reviewed by T. Rich, confirming many previous determinations made by workers such as P. J. M. Nethercott, R. L. Praeger, H. W. Pugsley, M. J. P. Scannell, P. D. Sell, E. F. Warburg and D. A. Webb, with occasional corrections. Literature records were only accepted where it was clear that the authors knew both *S. hibernica* and *S. aria*, but even then some records were corrected. Data were compiled into the BSBI Threatened Plants Database, and are available on request to A. Lockton.

Grid references were compiled from the original collections and cross-checked (one 'grid reference' turned out to be a telephone number!), or for the older records were allocated to the most likely hectad using maps and gazetteers. For a more detailed map, best-guess 1-km square grid references were allocated to look at the clustering of sites.

For comparison against the map in the *New Atlas of the British and Irish flora* (Preston *et al.* 2002), the *S. hibernica* data used to create the map were obtained from the Biological Records Centre, Monks Wood. These data had largely been supplied to the *New Atlas* project by the Office of Public Works from an unpublished and unchecked compilation of rare plant data prepared for a 'Scarce Irish Plants' project in the 1980s, and were largely summary hectad records for 1950+, 1970+ or 1987+, with very few details; we have not seen the original work for this project. They were cross-checked against the data in Appendix 1 to see how many records might equate, but the paucity of detail made the comparison somewhat uncertain. The *New Atlas* data have not been integrated into our data.

Data associated with the records (Appendix 1) were used to compile information on the population sizes and habitats. Woody species noted growing within a few metres of *S. hibernica* were also noted in eight sites during a field trip to collect DNA samples from scattered recent localities between v.c. H12 Wexford and v.c. H16 West Galway (Houston 2003), but no formal vegetation sampling was carried out. At the same time, soil samples were collected from the rooting zone around the base of the tree and air-dried. Later in the laboratory, they were mixed into a 50:50 slurry with distilled water and the pH measured, after at least 10 minutes equilibration, with a pHep2 Hanna pocket-sized pH meter.

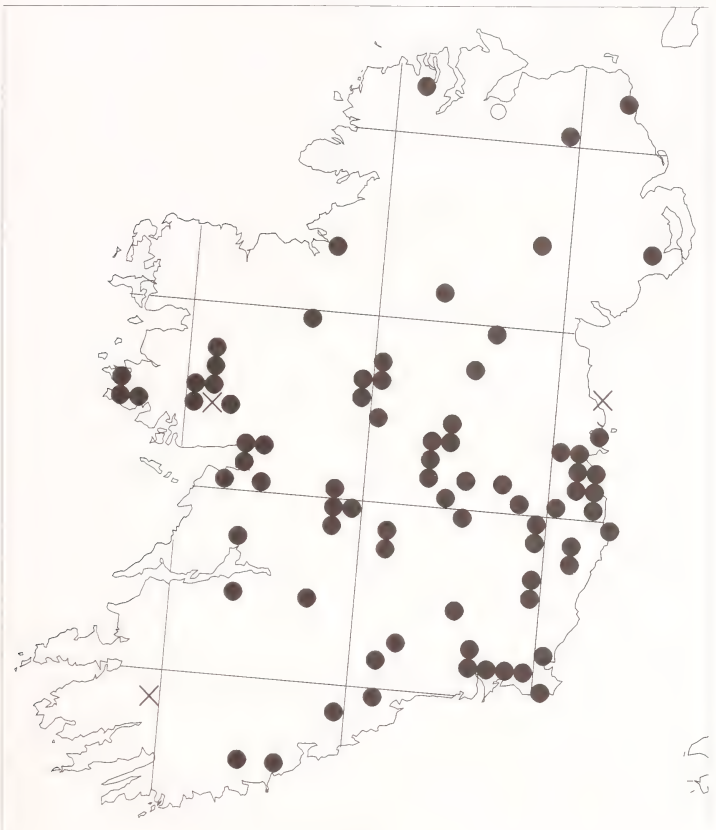


FIGURE 1. Distribution of *Sorbus hibernica* in Ireland in hectads. ● all dates. × = error. ○ planted

RESULTS

The c. 230 *S. hibernica* records traced are listed in Appendix 1, and indicate that there are probably over 150 localities in 76 hectads in 29 vice-counties, and two, possibly three, planted sites (most planted trees are *S. aria*; Praeger 1937). The earliest specimen traced was collected by H. C. L. Evans in 1885 at Knockdrin (**DBN**). The updated distribution map (Fig. 1) shows that *S. hibernica* is scattered mainly across the centre of Ireland, often in small clusters of sites, with outlying localities in the south and in the north. The 1-km square distribution map shows this clustering more clearly (Fig. 2). No doubt there are a significant number of additional unrecorded trees and populations.

A comparison between Figure 1 and the *New Atlas* map (Preston *et al.* 2002) shows just 33 dots in common; 44 of the dots on Figure 1 are not on the *New Atlas* map, and 32 dots only occur on the *New Atlas* map. These 32 dots unique to the *New Atlas* map include records for vice-counties H7 South Tipperary, H27 West Mayo, H33 Fermanagh, H34 East Donegal and H36 Tyrone for which we have seen no material. The *New Atlas* map records may be correct, but there is a large degree of uncertainty about them; we would welcome further details preferably supported by vouchers.

No consistent information is available on the population sizes or dynamics of *S. hibernica*, but there are fifty localities for which population data are available. These can be summarised as follows, taking the maximum counted for each site and excluding 'occasional', 'scarce', etc.: one single tree, 26 localities; two trees, eight localities; three trees, five localities; four trees, one locality; five trees, two localities; six trees, one locality; eight trees, one locality; ten or more trees, five localities; 100 or more trees, one locality. Thus half of the populations have only one tree. It is



FIGURE 2. Distribution of *Sorbus hibernica* at 1-km square level in Ireland (symbols plotted at 2 km size for visibility). Planted sites are excluded

possible that the sample data are biased to small populations as they are *ad hoc* – it is simple to count and note one or two trees, but takes more time and searching to get better population estimates. However, taking these data at face value the average population size can be calculated as 6·8 ± 2·7 s.e. trees per population, with a median of 1 which might be considered more representative.

Possible long term population trends across Ireland were investigated from the number of records for each decade, which can be summarised from the 1880s as follows: 1880–1889, 2 records; 1890–1899, 15 records; 1900–1909, 4 records; 1910–1919, 1 record; 1920–1929, 6 records; 1930–1939, 47 records; 1940–1949, 2 records; 1950–1959, 17 records; 1960–1969, 11 records; 1970–1979, 29 records; 1980–1989, 30 records; 1990–1999, 27 records; 2000+, 33 records. The large fluctuations between decades are due primarily to variations in the recording rather than in *S. hibernica* (e.g. there are disproportionate numbers of records for both the 1890s and 1930s when Praeger was investigating it), and other than noting that there are many recent records indicating it is currently widespread, no conclusions can be drawn about longer term trends. Records for some localities such as Roundstone Graveyard (1936–2003) show it can be persistent for long periods at some sites.

The habitats in which it has been recorded are listed in Table 1. The commonest habitats recorded are hedges, woods and roadsides (the latter could include hedges and hedgebanks). The woods are often noted as rocky or open, and *S. hibernica* is often recorded on the edge of woods and only rarely occurs in deep shade. Lakeshores, river and canal banks make up 10% of the

TABLE 1. HABITATS OF *SORBUS HIBERNICA*

Habitat	Number of localities (%)	Habitat	Number of localities (%)
Hedge	25 (22%)	Hills, hill slopes	4 (4%)
Roadside	20 (18%)	Cliff	3 (3%)
Wood	20 (18%)	Quarry	3 (3%)
Lake shore	7 (6%)	Islands	3 (3%)
River/canal	6 (5%)	Esker	2 (2%)
Rocks	5 (4%)	Walls	2 (2%)
Railway	5 (4%)	Churchyard	1 (1%)
Limestone pavement	4 (4%)		
Hedgebank	4 (4%)	Not stated	44

TABLE 2. DETAILS OF SOIL COLLECTED FROM AROUND BASES OF *SORBUS HIBERNICA* TREES

Locality	Soil pH	Soil type
Kilcullen Upper (v.c. H6)	3·5	blackish organic soil
Boolabrien Upper (v.c. H6)	3·3	dark brown loam
Lough Derg, Annagh (v.c. H10)	7·0	dark brown mineral loam
Preisthaggard (v.c. H12)	3·7	fine brown loam
Roundstone (v.c. H16)	6·2	blackish organic soil
Clifden (v.c. H16)	5·6	dark brown loam
Killeigh (v.c. H18)	6·9	dark brown mineral loam
Kilbeggan (v.c. H23)	5·5	black organic soil

recorded habitats, but in these situations it occurs in the banks and rocks associated with them rather than in the aquatic or semi-aquatic zones. *Sorbus hibernica* is occasionally recorded from cliffs, rocks and limestone pavements. It also occurs by railways and in quarries, and at one site occurs in a graveyard and at another on a ruined building. There is only limited information on its altitudinal range, occurring from just above sea level (Clifden) to semi-upland situations (316 m, Raven Rock is the highest altitude for which we have specific data).

It occurs on quite a wide range of soil types (Table 2), the soils either being derived directly from the underlying geology, or from the overlying drift. It also occurs on gravelly eskers, and in the Irish midlands on boulder clay and onto at least shallow peat at the margins of bogs. The soils are generally likely to be well-drained, but it has been recorded from swampy woodlands. The soils range from being strongly acidic (pH 3·3) to calcareous (pH 7·0).

Houston (2003) recorded 21 woody species and climbers associated with *S. hibernica* from eight sites in 2003. The most frequently recorded species were *Rubus fruticosus* (6 sites), *Hedera helix* (5 sites), and *Crataegus monogyna, Ilex aquifolium* and *Salix cinerea* (3 sites).

DISCUSSION

The records of *S. hibernica* show it is scattered across central Ireland, often in small clusters, and it is rarer in the north and south. Nowhere is it common, and in general it is rare and uncommon. It appears generally tolerant of a range of habitat conditions, occurring on acid and calcareous soils, in natural and man-made habitats (especially linear boundary features), in open and semi-open conditions (rarely more closed woodland), and growing with a broad range of other woody species. This contrasts markedly with the behaviour of the more widespread apomictic *Sorbus* species in Britain such as *S. anglica* Hedl., *S. porrigentiformis* and *S. rupicola* which tend to be restricted to cliffs or open rocky woods on calcareous soils in the more natural areas of the landscape. It is more similar to *S. devoniensis* and *S. aria* which also occur in hedges and woods on a range of soils in the more intensively used areas of southern England. In Ireland, the introduced *S. aria* also behaves somewhat like *S. hibernica* in that it occurs in similar habitats, but it may be more invasive (personal observations).

The combination of the contrasting clustered/scattered distribution pattern of *S. hibernica*, its widespread occurrence in man-made boundary features or other linear habitats, and small often isolated populations, suggests it behaves as a metapopulation with both colonisation and loss of sub-populations within an area. Some records note regeneration and the presence of saplings, and the records for quarries and railways show that it can colonise new habitats. There is little information on its reproductive biology to investigate the functioning of the metapopulation further. The only chromosome count traced is 2n = (50–)51 from seed from Rathdrum, Wicklow (Q. O. N. Kay, pers. comm. 2004), and like most polyploid species of *Sorbus* it is assumed to be apomictic and pseudogamous though this has not been tested. Plants in Botanic Gardens set fertile fruit (e.g. at Trinity College Botanic Garden, S. Waldren pers. comm. 2004, and at Cambridge Botanic Garden, pers. obs. T. Rich). The fruits are probably dispersed mainly by birds. Whilst these processes are on-going there seem to be no immediate concerns for its conservation, but as an endemic it should merit inclusion in the Irish Red Data Book (Curtis & McGough 1988) at its next revision.

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APPENDIX 1

LIST OF LOCALITIES OF *SORBUS HIBERNICA*

Localities for which there was no original grid reference are usually cited for a hectad only. Usually only one grid reference is given per locality. Erroneous and unconfirmed records are given in square brackets.

[H2 NORTH KERRY
Records for Long Range and Ross Island, Killarney area refer to *S. rupicola* and/or *S. aria*.]

H4 MID CORK
Belgooly, roadside tree, occasional in the area, W65, M. J. P. Scannell, 22 May 1987 (**DBN**).
Castlenalact, roadside hedge south of, W45, M. J. P. Scannell & J. White, 24 May 1976 (**DBN**).

H5 EAST CORK
Monavarnoge, 1 tree, W98, M. J. P. Scannell, 5 September 1989 (**DBN**).

H6 CO. WATERFORD
Boolabrien Upper, 8 trees, P. R. Green, 28 May 2003 (**NMW**). Nine trees along 40 m of hedgebank on the east side of the road, S189157, L. Houston, 18 September 2003 (**NMW**).
Cheekpoint, rocky cliff by bank of River Suir, S690135 (originally cited incorrectly as S675135), I. K. & L. F. Ferguson, 10 August 1975 (**DBN**, Ferguson & Ferguson 1981). The trees were later cleared from this cliff, and it has not been seen here again (P. R. Green, pers. comm. 2002).
Coolbunnia, 1 tree in hedge, S682125, P. R. Green, 10 June 2003 (**NMW**).
Crinnaughtaun West, 1 tree in hedgerow on west side of road, X125994, P. R. Green, 30 September 2003 (P. Green, pers. comm. 2004).
Curragh, a large tree on a field bank at R992053, and eleven small trees scattered over moorland amongst *Calluna vulgaris* and *Ulex gallii* at R991051, I. P. Green, 7 June 2000 (Green 2003).
Kilcullen Upper, 2 trees, S685113, P. R. Green & J. Wallace, 9 June 2003, (**NMW**). On slope above the River Suir, 2 trees, S684113, L. Houston, 17 September 2003 (**NMW**).
Killoter, 41+ trees, X1491, P. R. Green, 3 June 2003 (**NMW**).
Raven's Rock, 1 tree in a crevice on top, S258210, P. R. Green, 27 April 2000 (Green 2001).

H8 CO. LIMERICK
Ballyadam townland, SW of Cappagh, R3744, S. C. P. Reynolds, 3 August 2000 (**DBN**, Reynolds 2003).
Cappagh, in a roadside hedge and by the railway SSW of, R3844, S. C. P. Reynolds, 3 August 2002 (**DBN**, Reynolds 2003) and 21 July 2003 (**NMW**).
Pallas Green, R74, W. E. Bentley, 1897 (**DBN**, Reynolds 2003).
Patrickswell, by the railway, R34, R. N. Goodwillie, 1990 (Reynolds 2003, unconfirmed but accepted).

H9 CO. CLARE
Corkscrew Hill, 1 stunted shrub growing out of a deep gorge in limestone pavement, M20, C. A. Stace, August 1966 (**LTR**). "G. M.", 29 May 1969 (**MANCH**).

Ennis, near, R37, R. A. Phillips, 11 June 1933 (**DBN**). Ballyallia Lough, landscaped area near lake, possibly planted, C. M. Brady, 22 June 2002 (**NMW**).
Newtown Castle, hill slope above, M20, E. C. Nelson, 5 September 1990 and 16 August 1992 (**DBN**).

H10 NORTH TIPPERARY

Annagh, woodland and roadside by Lough Derg, 120+ trees, R8290, L. Houston, 18 September 2003 (**NMW**).
Ballinderry, 3 trees in woodland edge on east side of private drive, R837978, L. Houston, 18 September 2003 (Houston 2003).
Coolbaun, limestone quarry, west of Borris Okane, R89, M. J. P. Scannell, 25 May 1968 and 23 July 1968 (**DBN**). Twenty trees, R831923 (Parnell & Needham 1998).
Dromineer, Hazel Point 3 km south of, 5–6 trees, R88, D. A. Doogue, 27 August 1990 (confirmed M. C. F. Proctor, no voucher retained).
Monaincha Bog, 4 km SE of Roscrea, S18, M. J. P. Scannell, 20 July 1968 (**DBN**).
Slevoir Bay, Loch Derg, 1 tree on limestone pavement, M8803, R. J. Pankhurst, 4 August 1975 (**BM**, **DBN**, **TCD**).
Templemore, S17, R. A. Phillips, 1 December 1933 (**DBN**, Praeger 1934).
Terryglass, near Portumna, M80, R. L. Praeger, 18 July 1934 (**DBN**). Lough Derg, limestone lake shore, Bellvue House, R. FitzGerald, 24 July 1991 (**DBN**).

H11 KILKENNY

Rosbercon, S62, R. A. Phillips, August 1919 (**DBN**).
Thomastown, natural wood, S54, R. L. Praeger, 30 July 1898 (**DBN**, Praeger 1934).

H12 CO. WEXFORD

Bargy Commons, 1 tree in roadside hedge, S91, D. A. Webb, 2 August 1965 (**TCD**).
Bunclody, roadside hedgerow on main road between Bunclody and Carnew, S959601, S. M. Walters, June/July 1978 (**CGE**). 1 tree overhanging river, S910577, S. M. Walters, 30 June 1978 (**CGE**).
Butlerstown Castle, 2 trees in a hedgebank east of, T0308, R. FitzGerald, 23 July 1992 (**DBN**).
Coolmela, Clonegall, hedgebank, S9560, R. FitzGerald, 15 September 1991 (**DBN**).
Dunbrody Abbey, 1 tree on bank near railway, S7115, R. FitzGerald, 24 August 1992 (**DBN**).
Ferrycarig, T02, A. W. Stelfox, 26 July 1929 (**DBN**).
Killaven, 1 tree in hedge by lane, S6920, R. FitzGerald, 22 September 1991 (**DBN**). The Wood, S6920, R. Warner, 20 September 1995 (**DBN**).
Pilltown, hedge, S71, N. D. Simpson & S. M. Walters, 12 June 1952 (**BM**). 2 trees in planted alder wood near Pilltown House, N. D. Simpson, S. M. Walters & D. A. Webb, 11 August 1958 (**BM**, **CGE**, **TCD**).
Priesthaggard, S61, D. C. McClintock, 20 May 1953 (**RNG**; material young, but acceptable). 2 trees on edge of wood by roadside, S698180, T. C. G. Rich, 29 September 1998 (**NMW**). 3 trees, L. Houston, 17 September 2003 (**NMW**).
Shelmalier Commons, 1 tree in blackthorn/whitethorn hedge, S81, T. Casey, 9 September 1984 (**DBN**).

H13 CO. CARLOW

Gibbet Hill, old roadside west of, S95, E. Booth, 28 September 1978 (**CGE**).

H14 LAOIS

Maryborough Queens, esker ridge north of, R. L. Praeger, 3 August 1896 (**DBN**, Praeger 1934). Esker near, R. A. Phillips, 7 October 1926 (**DBN**). Old hedge near esker gravel pit along a side road north of, N4704, R. FitzGerald, 10 September 1991 (**DBN**).
Portarlington, canal 3 km south-west of, N5110, R. L. Praeger, 1 June 1934 (**DBN**).
Stradbally, roadside 3 km west of, S535976, S. M. Walters, 1 July 1978 (**CGE**).

H15 SOUTH-EAST GALWAY

"South Galway", in scrub on limestone pavement, W. A. Watts, 1 May 1953 (**TCD**).
Ballindereen, M31, E. C. Nelson, 17 August 1992 (**DBN**).

Castle Lambert, roadside fence, M42, R. L. Praeger, May 1936 (**BM**, **DBN**).
Castle Taylor, M40, R. L. Praeger, 3 October 1936 (**BM**, **DBN**).
Coole, limestone crag, M40, R. A. Phillips, 15 June 1933 (**DBN**). Occasional around Coole (Webb & Scannell 1983).
Galway, Merlin Park, outside wall, M32, Miss Gough, July 1935 (**DBN**, Webb & Scannell 1983). Galway, presumably planted in an enclosure near a house, in park 3 km east of Galway, M32, S. M. Walters & P. D. Sell, 21 August 1952 (**CGE**).
Garryland, Gort, limestone rocks, Cragland Wood, M40, R. L. Praeger & H. W. Pugsley, 16 May 1933 (**BM**, **DBN**, Praeger 1934). Garryland Wood, T. G. Tutin, 20 August 1952 (**LTR**). Limestone pavement, Garryland Turlough, V. Gordon, 11 July 1967 (**LIV**). Garryland, woodland, M. J. P. Scannell, 11 July 1967 (**DBN**). Ten trees on limestone pavement, Anon., 28 May 1981 (BSBI Threatened Plants Database 1999–2003).
Gort, west of, M40, T. G. Tutin, 20 August 1952 (**TCD**). Occasional around Gort (Webb & Scannell 1983).
Kilmacduagh, near, M40, T. G. Tutin, 21 August 1952 (**CGE**, Webb & Scannell 1983).
Lough Derg at Portumna, limestone shore about 4·5 km south of, M80, N. D. Simpson, 22 June 1952 (**BM**). West shore of Loch Derg, a little below Portumna Golf Course, limestone, J. N. Mills, 30 August 1953 (**MANCH** (one sheet mixed with *S. rupicola*), **OXF**). Open limestone woods north of Loch Derg, R. P. Libbey, 8 August 1974 (**LTR**).
Oranmore, Rocklands near, M32, R. L. Praeger, 4 October 1936 (**BM**, **DBN**). Oranmore, south of (Webb & Scannell 1983).

H16 WEST GALWAY

Ballynahinch, L74, R. L. Praeger, 27 September 1936 (**BM**). E. F. Warburg, 26 (holotype) and 27 September 1938 (**BM**, Warburg 1957, Webb & Scannell 1983).
Clifden, beach road, T. G. Evans, 10 June 1990 (**NMW**). 1 tree on the sea wall about 1·5 km along the beach road, L643503, L. Houston, 21 September 2003 (**NMW**).
Errislannan Point, roadside thicket, L6249, M. J. P. Scannell, 17 September 1975 and 23 October 1978 (**DBN**). 1 bushy tree in *Salix* thicket at tip of Errislannan Peninsula, L64, D. A. Webb, 5 September 1979 (**TCD**). D. A. Webb & M. J. P. Scannell, 1983 (**TCD**, Webb & Scannell 1983).
[Oughterard; herbarium vouchers and field searches indicate that records from around Oughterard, M14, reported by Webb & Scannell (1983) and others, are all *S. aria*; Houston 2003.]
Roundstone Church, in rough corner, R. L. Praeger, September 1936 (**BM**, **DBN**). 1 tree in graveyard (Webb & Scannell 1983). 1 tree, L722401, L. Houston, 21 September 2003 (**NMW**).

H17 NORTH-EAST GALWAY

Clonber, near (see also East Mayo), scarce, M05, E. S. Marshall & W. A. Shoolbred, 15 July 1895 (**BM**, **DBN**, Marshall & Shoolbred 1896 (as *S. aria*), Webb & Scannell 1983).
Grange, near road north of, M42, E. F. Warburg, 25 September 1936 (**BM**).
Headford, 2 old trees in open woodland c. 5 km SE of, M24, S. M. Walters, T. G. Tutin & D. A. Webb, 21 August 1952 (**CGE**, **LTR**, **OXF**, **TCD**).
Lough Bofin, 1 tree near the road south-east of, M04 (Webb & Scannell 1983).

H18 OFFALY

Clonad Wood, near Geashill, R. L. Praeger (Praeger 1934). Edge of east end of Clonad Wood, N338186, S. M. Walters, 1 July 1978 (**CGE**). Hedge, N3119, R. FitzGerald, 18 June 1981 (**DBN**).
Seagull Bog, 2 trees in hedge at southern edge, Killeigh, N358195, T. C. G. Rich, June 1994 (no voucher). 1 tree, T. C. G. Rich, M. F. Foley & S. Buczaki, 29 September 1999 (**NMW**). 1 tree, L. Houston, 19 September 2003 (**NMW**).
Tullamore, hedgerow south of, N32, R. L. Praeger, 25 May 1895 (**DBN**, Praeger 1934).

H19 CO. KILDARE

Milltown, hedgerow, N71, R. L. Praeger, August 1932 (**DBN**).

H20 CO. WICKLOW

Aughrim, roadside near, T17, J. P. Brunker, 1928 (Brunker 1950). Shelter belt woodland on north side of Rathdrum road 2 km from Aughrim, T146795, S. M. Walters, 25 June 1978 (**CGE**, **TCD**), and D. A. Webb, July 1978 (**CGE**, **TCD**).

Avondale, looking wild, T18, R. L. Praeger, 1899 (Praeger 1901). J. P. Brunker, 1933 (Brunker 1950).

Ballinacor, roadside between Avoca and, T18, J. P. Brunker, 1932 (Brunker 1950).

Ballinclea, roadside near, S99, A. W. Stelfox, 1940 (Brunker 1950).

Ballyknockan, in hedges by the field path from Ballinatone to Rathdrum, O00, J. P. Brunker, 1934 (Brunker 1950).

Bellevue, roadside north of, O21, J. P. Brunker, 1945 (Brunker 1950).

Blainroe, 1 tree in hedgerow south-west of, T312903, C. M. Brady, 15 June 2002 (**NMW**).

Bullingate, frequent, lane near the main Bunclody-Bullingate road with *S. intermedia*, E. Booth & M. McC. Webster, 30 August 1960 (**OXF**).

Carriggower, roadside, ½ km north of, O2306, J. P. Brunker, 1925 (Brunker 1950).

Delgany, large tree, Old Bellvue Estate, O21, A. W. Stelfox, 15 August 1934 (**DBN**).

Dunlavin, railway banks 1 5 km south of, N80, R. L. Praeger, 1934 (**DBN**, Brunker 1950).

Fortfaulkner, roadside near, T170802, S. M. Walters, 25 June 1978 (**CGE**).

Greenan, by the river in Ballinacor Desmesne, T18, J. P. Brunker, 1937 (Brunker 1950).

Killoughter, small roadside tree, T39, M. J. P. Scannell, 26 May 1979 (**DBN**).

Killybeg, by a lane on the east flank of Keadeen Mountain, S98, J. P. Brunker, 1930 (Brunker 1950).

Kilmullin Glen, O20, A. W. Stelfox, 1927 (Brunker 1950).

Kilpipe, T17, J. P. Brunker, 1933 (Brunker 1950).

Rathdrum, riverbanks at, T18, H. C. Hart, undated (Brunker 1950). On the embankment of the viaduct, J. P. Brunker, 1938 (Brunker 1950). Roadside hedge, NW side of road half way from Rathdrum to Greenane, T168878, S. M. Walters, 25 June 1978 (**CGE**). Hedge on north side of road half way between Greenane and Rathdrum, T18, D. A. Webb, 22 July and 11 September 1978 (**TCD**). 1 tree on the roadside 1 km south-west of Rathdrum, T1887, D. L. Kelly, 2 September 1990.

Roddenagh Bridge, between Annacurragh and, T17, J. P. Brunker, 1930 (Brunker 1950).

Spring Farm, Kilpedder, O20, J. P. Brunker, 1934 (Brunker 1950).

The Devil's Glen, south side, O20, A. W. Stelfox, 1934 (**DBN**, Praeger 1934, Brunker 1950). J. P. Brunker (Brunker 1950).

The Scalp, by the road at the south end, O21, J. P. Brunker, 12 July 1932 and 1934 (**DBN**, Brunker 1950).

Tinnakilly, T17, J. P. Brunker, 1934 (Brunker 1950).

View Crag, among the crags on the west side of the Glen of the Downs, O21, Dublin Naturalists Field Club, 1901 (Brunker 1950). J. P. Brunker, 1924 (Brunker 1950).

[Glencree, O11, J. Ball, cited by Brunker (1950) probably refers to a specimen of *S. aria* s.s. collected in June 1837 (**BEL**).]

H21 CO. DUBLIN

Anna Liffey Mills, in garden by River Liffey, O03, R. L. Praeger, September 1937 (**DBN**).

Ballybetagh, a little south of Kiltiernan, O203213, D. A. Webb & P. H. Carvill, 8 September 1978 (**CGE**, **TCD**). Several small trees in a roadside hedge just east of Ballybetagh Bog, O2020, S. C. P. Reynolds, 1984 (Doogue *et al.* 1998) and 30 July 2003 (**NMW**).

Clondalkin, Clunburris, O03, E. Carey, 9 July 1956 (**DBN**).

Collierstown, edge of cliff above pools by Grand Canal, O0131, M. P. Norton, 1988 (Doogue *et al.* 1998). 1981, D. Doogue & J. Parnell (Doogue *et al.* 1998).

Dalkey Quarry, O2626, F. E. R. Walsh, 3 June 1968 (**TCD**). Several trees, O2626, S. C. P. Reynolds & H. O'Reilly, 1985 (Doogue *et al.* 1998). Near Castle and in quarry, O2626, S. C. P. Reynolds, 30 July 2003 (**NMW**).

Golden Ball, hedges by fields to the north of, O204241, D. A. Webb & P. H. Carvill, 8 September 1978 (**CGE**, **TCD**, Doogue *et al.* 1998).

Ireland's Eye, rock near summit of, O24, Anon., August 1894 (**DBN**).

Killester, O13, L. P. Grogan, August 1903 (**DBN**).
Killiney Hill, well established, O2625, D. A. Webb, 1978 (Doogue *et al.* 1998).
Killiney Quarry, O251257, D. A. Webb, September 1978 (**CGE**). Western edge of the quarries on the north side of Killiney Hill, O2625, D. A. Webb, 1979 (Doogue *et al.* 1998).
Old railway bank between mouths of the Shanganagh River and the Deansgrange Stream, O2623, S. C. P. Reynolds, 1989 (**DBN**, Doogue *et al.* 1998).
Kiltiernan, 2 medium trees and several smaller in hedges to the west of the main road between Kiltiernan and The Scalp, O210212, D. A. Webb & P. H. Carvill, 8 September 1978 (**CGE**, Doogue *et al.* 1998).
Loughlinstown, near, O2423, M. J. P. Scannell, 14 June 1953 (**DBN**).
Mount Venus, roof of a ruin, O1224, D. L. Kelly, 1960s and 1985 (Doogue *et al.* 1998).
Sandyford, bank of the disused railway line north-west of industrial estate, O1926, S. C. P. Reynolds, 1988 (**DBN**, Doogue *et al.* 1998).
The Scalp (see also Wicklow), roadside north of, O22, E. F. Warburg, 19 September 1936 (**BM**).

H22 MEATH

Duleek, Mullafin, O26, D. Synnott, 28 June 1977 (material in **DBN** cited in Scannell & Synnott 1990 but not seen 2004).

H23 WESTMEATH

Coosan Point, Lough Ree, wood on rocky carboniferous limestone shore of lake, N04, D. P. Young, 23 May 1958 (**BM**, **TCD**).
Hare Island, Lough Ree, N04, D. A. Webb, June 1976 (**TCD**).
Kilbeggan, swallow lake between Kilbeggan and Tyrellspass, N33, J. P. Brunker, 20 July 1934 (**DBN**). Wooded esker halfway between Kilbeggan and Tyrellspass, several well-grown trees on slopes in beech wood, N382359, S. M. Walters, 1978 (**CGE**). Coppiced tree in a hedge near where road crosses esker between Tyrellspass and Kilbeggan, N33, D. A. Webb, 12 September 1979 (**TCD**). Scattered population on steep gravely slope of a road cutting at Long Hill, Kilbeggan, N366371, D. L. Kelly, 22 July 1990 (**TCD**). Kilbeggan, 44 trees (**TCD**, Parnell & Needham 1998). 3 trees along the roadside on the west side of a minor road north-east of Kilbeggan, N385396 and N380388, L. Houston, 23 September 2003 (**NMW**).
Kiltober, 1 tree at Yew Mill Bridge, N33, M. J. P. Scannell, 17 July 1982 (**DBN**).
Knockdrin, N44, H. C. L. Evans, August 1885 and 20 May 1890 (**DBN**). Woods at Knockdrin (Praeger 1934).
Lough Naneagh, roadside hedge near, N57, M. J. P. Scannell, 9 July 1983 (**DBN**).
Paslicktown, five trees in and on edge of wood, N432462, L. Houston, 23 September 2003 (**NMW**).
Portlick Castle, wood margin near the SE shore of Lough Ree, N04, D. L. Kelly & D. A. Webb, 16 August 1982 (**TCD**).

H24 CO. LONGFORD

Chapel Island, Lough Ree shore, M9959, Anon., 5 June 1897 (**DBN**).
Lanesborough, Lough Ree shore near (see also Roscommon), N0069, R. L. Praeger, 15 July 1933 (**DBN**, Praeger 1934).

H25 CO. ROSCOMMON

Lanesborough, N0070, M. J. P. Scannell, June 1974 (**DBN**).
Lecarrow, near, M9651, east of, M9953, and north-east of, M9953, J. J. Earley, 16 & 17 September 2003 (**NMW**).
Lough Gara, west shore, M69, R. L. Praeger, 28 June 1897 (Praeger 1934).
Lough Ree Islands near Athlone, N0245, R. L. Praeger, 1934 (Praeger 1934).
St. John's Castle, wood on Lough Ree near, M96, R. L. Praeger, 28 June 1893 (Praeger 1934). St. John's Wood, Lough Ree, M9956, R. L. Praeger, 25 June 1895 and 28 June 1899 (**DBN**). 3 trees, M96, E. F. Warburg, 1 October 1936 (**BM**). Struggling from hazel competition, M96, N. McKee, 1995 and October 1998 (McKee 2000).

H26 EAST MAYO

Brownestown, west of Ballinrobe (as *S. aria*), Lough Mask, M16, E. C. Nelson & W. F. Walsh, 4 September 1993 (**DBN**).

Clonbur, near (see also Galway), M15, E. S. Marshall, 15 July 1896 (**BM**, **CGE**, **DBN**).

Lough Carra, islet, M17, R. L. Praeger, July 1906 (**DBN**, Praeger 1934).

H28 CO. SLIGO

Lough Gill, west shore, G73, R. L. Praeger, 28 June 1897 (**DBN**). Lough Gill shore at Cloghercaugh, R. L. Praeger, September 1932 (**DBN**).

H30 CO. CAVAN

Annagh Lough, NW of Butlersbridge, woodland, H31, M. J. P. Scannell, 13 July 1968 (**DBN**, Reilly 2001).

Bailieborough, N69, T. J. Barron, 6 June 1954 (**DBN**, Reilly 2001).

H35 WEST DONEGAL

Kilmacrenan, east of, C1420, A. Gallinagh, 1 October 1984 and 18 September 1987 (**DBN**).

H37 CO. ARMAGH

Armagh, 2 trees in hedge by disused railway south of, H8846, N. Dawson, 1980 (**DBN**, Dawson 1983).

H38 CO. DOWN

Hollymount, in swampy woodland, Downpatrick, J44, D. L. Kelly, 21 June 1986 (**BEL**).

H39 CO. ANTRIM

Drumnasole, 3 trees, D2924, R. L. Praeger, August 1937 (**BEL**, **DBN**, Praeger 1937). Private grounds, J. P. M. Brenan & N. D. Simpson, 14 August 1939 (**BM**, **RNG**). 3 trees, W. J. Harron, 1985. P. Hackney, 1987. 3 trees, S. Beesley, 1992.

Garron Point, 1 tree on steep wooded scarp in little glen 1 km south of Garron Tower, D22, R. L. Praeger, 1936 (Praeger 1937). Basalt cliff 1 km NW of Garron Tower, D2924, R. L. Praeger, May 1936 (Praeger 1937). In line of trees below cliffs near Galboly, D2924, R. L. Praeger, May and 14 October 1936 (**BM**, Praeger 1937). Garron Head, D2924, P. Hackney, 11 September 1987 (**BEL**).

Tornavoy Bridge, 1 young tree, cliff of Collin river ½ km above, J268736, P. Hackney, 30 August 1991 (**BEL**).

H40 CO. LONDONDERRY

Muff Glen, 2 trees apparently planted, either side of a path near the river, C524180, P. Hackney, 26 August 1992 (**BEL**).

Portglenone, 1 tree and 4 seedlings in dry birch wood on cut-out bog beside the Bann Meadows, C968053, P. Hackney & N. McKee, 24 July 1998 (**BEL**).

Population sizes of three rare Welsh endemic *Sorbus* species (Rosaceae)

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ABSTRACT

Population estimates and IUCN Threat Categories are given for three rare Welsh endemic *Sorbus* species. There are 113 *S. leptophylla* plants in four populations, the Montgomery plants differing from the Brecon plants in leaf shape; it is Endangered. There are 17 *S. leyana* plants in two populations in Brecon; it is Critically Endangered. There are 780 *S. minima* plants in three populations in Brecon; it is Vulnerable. Differences in surveys probably account for apparent increases in population sizes.

KEYWORDS: IUCN Threat Categories, *Sorbus leptophylla*, *Sorbus leyana*, *Sorbus minima*.

INTRODUCTION

The three Welsh endemic whitebeams *Sorbus leptophylla* E. F. Warb., *S. leyana* Wilm. and *S. minima* (Ley) Hedl. were amongst the species of *Sorbus* considered as requiring the highest priority for conservation in the UK (Flanagan 1998), though only *Sorbus leyana* is currently a UK Biodiversity Action Plan Priority species. Recent accounts of these species are given in Kay (1998), Wigginton (1999) and Woods (1998), the last-named noting that detailed surveys were urgently needed to reconcile data from previous surveys. Such surveys were carried out between 2000 and 2004 and have markedly revised the previously reported population sizes and trends; these updated population estimates are reported here with their revised conservation status.

METHODS

Historical records were traced in herbaria (**BEL**, **BIRA**, **BIRM**, **BM**, **BRISTM**, **CGE**, **DBN**, **K**, **LIV**, **LTR**, **MANCH**, **NMW**, **OXF**, **RNG**, **TCD** and **UPS**), the literature and in unpublished information held by the Countryside Council for Wales (CCW).

Population surveys of *S. leptophylla* and *S. minima* were carried out by T. Rich 2000–2004, with help from C. Charles, L. Houston and A. Tillotson, and surveys of *S. leyana* 1998–2004 by Q. O. N. Kay and G. S. Motley. Trees were usually counted by walking along the bottom and top of cliffs with occasional scrambling up the more accessible parts, and by using binoculars. The main problems with counting trees on cliffs are seeing the *Sorbus* amongst other woody species, being

certain that plants counted from cliff tops are not also counted from below, and distinguishing inaccessible plants from related species. Vouchers for the population surveys are lodged in the Welsh National Herbarium (**NMW**) and full details have been lodged with the Threatened Plants Database.

For the morphological analyses, following the standard procedure for *Sorbus* (e.g. Aas *et al.* 1994), the broadest leaves from vegetative, short, lateral shoots, excluding the oldest and youngest leaf, were measured on fresh and/or herbarium material.

SORBUS LEPTOPHYLLA

Sorbus leptophylla, Narrow-leaved Whitebeam, Cerddinen Gymrieg in Welsh, was first described by Warburg in 1952 (formalised by Warburg 1957) who reported it from two localities in the Brecon Beacons and probably also Montgomery from where he had not seen fruiting material. The specific epithet '*leptophylla*' either means 'thin-leaved' or 'narrow-leaved', and Warburg's description implies he meant the latter.

As reported by Proctor & Groenhof (1992), the classic growth form of this species in the Brecon Beacons is as a shrub with its trunk appressed against a rock face, with a dense growth of small twigs at the base, often pendulous branches, and large, obovate, shallowly lobed leaves with large fruits 11–16 mm long which are longer than wide; such plants are well known at Craig y Cilau and also occur at Craig y Rhiwarth. On the exposed cliff tops and sides at both sites, the trees grow more erect, and have smaller leaves of the same shape. These plants are often overlooked as belonging to the *S. porrigentiformis* group unless the fruits are present. Conversely, vegetative plants of the *S. porrigentiformis* group with an appressed growth form have been misidentified as *S. leptophylla* but, when fertile, have fruits wider than long.

CRAIG Y RHIWARTH, BRECON (V.C. 42)

Sorbus leptophylla was first collected at Craig y Rhiwarth (SN8415) in 1935 by E. F. Warburg (below Penwyllt, **BM**). Although A. Ley had collected *Sorbus porrigentiformis* at this site in 1899 (**UPS**), he apparently did not collect *S. leptophylla*. The first population count was about 16 plants in 1988 by V. Morgan (Rare Species Form held by CCW).

The population was surveyed in detail in 2002 by T. Rich, with additional notes in 2003 and 2004. A population of 29 plants occurred with *S. porrigentiformis* between the western tip and the natural arch of the large north-facing crag, on both the open cliff (23 plants) and on ledges in the shaded woodland below (six plants). One small vegetative plant c. 50 cm tall with three branches was found on the adjacent crag c. 200 m to the south-east. The flowering and fruiting performance varied depending on location: plants in deep shade tended to be vegetative, those along the cliff top were rather weather-beaten and rarely fruited even if they flowered, but those on the sheltered open cliff face flowered and fruited regularly. Most of the plants were mature, and the apparent increase in population size is probably due to a more detailed survey.

No plants were found nearby on the limestone crags of Cribarth, Craig-y-nos (where *S. porrigentiformis* is present), or Dan-y-Ogof. The aberrant individual with oval leaves at Craig y Rhiwarth reported by Proctor & Groenhof (1992) belongs to the *S. porrigentiformis* group.

CRAIG Y CILAU (CRAIG CILLE), BRECON (V.C. 42)

Craig y Cilau (SO1815 and SO1816) is the type locality of *S. leptophylla*. The earliest collections traced were by W. C. Barton in 1901 (**BM**), and by A. Ley in 1909 (**BIRM**, **UPS**). It has since been regularly collected and recorded from this site, mostly from the well-known plants on the central cliffs. L. Farrell and P. D. Sell reported 28 trees from the N.N.R. in 1975, but additional notes by M. Massey in September 1976 suggested this number included some *S. porrigentiformis,* and he confirmed only ten fruiting trees in 1977 (Rare Species Forms held by CCW).

During the 2002 survey which was carried out over three days in September in a good fruiting year (Rich 2003), 45 trees were found, mostly concentrated on the main cliff where it has mostly been reported before, with scattered trees elsewhere on limestone cliffs above. As not all trees were accessible due to the size of the cliffs, the count must be regarded as approximate but it is certainly more than 40 plants. One additional tree was found on the BSBI Welsh AGM excursion on 7 September 2003. The two trees reported at Chwar Mawr at the east end of the N.N.R. by

Farrell & Sell (Rare Species Form) were searched for carefully, but these may have been of a large-leaved form of *S. porrigentiformis* which was growing appressed to the rock surface in that locality. The apparent population increase is probably mainly due, first, to identification of more specimens due to the presence of fruit, and second, to an increased intensity of survey (Sell & Farrell spent one day in June 1975 and surveyed both *Sorbus* and *Hieracium*).

The extensive quarrying at this site (cf. *S. minima* below) could have resulted in loss of some *S. leptophylla* plants but there is no evidence that this is so, most trees occurring on and around the central cliff which was not quarried.

Records for *S. leptophylla* from the nearby Cwm Clydach (SO21), Craig y Castell and Tarren yr Esgob (the latter determined by Warburg) are errors for the *S. porrigentiformis* group (pers. obs. and M. Porter, pers. comm. 2003).

BREIDDEN HILL (CRAIG BREIDDEN), MONTGOMERY (V.C. 47)

Breidden Hill has been a well-known rare plant site for many years, with an early collection of *S. anglica* Hedl. in 1834. The earliest collection of *S. leptophylla* was 1955, Cambridge Botany School expedition (**CGE**), but Warburg (1957) declined to confirm the identification in the absence of ripe fruit. Subsequently, P. D. Sell saw fruit collected by R. G. Woods in 1977 and confirmed it as *S. leptophylla*. *Sorbus porrigentiformis* has been reported but not confirmed from the site (Trueman *et al.* 1995), and the records are probably errors for small-leaved *S. leptophylla.*

The *Sorbus* species on the West Crags (c. SJ2814) were mapped and counted by G. Wilson (Wilson 1986); he reported 42 plants of *S. anglica,* 32 plants of *S. rupicola* (Syme) Hedl. and 35 of "*S. leptophylla/porrigentiformis*", with another ten plants on cliffs that could not be reached to confirm their identity. After examination of accessible plants on site in 2001 and 2002 (the latter an excellent fruiting year), T. Rich regarded Wilson's *S. leptophylla/S. porrigentiformis* plants as one taxon related to *S. leptophylla*. These plants occur as trees scattered on the steep open rocks and screes and occasionally on the edges of more scrubby and wooded areas, but not in shade. The *S. leptophylla* trees on deeper scree soils grew to c. 5 m tall, with several trunks which tended to grow ascending at an angle of c. 45–60° rather than straight up, and they also occurred as sprawling shrubs 1–2 m long on the rocky cliff faces. The detailed 1986 survey appears to represent the present situation.

Proctor & Groenhof (1992) reported P. J. M. Nethercott had found two plants of *S. leptophylla* on the North Crags (SJ2914) in 1990, with larger leaves than plants on the West Crags which were attributed to the shadier and less droughted habitat (photocopies of specimens seen by T. Rich). Although the plants were not refound by T. Rich and L. Houston in 2003 they are still likely to be present.

COMPARISON OF BRECON AND BREIDDEN *S. LEPTOPHYLLA*

Morphological examination of the Brecon and Breidden plants show that the leaves are not identical, though they are similar (Fig. 1). The leaves of the Breidden plants are generally widest at or below the middle (markedly obovate in Brecon plants), are less markedly biserrate, and are generally smaller in size though there is overlap (Fig. 2). The fruits are also on average smaller in the Breidden plants, but otherwise generally similar. The leaves and fruits of the Craig y Rhiwarth population are in essence a subset of the variation seen in the Craig y Cilau population (Fig. 1).

The cytological and genetic evidence also suggests that Brecon and Breidden plants are closely related. H. McAllister has counted the chromosome numbers of three seedlings of *S. leptophylla* from Craig Breidden grown from fruits collected from one plant overhanging a quarry on the West Crags sent to him by R. G. Woods in 1977 (BSBI cytological database). Two of the seedlings were 2n = 68 = tetraploid and one was 2n = 51 = triploid; this triploid count requires confirmation (H. McAllister, pers. comm. 2003). Counts of seedlings grown from plants collected at Craig y Rhiwarth and Craig y Cilau were both 2n = 68 (J. P. Bailey *et al.*, in prep.). Proctor & Groenhof (1992) reported that biochemically the Breidden and Brecon plants have the same peroxidase phenotype, and M. Chester *et al.* (in prep.) found that they have the same plastid haplotype, which is otherwise only found in *S. aria* (L.) Crantz and in the *S. porrigentiformis* group.

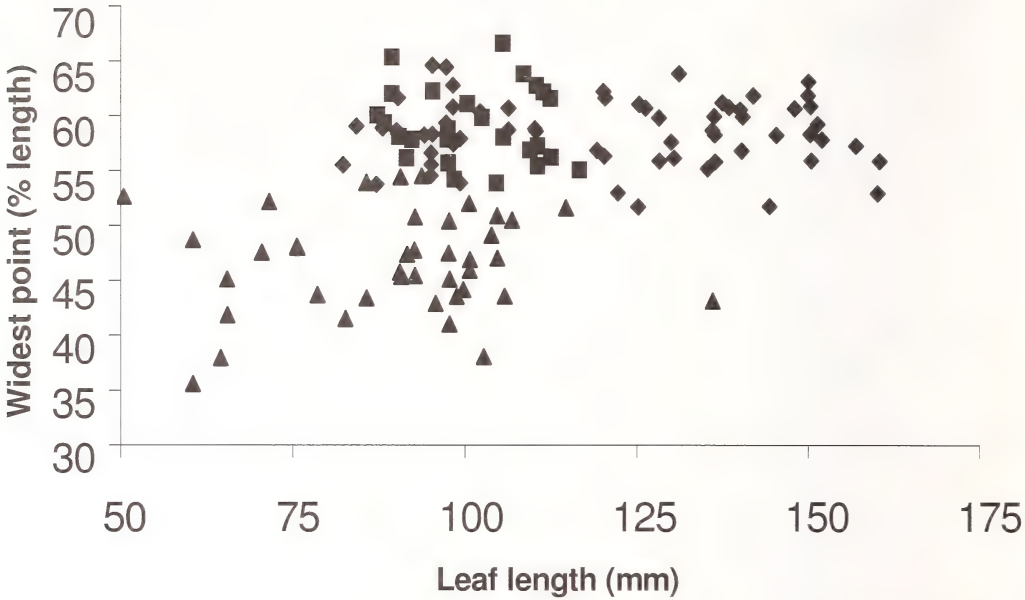


FIGURE 1. Variation in leaf length and position of widest point between populations of *Sorbus leptophylla*. ◆ Craig y Cilau. ■ Craig y Rhiwarth. ▲ Breidden Hill.

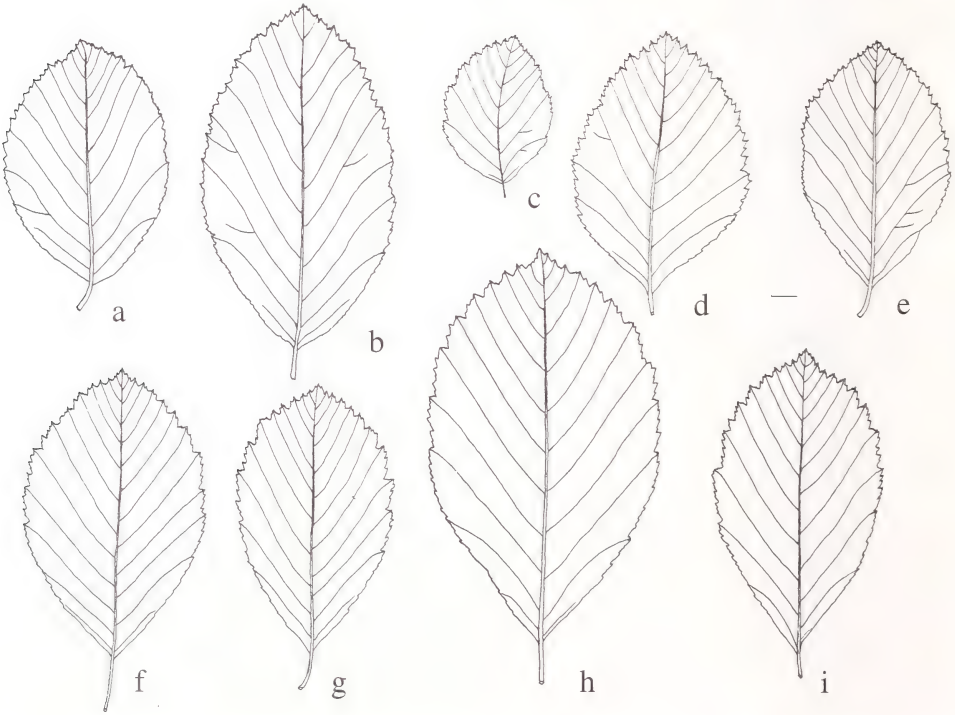


FIGURE 2. Broad leaves of short shoots of *Sorbus leptophylla*. a–e, Breidden Hill. f, g Craig y Rhiwarth. h, i Craig y Cilau. Scale bar = 1 cm.

SORBUS LEYANA

Sorbus leyana, Ley's Whitebeam, or Cerdin Darren Fach in Welsh, was first described by Wilmott (1934), who named it after Augustin Ley who had first discovered it in 1896 and distributed it as '*Pyrus scandica*?' (Ley 1901). G. S. Motley has monitored the sites since 1998, and full details are held in CCW files (Motley 2004).

DARREN FACH, BRECON (V.C. 42)

This was the first site at which *Sorbus leyana* was discovered, and in addition to the specific site name Darren Fach (SO0110), has been variously reported as near Cefn Coed, above Dan-y-Graig, at Cefn Cil-Sanws, or even near Merthyr Tydfil.

Ley (1901) reported 15–20 mostly inaccessible shrubs. Wilmott (1934) noted it from a single, short, rock face where there were "many small bushy trees of it, all identical, growing with numerous *S. rupicola*, *S. aucuparia* and one or two *S. aria*" (the last-named are now known to be *S. porrigentiformis*). J. E. Lousley noted that the severe frosts of the winter 1947/48 had killed many bushes and that others were badly eaten by caterpillars (Lousley 1950; **RNG**). M. Porter found 13 plants in 1983 (Kay 1998). V. Morgan and G. Barter counted five trees in 1988 (Rare Plant Form held by CCW).

In 1998, G. S. Motley counted seven trees, and in 2000, G. Motley and Q. Kay found eight trees, from which they collected material for grafts (now growing at the National Botanic Garden of Wales). In 2004, G. Motley confirmed eight trees were present.

PENMOELALLT (COED PENMAILARD), BRECON (V.C. 42)

Sorbus leyana was first found at Penmoelallt (SO0109) by J. O. Evans in 1958 (**NMW**), and he noted three trees, 8–9 m tall, on the cliff faces in his paper on the woodland vegetation (Evans 1960). V. Morgan saw one certain and one possible tree in a brief search in 1988 (Rare Plant Form held by CCW). Trees and some 2–4 year old seedlings were seen in 1995 by M. Hampton (Kay 1998). In about 1996, one *S. leyana* sapling was dug up and stolen from the site by a non-botanist.

In 1998, G. Motley found the three native trees and two saplings. In 1999 two more saplings were found, and all saplings were estimated to be 5–6 years old. In 2000, G. Motley and Q. Kay collected grafts from six plants (cf. above). In 2004, two further saplings were found, bringing the total to nine plants.

In addition to these wild trees, in April 1963 the Forestry Commission planted seven 2-year-old saplings, grown from seed collected from this site in 1959, in three separate fenced enclosures on the level ground above the cliffs adjacent to the wild plants. Six of these trees survived to the following year and by 1968 had grown to between 1·7 and 2·7 m tall. The fences were removed in the early 1990s. All six trees survive to 2004, and had a mean estimated height of 10 m and mean girth at 1·3 m of 58 cm.

GARWNANT, BRECON (V.C. 42)

Two trees planted beside the Forestry Commission Visitor Centre at Garwnant (SO0013) are widely reported as *S. leyana* (including one designated by the Tree Council in 2002 as one of the fifty great British trees; Stokes & Rodger 2004) but are *S. intermedia* (Ehrh.) Pers. (**NMW**).

At Darren Fach and Penmoelallt *S. leyana* occurs scattered along the open top edges of wooded Carboniferous Limestone cliffs where the trees can reach the light. Both cliffs are rich in woody plants indicative of a long history of woodland cover, and the presence of coppice and lime kilns indicates that both woods were periodically coppiced. Many of the plants at Darren Fach are many-branched depauperate bushes *c.* 2 m tall which flower sporadically, whilst those at Penmoelallt tend to be maidens 8–10 m tall and flower freely though fruiting is irregular (Kay 1998). The Darren Fach population is currently decreasing, and by extrapolation from the crude population data could become extinct by 2100. In contrast, the Penmoelallt population is currently increasing due to recent regeneration under one tree. Personal observations suggest that this is due to the loss of one of the three largest trunks from the cliff top tree prior to 1992, resulting in increased light conditions below the tree allowing germination of seed which had either fallen from the other trunks or been carried down by small mammals. Sections of trunk cut from the fallen tree in 2004 show regular growth rings up to about 1988, and then two poor years followed by recovery (**NMW**). One possible interpretation is that the tree was damaged in the Great Storm

of 1987, and then the first large trunk was blown down in the second storm in 1989. Estimation of the age of the saplings in 2004 from the bud scars was difficult as most saplings have had some damage to the leading stems, but they ranged from at least 4 years to at least 12 years, indicating sporadic recruitment. The loss of the two remaining large trunks from the cliff top tree in early summer 2003 may bring this recruitment to a halt, though the regrowth after the fall of the first trunk is already producing some fruit. This response to natural changes in the canopy suggests that coppicing the woodlands at Darren Fach could result in population increases there too, provided grazing is excluded, as combinations of deer, sheep and rabbit grazing probably prevent colonisation of nearby grassland and scree (Woods 1998). We request that those wishing to see *S. leyana* do not scramble on the cliffs where the small saplings could be easily trampled.

No other *S. leyana* trees have been found during searches of other limestone cliffs or hedges in the area. *Sorbus rupicola* is abundant at Penmoelallt (where it is often mis-recorded as *S. porrigentiformis*) and rare at Darren Fach (it too has declined since Wilmott reported it as 'numerous'), and *S. porrigentiformis* is rare at Darren Fach. Some former sites could have been destroyed by quarrying (Kay 1998).

In 1999, G. Motley found a sapling with leaves intermediate between *S. leyana* and *S. aucuparia* under a *S. aucuparia* tree at Penmoelallt, which was interpreted as a hybrid between them. A second sapling was found nearby in 2004.

SORBUS MINIMA

Sorbus minima, Lesser Whitebeam or Least Whitebeam, or Cerdin Wen Leiaf in Welsh, was first found by Augustin Ley in 1893. He named it *Pyrus minima* Ley after observing it in flower and fruit (Ley 1895, 1897). Hedlund subsequently made the current combination under *Sorbus* (Hedlund 1901).

According to the recent Red Data Book (Wigginton 1999), the total world population was fewer than 350 plants in two sites; our surveys have significantly revised this figure upwards.

CWM CLEISFER, BRECON (V.C. 42)

The earliest unambiguous record for Cwm Cleisfer (SO1416) is that of D. P. M. Guile, June 1951 (**NMW**). The first population estimate was by L. Farrell and P. D. Sell on 29 June 1975 who counted 17 plants. M. Porter counted 15 plants in 1975 (Kay 1998), and V. Morgan counted 17 plants in 1988 (Rare Plant Form, held by CCW).

On 5 July 2000, 27 plants covering a range of age classes were counted on sparsely wooded crags, mainly concentrated at the south-east end of the outcrop. A repeat survey on 9 July 2001 found 26 plants. Some small plants were hidden amongst the clefts in the rocks and may have previously been over-looked, or could result from regeneration.

BLAEN ONNEU, BRECON (V.C. 42)

The population at Blaen Onneu (SO1516) was reported by A. Ley from 'limestone rocks at Blaen Onnen [*sic*], two miles westward from Craig Cille' (Ley 1895). Cwm Cleisfer is three miles west of Craig y Cilau and Craig y Castell one mile west; it is possible that this record refers to Craig y Castell or Cwm Cleisfer. The area has now been extensively quarried and no plants are currently known, and the site is assumed to have been destroyed. *Sorbus rupicola* was recorded from Blaen Onneu in 1934 (**UPS**) but no longer occurs there.

CRAIG Y CASTELL, BRECON (V.C. 42)

The earliest unambiguous record for Craig y Castell (SO1716) is that of H. A. Hyde and A. E. Wade, 9 June 1927 (**NMW**). V. Morgan was unable to find it in 1988 (Rare Plant Form, held by CCW), but one mature shrub still occurs on the cliff-top south-east of the lime kiln (2000–2004; **NMW**). The shrub is potentially under threat as it is adjacent to a climbing route.

One plant of the *S. porrigentiformis* group is present on the cliff below the *S. minima*. *Sorbus anglica* was recorded from this site in 1927 (**NMW**) but no longer occurs.

CRAIG Y CILAU (CRAIG CILLE) , BRECON (V.C. 42)

Craig y Cilau (SO1815, SO1816, SO1915 and SO2015) was the first site at which *S. minima* was found by A. Ley on 12 June 1893, and he reported it as occurring 'in great abundance', clothing the limestone cliff to its head at an altitude of 2000 ft (Ley 1895); this is still true today. It is the best known site, and there are many specimens collected from it in herbaria. Most of the site is a National Nature Reserve (N.N.R.).

TABLE 1. POPULATION SIZES, NUMBER OF SITES AND IUCN THREAT CATEGORIES FOR *SORBUS* TAXA

Taxon	No. of plants	No. of populations	2001 IUCN Threat Category
Sorbus leptophylla	113	4	Endangered
Sorbus leyana	17*	2	Critically Endangered
Sorbus minima	780	3	Vulnerable

* excludes planted trees

Farrell & Sell (1975) reported 305 trees on 30 June 1975, occurring throughout the N.N.R. In September 2002, T. Rich found a total of 730 plants within the N.N.R., the apparent increase probably being due to more intensive survey coverage over three days, especially of the upper cliffs, and also to an increased visibility of plants due to the autumn leaf coloration (Rich 2003). There are also an additional seven plants on the quarry to the west of the N.N.R., and 12 at Darren Cilau immediately to the east of the N.N.R., and a further three plants 300 m further east on the face of the old quarry at Pinnacle Bay in the adjacent 10-km square (**NMW**). These latter three shrubs have obviously been present for some years, and it is surprising that they have not been reported before, as many people walk past them along the eastern access route into Craig y Cilau.

Quarrying has destroyed many plants at Craig y Cilau – Darren Cilau, the eastern populations now being the scattered fragments of what may have once been a more continuous population. Quarrying of the Llangattock ridge commenced sometime between 1797 and 1812 to provide stone for the construction of the Monmouthshire and Brecon Canal, eventually extending nearly 5 km along the scarp. The quarries were last used in the 1940s. Although *S. minima* has recolonised some of the quarries, the density of plants is only c. 40% of that on unquarried rocks (Rich 2003); historically, the Craig y Cilau population could have been over 1000 plants.

Other suitable cliffs in the area have been searched without success.

DISCUSSION

It is difficult to determine if the differences between the historical and current population sizes reported for each species are due to differences in quality of survey (surveys in 1988 seem to consistently under-estimate the numbers of plants present) or reflect real changes in populations. Only in the case of *S. leyana* at Darren Fach is there any evidence that the population has declined, in the other cases variations between survey methods are too large to separate real change from sampling effects, as was also found for the Arran endemic whitebeams by Robertson (2004). A standard monitoring protocol has now been drawn up for Craig y Cilau (Rich 2003) and the principles should be applied elsewhere for these and other rare *Sorbus* species.

The current number of plants and IUCN Threat Categories from the 2001 criteria now used for British plants are summarised in Table 1. These should now provide a sound basis for assessing the priorities for conservation in the context of other rare plants in Britain. The greatest threat is probably to *S. leyana*, through trampling, collecting of specimens and theft of whole plants, and in the longer term by lack of regeneration. All populations of these taxa are currently within Sites of Special Scientific Interest with the exception of the *S. minima* at Cwm Cleisfer. *Ex-situ* populations of all taxa are held at the National Botanic Garden of Wales.

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Clonal diversity in two recently discovered English populations of *Carex vaginata* Tausch (Cyperaceae)

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ABSTRACT

Two populations of *Carex vaginata* have recently been discovered in the northern Pennines representing the first records of this species for England. We have used Random Amplified Polymorphic DNA (RAPD) fingerprinting analyses to investigate the population structure of *Carex vaginata* in its English localities and have also compared these findings with two populations from the Southern Uplands of Scotland. Extensive clonal mats (up to 6 m in length) were detected, although in some cases, individual patches were made up of a small number of spatially structured different clones. The presence of extensive clonal mats within the English populations suggests that the plants must have been present at these sites for a considerable period of time. In addition, no genotype was found in more than one local patch within a population. This restriction of individual genotypes to single patches, and the presence of different genotypes in different patches, suggests that sexual reproduction and seed dispersal, rather than vegetative dispersal, has been the primary mechanism for the formation of new patches.

KEYWORDS: British flora, sedge, grazing, clonal growth

INTRODUCTION

Carex vaginata Tausch (Cyperaceae), Sheathed sedge, is a circumboreal arctic-alpine (Hultén & Fries 1986) with a locally abundant British distribution (Preston *et al.* 2002). Within Britain, this perennial rhizomatous sedge is a characteristic constituent of flushed montane grassland of the Breadalbane and Cairngorm mountains of Scotland (Jermy *et al.* 1982), with the most southern British populations located in the Southern Uplands of Scotland. These sites are located in the Moffat Hills, Dumfriess. (v.c. 72, Ratcliffe 1959); the upper Ettrick valley, Selkirks. (v.c. 79); and the Tweedsmuir Hills, Peebless. (v.c. 78, Corner 1981). In 2002, however, two further sites were discovered which extended the UK range of the species southwards to England (Dufton Fell, Westmorland, v.c. 69; and Green Fell, Cumberland, v.c. 70) (Corner 2004). The English sites are approximately 85 km south of the most southern Scottish site (Ettrick valley).

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One of the English sites (Dufton Fell) was surveyed as part of the Flora of Cumbria project in 1991 but during these surveys, *C. vaginata* was not detected (Corner 2004). The failure to detect this species was perhaps attributable to the generally shy flowering nature of *C. vaginata* (Jermy *et al.* 1982), and the heavy sheep grazing in the northern Pennines (Robinson 2003). In 2001, however, the foot and mouth outbreak led to extensive sheep culls, and grazing was effectively eliminated over two successive summers (Robinson 2003). This decline in sheep grazing led to the "blooming" of Cross Fell (Roberts 2003), and extensive flowering of *Alopecurus borealis* at Green Fell (Robinson, 2003) and *C. bigelowii* at Dufton Fell (Corner, 2004). It was following this reduction in grazing that the two new *C. vaginata* sites in England were discovered and up to 50 flowering spikes were observed in one patch on Dufton Fell in 2002 (F.J.R. pers obs.).

To contribute towards ongoing research on the effects of sheep grazing on upland floras (English Nature, 1993; English Nature 2001), we have examined the population structure of *C. vaginata* at the two new English sites. Specifically we wished to assess the levels of clonal diversity. Although there are few other published studies on rhizomatous sedges, those that have been undertaken have shown high levels of genotypic diversity, indicating an important role of sexual reproduction in perpetuation and dispersal, despite a lack of field observations of seedling recruitment (McClintock & Waterway 1993; Jonsson *et al.* 1996).

Plants of *C. vaginata* show a clumped distribution within populations in the Pennines, and occur in a series of discrete patches. It is, however, uncertain as to whether these patches consist of single clones, or instead consist of multiple sexually derived individuals. Field observations of flowering material have not detected any viable seed, leading Corner (2004) to suggest that the plants could be derived from single clones with inbreeding taking place. Corner (2004) also noted that the Pennine plants generally looked less vigorous than their counterparts from the Southern Uplands, but stressed that this may simply be attributable to their recent release from heavy grazing, rather than being attributable to a genetically determined lower level of fitness.

In the current paper we have used Random Amplified Polymorphic DNA (RAPDs; Williams *et al.*, 1990) to assess patterns of clonal diversity in *C. vaginata*. Our goals have been to establish the extent to which the English populations consist of single or multiple clones, and how their population structure compares with the Southern Upland sites. RAPDs have been used to assess patterns of clonal diversity in several other plant species, and represent a cost-effective and efficient tool for assessing the distribution of different genotypes (Esselman *et al.* 1999; Kreher *et al.* 2000; Hollingsworth & Bailey 2000; Persson & Gustavsson 2001).

MATERIALS AND METHODS

PLANT MATERIAL

The two English localities of *Carex vaginata* were visited by F.J.R., R.W.M.C. and M. S. Porter in August 2003. Within each locality, leaf material was collected at approximately 0 5–1 m intervals, along rough transects in all known patches. Samples were placed in silica gel for long-term storage. In total, five patches were sampled at Dufton Fell and three patches at Green Fell, including a new patch discovered during this field work by Linda Robinson. The number of samples collected ranged from 3–10 per patch (Table 1). Despite dense growth of *C. vaginata*, with thousands of vegetative shoots within each patch, only one inflorescence was noted from either population. Therefore, identification of each sample was performed in the field, by R.W.M. C., using vegetative characters only.

To compare population structure in the English populations with Scottish populations, samples from two populations of *C. vaginata* were collected from the Ettrick valley, southern Scotland, by R.W.M.C. in August 2003. A similar sampling strategy was performed for each population, with a total of nine patches sampled at Bught Hill and three patches at White Shank. The number of samples collected ranged from 1–4 per patch, with sample numbers reflecting patch size (Table 1). No inflorescences were noted in either population so identification was again based on vegetative characters.

TABLE 1: LOCATION OF TWO ENGLISH AND TWO SCOTTISH POPULATIONS OF *CAREX VAGINATA*, WITH THE GRID REFERENCE AND ALTITUDE OF EACH PATCH RECORDED USING A GPS WITH ACCURACY OF 5 M. THE APPROXIMATE SIZE OF EACH PATCH AND NUMBER OF SAMPLES FROM EACH PATCH IS ALSO GIVEN

Location	Vice County	Grid Reference	Altitude (m)	Approx. patch size (m)	Number of samples
ENGLAND					
Dufton Fell	Westmorland (v.c. 69)				
Patch A		NY7442029892	727	10 × 7	4
Patch B		NY7528329848	723	10 × 4	7
Patch C		NY7531529838	721	3 × 3	10
Patch D		NY7532929856	723	15 × 4	6
Patch E		NY7534729883	723	8 × 10	5
Total					32
Green Fell	Cumberland (v.c. 70)				
Patch A		NY6678836480	700	3 × 4	3
Patch B		NY6668236334	700	6 × 4	6
Patch C		NY6667335999	710	8 × 4	7
Total					16
SCOTLAND					
Bught Hill	Selkirkshire (v.c. 79)				
Patch A		NT1766910845	520	3 × 2	2
Patch B		NT1771510951	490	1 × 1	1
Patch C		NT1774010827	520	3 × 2	2
Patch D		NT1776710813	520	5 × 3	4
Patch E		NT1807110738	520	3 × 2	2
Patch F		NT1811910720	520	4 × 2	3
Patch G		NT1814310710	520	5 × 3	4
Patch H		NT1819810666	520	5 × 3	4
Patch I		NT1822710653	520	3 × 2	2
Total					24
White Shank	Selkirkshire (v.c. 79)				
Patch A		NT1705508523	530	3 × 2	2
Patch B		NT1711808523	510	3 × 2	2
Patch C		NT1724508393	530	3 × 2	2
Total					6

DNA EXTRACTION AND RAPD ANALYSIS

DNA was extracted from approximately 25 mg of dried leaf material, using a modified 2xCTAB (cetyltrimethyl-ammonium bromide) method (Doyle & Doyle 1987). The quality and quantity of the extracted DNA was assessed on 1·0% agarose (Bioline) gels. DNA was diluted 1:20 with autoclaved deionised water, prior to RAPD analysis, performed using the protocol of Hollingsworth *et al.* (1998), with the addition of 2% formamide (Amresco). The resultant DNA fragments were separated on 1 6% agarose gels, stained with ethidium bromide and visualised under UV light. One individual from each population was initially screened with 34 decamer primers. Of these, five primers (OPG1, OPG5, OPG6, OPC6 and OPP13 (MWG-Biotech)) yielding polymorphic and reproducible bands were selected to screen all 78 individuals. To reduce PCR amplification artifacts, for each primer, all individuals were amplified during one PCR run on the same PTC-200 Peltier Thermal Cycler (MJ Research). In addition, DNA from one individual was amplified twice within each PCR run. A subset of the samples was subjected to repeat DNA extractions and repeat PCRs to check that the fragment profiles were reproducible. Amplification across all five primers was successful in 76 out of the 78 individuals. Two individuals that showed poor amplification were excluded from further analyses.

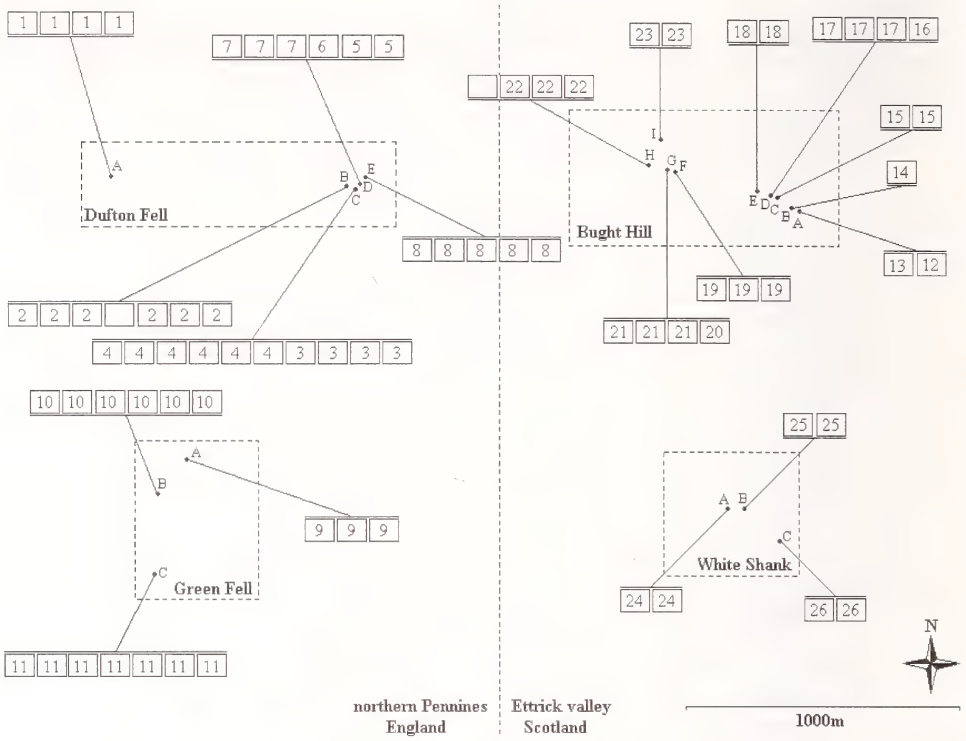


FIGURE 1. Genets of *Carex vaginata* from two northern English and two southern Scottish localities, sampled August 2003. 26 genotypes (genets) were distinguished using 52 polymorphic RAPD markers. Sites within localities represented by letters (see Table 1), samples represented by small squares (arranged along transects), genotypes represented by numbers (1–26), failed amplification represented by empty square.

Bands were scored manually as either present or absent, generating a binary matrix. From this matrix, the RAPD phenotypes for all 76 individuals were compared. Plants showing identical banding patterns were considered to belong to the same multilocus genotype and were interpreted as being members of the same clone (=genet). Each of the different multilocus genotypes were assumed to correspond to a different genet, with each plant (sample) considered as an individual ramet (potentially independent part of a genet (Cook 1983)). The spatial distribution of each putative clone (genet) was represented on a schematic diagram, with intra-population clonal diversity assessed by calculating the mean number of ramets per genet, *R/G*, for each population.

RESULTS

Of the 59 bands scored, 52 (88·1%) were polymorphic. In terms of their distribution among individuals, from the 76 samples, 26 multilocus genotypes (putative genets) were identified. Reproducibility tests showed that all of the banding differences investigated were reliable based on an independent re-extraction of the sample DNA and re-amplification using the RAPD primers. The number of bands amplified in each genotype ranged from 20–35, with an average of 15·7 ± 3·8 band differences between genotypes (range 2–24).

The number of putative genets per population ranged from three at Green Fell and White Shank, eight at Dufton Fell, to the maximum of twelve at Bught Hill (Fig. 1, Table 2). Within each of the sites, each patch contained 1–3 putative genets, with 15 out of the 20 patches consisting of a single genet (Fig. 1). The most extensive distribution of a single genotype was at Green Fell with one

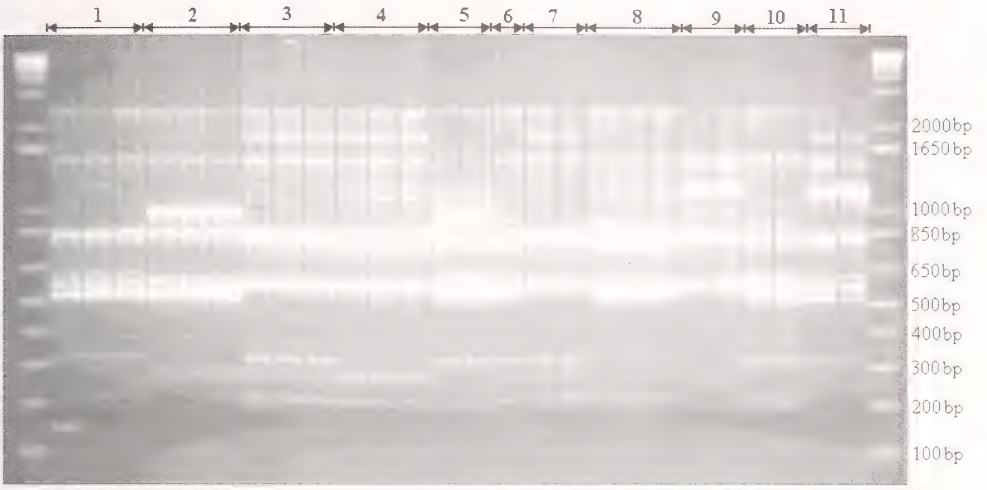


FIGURE 2. RAPD band profile of 26 individuals from Dufton Fell and Green Fell, using primer *OPC6*. Eleven genets (numerical codes as in Fig. 1) are indicated above the lanes. Genets 3 and 4 which show intensity, but not discrete banding differences were scored as identical for this RAPD primer, but showed clear differences with other primers.

TABLE 2: CLONAL DIVERSITY IN FOUR POPULATIONS OF *CAREX VAGINATA*, TWO IN THE NORTHERN PENNINES, ENGLAND AND TWO IN SOUTHERN SCOTLAND. P = NUMBER OF PATCHES SAMPLED; R = NUMBER OF RAMETS SAMPLED; G = NUMBER OF PUTATIVE GENETS (CLONES); R/G = MEAN NUMBER OF RAMETS PER GENET

	P	R	G	R/G
ENGLAND				
Dufton Fell	5	31	8	3·88 ± 1·81
Green Fell	3	16	3	5·33 ± 2·08
SCOTLAND				
Bught Hill	9	23	12	1·92 ± 0·90
White Shank	3	6	3	2·00 ± 0·00
Total	20	76	26	2·92 ± 1·79

genet being spread over at least 6 m (Site C) (Fig. 1). Where multi-clonal patches were detected, the ramets were spatially aggregated, with adjacent samples having identical genotypes. An example of a RAPD banding profile is shown in Figure 2.

No multilocus genotypes were detected that were shared between patches. All patches and populations contained different multilocus genotypes (genets) (Fig. 1).

DISCUSSION

Carex vaginata populations in England consist of a series of plants sharing multi-locus RAPD profiles. This is consistent with the presence of several clonal mats. The finding of these extensive clonal mats at the two English populations of *C. vaginata* supports the notion that the species has been present at these sites for a long period of time, rather than being a recent colonist. Cessation of grazing following the foot and mouth outbreak has resulted in the sedge becoming more conspicuous as it has been allowed to grow and flower in the absence of extensive sheep cropping.

Without a reliable estimate of clonal growth rates in *C. vaginata*, assessing the ages of these

populations is difficult. A similar study on clonal diversity on another rhizomatous sedge (*C. bigelowii* in Iceland), has, however, estimated a relatively slow growth rate with new ramets being produced on average 3·4 cm apart every 1·5 years (Jonsson 1996). If the rates of clonal spread in *C. vaginata* are similar, then a (highly speculative) extrapolation would suggest that the maximum clone size detected here (e.g. at least 6 m in Patch C at Green Fell), would indicate a persistence of the species at these sites in excess of 250 years. Of course such an estimate should be interpreted with extreme caution as there are many confounding variables, but it does seem safe to conclude that the plant's arrival is at least not very recent, and its existence at the site is likely to far pre-date the Flora of Cumbria surveys. Indeed, *C. vaginata* in the northern Pennines may represent another example of a "relict" species whose presence may be measured in thousands of years, as has been postulated for other species within the Upper Teesdale flora (Clapham 1978).

On both Dufton Fell and Green Fell, multi-clonal patches were detected. This suggests that sexual reproduction has been important in producing diversity within these English populations, and that genotypic diversity has been maintained, despite long-term intensive grazing. However, the apparent restriction of genotypes to single patches at these and the Scottish sites (no genotype was found in more than one patch) suggests that founding of new patches within populations is due to seed and not vegetative dispersal. Thus although the species, and some level of clonal diversity, has persisted under heavy grazing, it is evident that repeated removal of flowering spikes by grazing is likely to retard the dispersal ability of the species, and decrease the likelihood of colonisation of new patches. It is also worth noting that if heavy grazing reduces opportunities for sexual reproduction, then by definition this also reduces the opportunities for new genotypes to be produced. With a limited production of new genotypes, there will be a limit to the raw genetic material available for natural selection, and hence a limit to the opportunities for the species to adapt at these sites in the face of future environmental change. Thus a long term reduction in grazing in the northern Pennines may not only be beneficial for the performance of these plants in the short term, but may also maximize their chance of survival and evolution in the longer term.

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Could *Centaurium scilloides* (L. f.) Samp. (Gentianaceae), Perennial Centaury, have colonised Britain by sea?

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ABSTRACT

The hypothesis that the disjunct distribution pattern of the western European endemic *Centaurium scilloides* can be explained by dispersal of seeds in sea water has been tested. The Welsh genotype was found to be self-compatible and one plant produced 11500 seeds in its second year alone. About one third of the seeds floated in sea water for up to 14 days, and 18% of seeds floated for at least 28 days, and they retained 95% viability. The results are consistent with, but do not prove, the hypothesis that *C. scilloides* could have colonised Britain by sea.

KEYWORDS: Dispersal, germination, pollination.

INTRODUCTION

The western European endemic *Centaurium scilloides* (L. f.) Samp. (Gentianaceae), Perennial Centaury has a series of disjunct populations scattered up the Atlantic coasts from Portugal to Wales, and occurs in the Azores (Figure 1; Rich *et al.* 2005). This disjunct distribution pattern could be relict from fragmentation of a more continuous distribution earlier in this interglacial, or could have resulted from a series of dispersal events from southern donor colonies to new sites in the north after the last glaciation. The latter has been found for coastal species such as *Cakile maritima, Carex arenaria* and *Eryngium maritimum* which are believed to have survived the last glaciation in refuges in SW Europe and North Africa, and have since re-colonised northern Europe showing decreasing genetic diversity northwards (Clausing *et al.* 2000, Jonsson & Prentice 2000).

In Britain *Centaurium scilloides* is currently only known from one native site in Pembrokeshire, Wales, where it is locally frequent along about 3 km of dune and sea cliff; it also formerly occurred at two sites in Cornwall, one near Land's End and the second on the north Cornish coast (Rich *et al.* 2005). These British localities are somewhat isolated from the French and Spanish populations (the nearest populations occurring in Normandy and Brittany), but their coastal location suggests that dispersal to them could have occurred by seeds floating in the sea from France. The seeds of *C. scilloides* are *c.* 0·3–0·4 mm diameter and have no obvious dispersal mechanism other than being shaken out of the fruiting capsules. Tchernia (1980) provided maps of February surface currents in the Atlantic Ocean, which are also summarised in Figure 1 (his maps are amongst the most detailed available, and likely to be representative of summer currents when seeds would be dispersed). There is a general clockwise water circulation driven by the North Atlantic Drift current, with a divergence south-west of Ireland, and local circulation within the Bay of Biscay. Overall, the frequency of the currents is somewhat irregular (Tchernia 1980). Local currents may differ from the overall picture, and Nelson (2000) gives a more detailed map of sea currents for Britain: in south-west Britain there are easterly currents from Dorset eastwards, westerly water movements along the south Devon and Cornish coasts, and northerly currents along the north Cornish and Devon coasts towards Wales and the Irish Sea. The combined directions of the Atlantic and local sea currents indicates that there is potential for sea water currents to account for at least some of the observed distribution pattern of *C. scilloides*, though it should be noted that the currents at the time that dispersal might have originally happened may be different to what they are now.

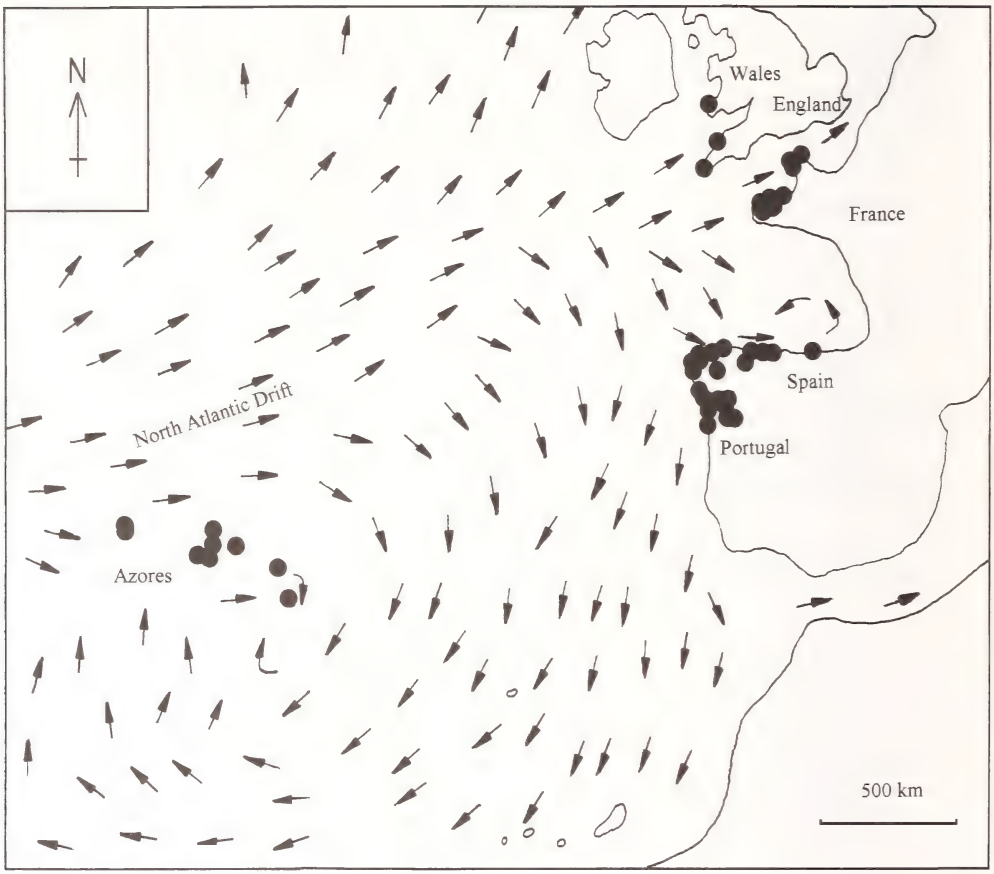


FIGURE 1. Distribution of *Centaurium scilloides* (•, after Rich *et al.* 2005) and direction of February surface water currents in the Atlantic Ocean (→, redrawn from Tchernia 1980).

For the distribution pattern to be explained by dispersal in the sea, two predictions would have to be met. First, seeds must float in sea water and remain viable. Second, to establish a population from a single seed, individual plants should also be self-compatible and produce fertile seeds. Observations and experiments were carried out to test these two predictions.

METHODS

One plant was grown from seed collected from the sea cliffs north of Newport, Pembrokeshire, Wales and cultivated by itself in an open, unheated greenhouse in Cardiff (the Cornish genotypes could not be tested as the populations are extinct). The plant flowered profusely in its second year, when observations were made on its floral biology by following marked flowers through their development. Four flowers had anthers removed in bud before anthesis. At the end of the summer, capsules were harvested and the mature seeds counted. The number of seeds per capsule was compared with seed production from the wild populations at Newport with open pollination, and with another plant from Sussex with open pollination, cultivated at the National Botanic Garden of Wales.

The harvested seeds were stored for about eight weeks at room temperature before being used for the flotation experiments. Samples of 100 seeds were dropped into *c.* 75 ml of sea or fresh

water in white plastic beakers and stirred to simulate wave action. Pots were stirred again each day, and the number of seeds floating counted after stirring. Water volumes were maintained by topping up the beakers with tap water.

For the germination experiments, all seeds (floating and submerged) were taken from the beakers and flushed with fresh tap water, and then placed on wet filter papers in Petri dishes in warm and light conditions to germinate. After a month, minor mould development began on the filter paper in some dishes. The germination experiment was terminated after three months.

RESULTS

The single isolated plant of *C. scilloides* flowered profusely in its second year, producing 59 flowers between June and August. It set abundant seed (Table 1) and it is therefore self-compatible. Extrapolation from counted samples indicates that this one plant produced about 11500 seeds in this second year. It is a polycarpic perennial and flowered even more profusely in its third year. Removal of the anthers from unopened flowers resulted in a reduction in mean seed set of about 40% (Table 1), indicating that some cross-pollination must have occurred for them to set seed, though no pollinators were observed visiting the flowers. A comparison of the numbers of seeds per capsule from this cultivated plant with capsules collected from wild populations with open pollination shows that the seed set per capsule is very similar (Table 1), though again rates of self- and cross-pollination are not known.

Observations on the floral biology showed that individual flowers followed the same general sequence but varied in rate of development. In bud, the stigma is located at about the middle of, and between, the undehisced anthers. The flowers open in bright weather by mid-morning and close in the evening; they may remain closed all day in very dull or in wet weather. The flowers are about 17–18 mm in diameter, are slightly cupped and have a bright pink corolla but have no discernible scent. The bright yellow anthers dehisce in sequence, slowly twisting and curling exposing yellow pollen on the outer sides, and the filaments slowly elongate. The stigma and style initially may or may not be bent slightly to one side of the stamens, and may or may not move upright during the day and come into contact with the anthers, but the stigma does not appear to be receptive at this stage. Three, four or all five anthers may dehisce in turn on the first day, any remaining anthers dehiscing the following day. By the third day, the filaments have elongated taking the dehisced anthers above the level of the stigma, which again may or may not be strongly bent to one side. The stigma becomes strongly bi-lobed on the third day when, presumably, it becomes receptive to pollen. The flowers may open for a further two days with the stigma in similar condition. When the flowers close, they may force the stigma to come into contact with the anthers thus allowing self-pollination, and pollen may also be deposited on the petals. Four to seven days after opening, the flowers close and do not open again, and the pink coloration fades whitish. The flowers thus are adapted for cross-pollination if there are suitable pollinators, but will self-pollinate if not cross-pollinated.

TABLE 1. NUMBER OF SEEDS PER CAPSULE OF *CENTAURIUM SCILLOIDES* WITH VARIOUS POLLINATION TREATMENTS

Source	Treatment	Number of seeds per capsule	Mean
Newport, cultivated plant	Isolated plant, intact flowers, open pollination	83, 169, 177, 196, 203, 224, 245, 261	195
Newport, cultivated plant	Isolated plant, anthers removed, open pollination	4, 103, 171, 199	119
Newport, wild population 1	Open pollination	163, 214, 243, 281	225
Newport, wild population 2	Open pollination	142, 174, 194, 239	187
Newport, wild population 3	Open pollination	9*, 185, 264, 271	199
Sussex, cultivated plant	Open pollination	93, 120, 157, 184	139

* small atypical capsule

TABLE 2. NUMBER OF SEEDS FLOATING IN SEA AND FRESH WATER WITH TIME, WITH FINAL PERCENTAGE GERMINATION

Treatment	1 day	2 days	4 days	7 days	14 days	21 days	28 days	final germination
Control	-	-	-	-	-	-	-	80%
Sea water + detergent	0	-	-	-	-	-	-	-
Fresh water + detergent	0	-	-	-	-	-	-	-
14 days fresh water	70	68	64	60	30	-	-	86%
21 days fresh water*	32	31	31	28	19	3	-	95%
1 day sea water	41	-	-	-	-	-	-	78%
2 days sea water	41	39	-	-	-	-	-	72%
4 days sea water	55	55	49	-	-	-	-	88%
7 days sea water	42	41	39	38	-	-	-	88%
14 days sea water	68	59	59	56	47	-	-	93%
28 days sea water	54	54	53	48	30	19	18	95%
Average	50·4	49·6	49·2	46	31·5	11	18	87%

* Initially planned for 28 days but terminated following significant germination under water.

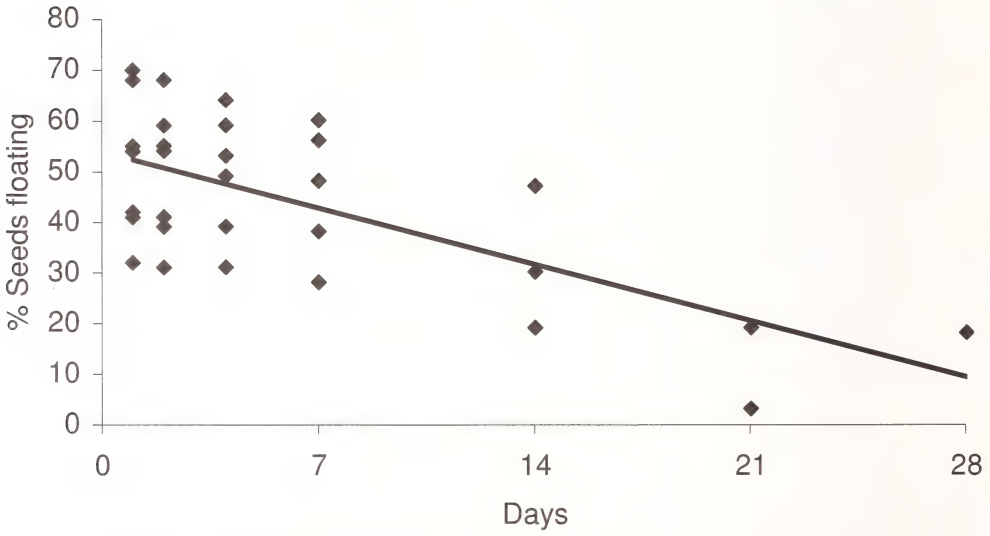


FIGURE 2. Number of seeds floating with time for all treatments. A best fit line is also shown

The numbers of seed floating with time for each treatment is shown in Table 2 and plotted in Figure 2. About 66% of the seeds floated initially, but a further third sank on first stirring. Groups of 5–15 seeds often floated together. Addition of a small drop of household detergent to additional samples of 100 seeds in both sea and fresh water resulted in all seeds sinking immediately, indicating the role of surface tension in flotation. About one third of the seeds floated in sea water for up to 14 days, but stirring is a poor substitute for turbulent water at sea. 18% of seeds floated for at least 28 days in sea water, and retained high viability in all treatments (mean 87%; Table 2).

Germination was first observed after 18 days in the Petri dishes. After 20 days a large flush of

germination was also observed happening under water in the 28 days fresh water treatment, which was therefore terminated and the seeds were transferred to a Petri dish for further germination. Seeds from sea water and control treatments germinated slowly over time, typically 3–4 per day, rather than in one flush. The final percentage germination was generally very high (Table 2), with both the three weeks fresh water and four weeks sea water treatments achieving 95% germination. There was an interesting minor trend suggesting that the longer the immersion in water the higher the percentage germination (for all treatments combined $r = 0{\cdot}82$, 7 d.f., $p = 0{\cdot}01$).

DISCUSSION

The pollination and flotation results are consistent with, but do not prove, the hypothesis that *C. scilloides* could have colonised Britain by sea from French populations. The Welsh genotype of *Centaurium scilloides* is self-compatible, and the one plant produced thousands of viable seeds in its second (and subsequent) year; the Welsh populations could therefore establish from a single seed. Seeds can float in sea and fresh water by surface tension for significant periods of time, and they are still viable after immersion in sea water for at least four weeks. Extrapolation of the best fit line in Figure 2 suggests that they would float for only five weeks. Seeds of quite a number of plants are well known to float in sea water and remain viable, at least for short periods (Nelson 2000). Dispersal by sea is thus most likely to have been by a series of short sea current dispersal events, perhaps from Brittany or Normandy to Cornwall and then to Wales, rather than by multiple long distance events.

Whether dispersal by sea from the mainland could also explain the localities in the Azores is another matter. The Azores populations differs from the mainland European populations in being generally white-flowered and with narrow leaves, and are likely to be derived from the mainland population rather than *vice versa* (Rich *et al.* 2005). The Azores lie about 1300 km west of Portugal, and, given that the currents between the Azores and mainland Europe are typically less than 12 nautical miles per day (Tchernia 1980), seeds would perhaps have to float for four months to reach the Azores. Schäfer (2003) thought *C. scilloides* seeds were dispersed by both wind and water, but he regarded dispersal by birds as the main mechanism by which native species have arrived on the Azores, with wind dispersal uncommon and sea dispersal rare. It is also possible that *C. scilloides* could also have arrived in Britain by birds or wind.

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Conservation of Britain's biodiversity: *Hieracium radyrense* (Asteraceae), Radyr Hawkweed

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ABSTRACT

Hieracium radyrense (Pugsley) P. D. Sell & C. West (Asteraceae), Radyr Hawkweed is a very rare endemic species restricted to Radyr, Glamorgan (v.c. 41), Wales. It was first found in 1907, and was described as a variety in 1948 and as a species in 1955, and belongs to *Hieracium* Section *Vulgata*. It has been seen only a few times since it was first found. Surveys between 1998 and 2004 indicate that only one population with 20–25 plants survives, and it is extinct in two other sites. Neither the species nor the site has any legal protection, and it is under significant threat of extinction. Seed has been deposited in the Millennium Seed Bank, and it is being grown in cultivation.

KEYWORDS: Compositae, endemic, rare species, Wales.

INTRODUCTION

Hieracium radyrense (Pugsley) P. D. Sell & C. West (Asteraceae), Radyr Hawkweed, or Heboglys Radyr in Welsh, is a very rare, endemic plant, restricted to Radyr in Glamorgan (v.c. 41), South Wales. It is included in the 3rd edition of the national vascular plant Red Data Book (Wigginton 1999), and it is a Red Data Book species and a Local Biodiversity Action Plan species in Cardiff (Cardiff County Council 1996, 2001). It has been seen only a few times since it was first found, and little is known about its distribution or ecology. In 1998 a joint project was set up between Cardiff County Council and the National Museums & Galleries of Wales to establish its current status and determine its needs for conservation. The project is summarised here; fuller details are given in Hutchinson & Rich (1998, 2003).

TAXONOMY AND IDENTIFICATION

The history of *H. radyrense* was set out by Pugsley (1948). Plants which were eventually named *H. radyrense* were collected from Radyr Quarry in 1910 but were originally determined as *H. cacuminatum* Dahlst. Initial comments by H. J. Riddelsdell, J. A. Wheldon and E. S. Marshall that some of the plants at Radyr could be a distinct taxon were published in 1912 (Wheldon 1912), where the plant was referred to as *Hieracium sciaphilum* Uechtr. forma *paucifolia* Ley. Roffey (1925) referred the Radyr plants to *Hieracium paucifoliatum* Jord., but as this was not known as a British species Pugsley (1948) named it *H. lachenalii* Gmelin var. *radyrense* Pugsley. Sell and West (1955) subsequently raised it to species level as *Hieracium radyrense*, its currently accepted rank (Sell & Murrell 2005).

The main identification features are the broadly ovate-lanceolate, acute basal rosette leaves, with sharp, spreading, unequal teeth interspersed with fine teeth with the lowest teeth longest and spreading out from the subtruncate base, with simple hairs on the surfaces and margins. There are 2–3(–5), ovate-lanceolate, acuminate stem leaves which are irregularly and sharply toothed and sometimes laciniate-dentate towards the base. The involucral bracts are linear-lanceolate, acute, and have dense stellate hairs and unequal glandular hairs and rarely a few long simple eglandular hairs. The ligules are hairy at the apex. The styles are yellowish becoming fuscous (brownish). P. D. Sell considers the diagnostic characters to be the marked teeth on tne rosette leaves and the dense stellate hairs on the involucral bracts (a few simple hairs present or not). The plant is illustrated in Figure 1.

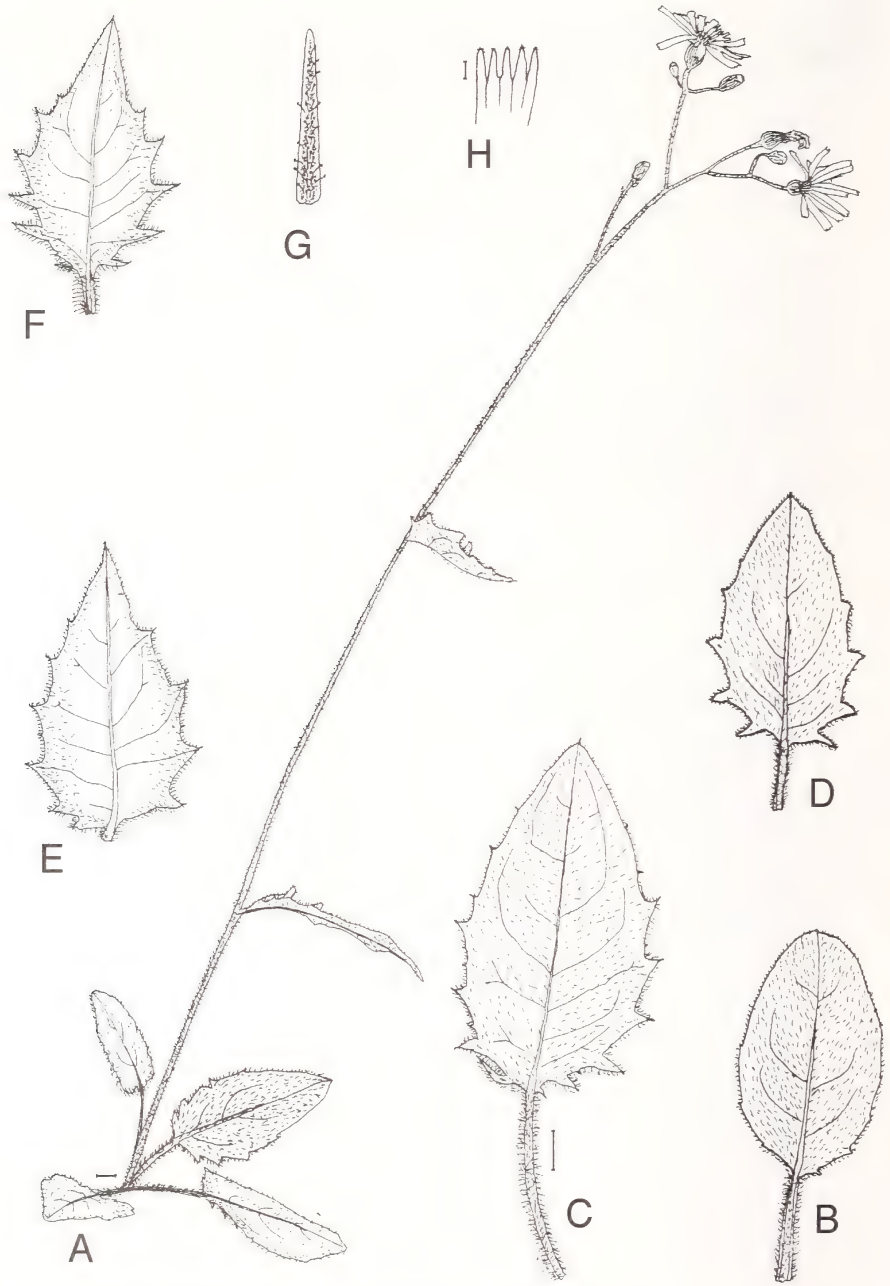


FIGURE 1. *Hieracium radyrense* (del. TCGR). A, plant. B, outer rosette leaf. C–D, inner rosette leaves. E–F, stem leaves. G, involucral bract. H, pilose ligule tips. Scale bars A–F 1 cm, G–H, 1 mm.

Hieracium radyrense belongs to Section *Vulgata* (Griseb.) Willk. & Lange, and it is reasonably closely related to other species in the Section. It is presumably a neoendemic which may have evolved from another extant member or extinct member of the Section since the last Ice Age.

DISTRIBUTION AND POPULATION SIZE

Locality and habitat information in the archives at the National Museums & Galleries of Wales, the literature and herbaria (**BEL**, **BIRM**, **BM**, **CGE**, **LIV**, **MANCH**, **OXF** and **NMW**) has been compiled. Field surveys were carried out between 1998 and 2004.

RADYR (ST17-ST18)

Hieracium radyrense was first collected from Radyr by H. J. Riddelsdell in 20 July 1907 (**BM**). Nearly all roadsides around Radyr were searched in 1998 and 1999, but the area is now one of the suburbs of Cardiff and no surviving plants could be found.

RADYR QUARRY (ST1379-ST1479)

H. J. Riddelsdell collected *H. radyrense* at Radyr Quarry on 18 July 1910 and again on 3 June 1911 (**BEL**, **BM** (holotype), **CGE**, **LIV**, **OXF**, **NMW**). It was recorded again by C. West in June 1955 (**CGE**). The BSBI *Hieracium* Group saw one plant nearly in flower on the densely tree-covered quarry-face on 8 June 1985 (Bevan 1985). No plants were found in 1998 or 1999.

The quarry was active by 1844 but had ceased by the 1930s, and it was then commandeered as a rubbish tip and in-filled (Radyr and Morgantown New Horizons History group 1991, 1993). *Hieracium radyrense* survived on the quarry cliffs until the 1980s, presumably shade from colonising trees causing the decline.

DANYBRYN, RADYR (ST130806)

The earliest *H. radyrense* record for this site is Radyr (drive), 4 July 1953, C. Andrews, C. West and 'J. C.' (**BIRM**), and it is probably also the site seen by B. A. Miles on 7 July 1955 with a slightly inaccurate grid reference (**CGE**). The BSBI *Hieracium* Group saw it on 8 June 1985 (**BM**, Bevan 1985).

Nine flowering plants were found at Danybryn on 24 July 1998 (**NMW**). On 6 July 1999, 13 flowering plants and 12 possible rosettes were counted. On 20 June 2003, 12 flowering plants with at least seven vegetative rosettes were counted (photographs in **NMW**).

QUARRY NORTH OF MORGANSTOWN, RADYR (ST127822)

A specimen collected on 18 August 1965 by J. N. Mills from the disused quarry north of Morganstown, Radyr is labelled *H. radyrense* (**MANCH**), but lacks a basal rosette. The quarry was searched in 2003 and 2004 but only *H. cinderella* (Ley) Ley (det. D. McCosh) could be found; this looks very similar to *H. radyrense* but differs in having weakly toothed rosette leaves, one stem leaf and sparse stellate hairs on the phyllaries. It is likely that the **MANCH** material is also *H. cinderella*.

COURT COLMAN, BRIDGEND (SS8881)

Cultivated material originating from a wall at Court Colman, Bridgend collected by H. J. Riddelsdell on 1 July 1915 is held in **CGE** and was named *H. radyrense* and reconfirmed by P. D. Sell in 1998 (this specimen is the basis of the record in Perring (1968) and Ellis (1983) which was rejected by Wade *et al.* (1994)). Searches of the area in 1998 and 2003 revealed only one population of a similar-looking plant which when cultivated was found to clearly differ from *H. radyrense* in leaf shape and toothing. Re-examination of the 1915 specimen in **CGE** in 2000 showed it to consist of one inflorescence with one detached leaf (probably from a stem) lacking a basal rosette, and in all probability is the same as the plant still present; the 1915 specimen is considered by T. Rich to be inadequate for identification, and the record is not accepted.

There are also a number of erroneous records for the Radyr and Cardiff area, and some material in herbaria is incorrectly named as *H. radyrense*. We have seen no other material to support Roffey's (1925) claim to have seen it elsewhere in South Wales. An updated distribution map is given in Figure 2.

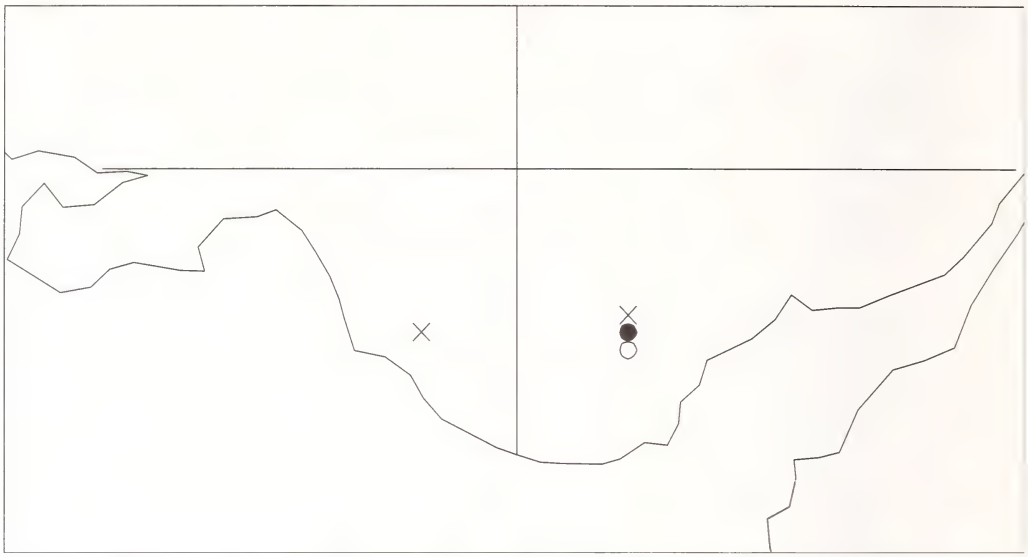


FIGURE 2. Tetrad distribution map of *Hieracium radyrense* in South Wales. ● 1998–2004. ○ Extinct. × Error.

BIOLOGY AND ECOLOGY

Hieracium radyrense is a polycarpic perennial. It is assumed to be an apomictic polyploid like most other British *Hieracium* species, but this has not been investigated. Plants vary in flowering time from late May in cultivation to early June or early July in the wild, and they usually finish flowering by August. In both cultivation and in the wild, plants have lived for at least seven years.

There appears to be nothing particularly special about the habitats from which it has been recorded. At Danybryn *H. radyrense* grows mostly on the grassy driveway bank and lawn which are cut once or twice a year, under the partial shelter and shade of trees and shrubs. The soil is probably derived from the underlying marl of the Lower Devonian Old Red Sandstone (British Geological Survey 1986) and is a fine, light brown soil, pH 7·3. At Radyr Quarry it grew on rocks of the Llanishen Conglomerate which is also part of the Lower Devonian Old Red Sandstone. It has been recorded from altitudes of c. 60–80 m.

At Danybryn the following species were recorded with DAFOR cover ratings growing with or close to *H. radyrense*: *Agrostis capillaris* L. F, *Brachypodium sylvaticum* (Hudson) P. Beauv. O, *Cornus sanguinea* L. R, *Cotoneaster horizontalis* Decne. R, *Epilobium ciliatum* Raf. O, *Fagus sylvatica* L. R, *Geranium robertianum* L. O, *Glechoma hederacea* L. O, *Hieracium diaphanum* Fries O, *Hieracium sabaudum* L. O, *Hieracium stenstroemii* (Dahlst.) Johanss. O, *H. submutabile* (Zahn) Pugsley R, *Holcus lanatus* L. O, *Hypochaeris radicata* L. F, *Ilex aquifolium* L. R, *Pinus nigra* J. F. Arnold O, *Plantago lanceolata* L. O, *Primula vulgaris* L. O, *Prunella vulgaris* Huds. O, *Quercus* × *rosacea* Bechst. R, *Senecio jacobaea* L. R, *Sequoiadendron giganteum* (Lindl.) Buchholz R, *Solidago virgaurea* L. F, *Stachys sylvatica* L. O, *Taraxacum* sp. O, *Teucrium scorodonia* L. R, *Trifolium medium* L. O, *Viburnum tinus* L. R, *Viola riviniana* Rchb. O and the bryophytes *Atrichum undulatum* (Hedw.) P. Beauv. O and *Mnium hornum* Hedw. O. The garden vegetation does not fit any recognised plant communities.

Many of the stem leaves of all the hawkweeds in the Radyr area observed during July 1998 had leaf-roll caused by toxins in the saliva of aphids feeding on the leaves (J. Deeming, pers. comm. 2004). In cultivation, the lower parts of the plant often become covered in mildew.

CONSERVATION

Our 1998–2004 surveys show *H. radyrense* is now confined to one of the three sites, with a total population of about 20–25 plants.

Neither the species nor the site has any legal protection, and it is under significant threat of extinction. Under the IUCN Threat Criteria (IUCN 2001) it qualifies as Critically Endangered. Its inclusion as a Red Data Book species nationally and in Cardiff, and in the Local Biodiversity Action Plan process (Wigginton 1999, Cardiff County Council 1996, 2001) help to raise its profile but provide no long term security. The site is currently being managed with care by the owners, with grass-cutting in the immediate area of the plants being limited until at least mid-August which will allow seeds to mature, but the population is precariously small and subject to chance mismanagement.

Hieracium radyrense has been cultivated by T. Rich since 1998, and several batches of seed from it have been sent to the Millennium Seedbank, Wakehurst Place. Material is also in cultivation at the National Botanic Garden of Wales.

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Notes

CARDAMINE ×FRINGSII F. WIRTGEN (BRASSICACEAE) IN THE BRITISH ISLES

The hybrid *Cardamine flexuosa* With. × *pratensis* L. = *C.* ×*fringsii* F. Wirtgen (= *C.* ×*haussknechtiana* O. E. Schulz) has been reasonably widely recorded in the British Isles, but is probably overlooked. In this note the records are summarised and mapped for the first time.

The main characters separating *C.* ×*fringsii* from its parents are given in Table 1. *Cardamine* ×*fringsii* can be easily picked out from both parents at flowering by the intermediate size of the petals and their lilac or more rarely white coloration, and its failure to set fruit (it should be noted that *C. pratensis* is self-incompatible and often does not set seed). The plants can reproduce vegetatively and spread to form patches of clones (Allen in Jones 1975; Bevan & Rich 1991). The clones may differ depending on which race of the polymorphic and cytologically complex *C. pratensis* (Hussein 1955; Lövkvist 1956; Allen 1981) was involved. In the past, many specimens were incorrectly and inconsistently referred to *C. pratensis* L. var. *hayneana* (Welwitsch) Schur, a taxon now regarded as meriting subspecific rank but probably confined to central Europe.

Except where stated otherwise, the records below have been determined by one or other of us. Pollen fertility examined using Alexander's Stain (Alexander 1969) ranged from 0% to c. 20% unless otherwise stated.

v.c. 5, South Somerset. Higher Mill, Exford, undated, C. P. Amhurst (**BM**).

v.c. 9, Dorset. Island in the Stour, Shapwick Vicarage, Shapwick, subsequently cultivated in garden, 3 April 1892, 23 April 1893, 4 May 1893, labelled as E. F. Linton (**BM**, **CGE**, **DBN**) but he later attributed the record to W. R. Linton (Linton 1900).

[There is a record for Lydlinch Common, ST7313, 2001, H. J. M. Bowen in his card index of Dorset records but no voucher has been seen. A Biological Records Centre record for SY88 tetrad U, 1987+, is not included in Bowen's files and is assumed to be an error.]

v.c. 13, West Sussex. Parkhurst, by brook towards North Chapel, 25 April 1924, J. E. Little & R. J. Burdon (**CGE**). Roadside near Bignor, 9 May 1930, P. M. Hall (**BM**).

v.c. 14, East Sussex. Chailey Common, by pond, 5 May 1933, J. E. Lousley (**RNG**). Roadside, Chailey Common, 23 May 1936, A. H. Wolley-Dod (**BM**, Wolley-Dod 1937; det. H. W. Pugsley as 'first parent uncertain'). Chailey Common, grassy heathland in a slightly moist pit, 26 April 1952, D. P. Young (**BM**). Horncastle Wood, Twyford, TQ394315, one plant on woodland ride with very pale pink flowers with both parents, 1994, D. Bevan & T. C. G. Rich; it did not persist into 1995 (Rich *et al* 1996). Meres Farm, Five Ashes, TQ575252, 27 April 1994 (still present in 2002), Miss E. J. Rich (**BM**). Ditch by track, Meres Farm, Five Ashes, 20 May 1997, O. M. Stewart (**E**). Paiges Wood, Haywards Heath, TQ317248, 23 April 1993, Miss G. Barter (specimen not retained). Wakehurst Place, marshy ground by the lake, 24 April 1967, J. P. M. Brenan (**K**). Waldron 'flowers mauve; a good intermediate', E. D. Morgan (**BM**, Wolley-Dod 1937).

TABLE 1. MAIN CHARACTERS SEPARATING *CARDAMINE FLEXUOSA*, *C. PRATENSIS* AND THEIR HYBRID *C.* ×*FRINGSII*

	C. flexuosa	*C.* ×*fringsii*	*C. pratensis*
Habit	Annual or biennial (rarely perennial)	Perennial	Perennial
Stems	Usually hairy	Usually glabrous	Usually glabrous
Upper leaf surface	Hairy	Hairy to glabrous	Sparsely hairy to glabrous
Sepal length	1·5–2·5 mm	2·1–3·7 mm	2·7–5·3 mm
Petals	2·1–4·4(–5.0) mm long, white	4·4–10·3 mm, white, pale lilac or lilac	6·1–15·5(–18) mm long, purple, pink, lilac or white
Seed set	Good	Not set	Variable

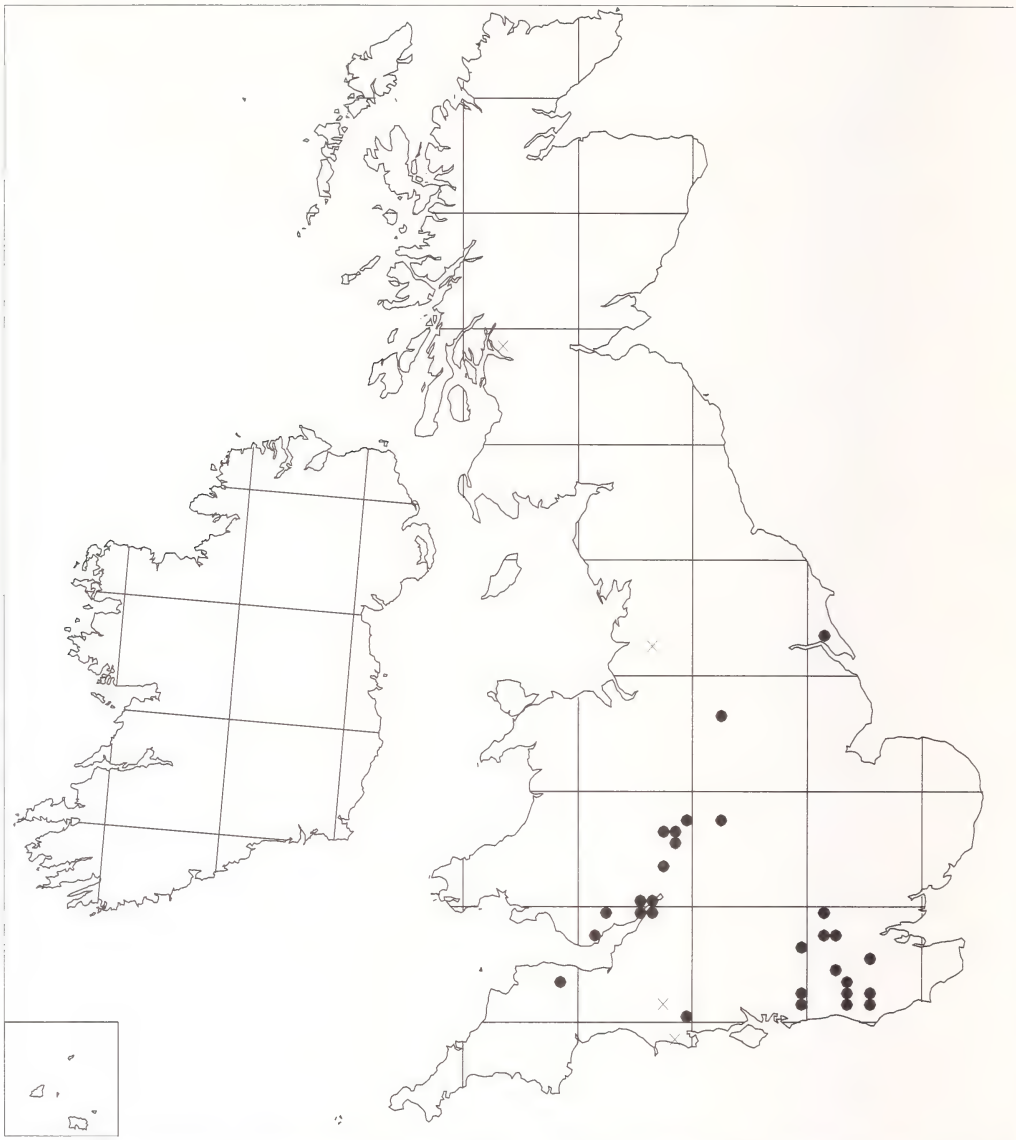


FIGURE 1. Distribution of *Cardamine* ×*fringsii* F. Wirtgen (= *C. flexuosa* With. × *pratensis* L.) in the British Isles (•). Probable errors or unconfirmed (×).

v.c. 16, West Kent. Verge, Sevenoaks Common, Hopgarden Lane, TQ524533, 10 May 2001, E. G. Philp (**NMW**).

v.c. 17, Surrey. Kew, bank of Thames near iron railway bridge, 1879–1882, G. Nicholson (**ABD**, **BIRM**, **BM**, **CGE**). Mortlake, banks of Thames, willow beds, 26 May 1879, 1880 and 1882, G. Nicholson (**ABD**, **BM**, **K**, **NMW**, **OXF**, some of which is cultivated material). Damp ditch close to Povey's Cross, Horley, 30 April 1882, W. H. Beeby (**ABD**, **BM**, **CGE**).

v.c. 21, Middlesex. Bentley Priory, flush, April 1989, D. Bevan & T. C. G. Rich (**NMW**; see Bevan & Rich 1991).

v.c. 22, Berks. Ascot, 5 July 1932, A. H. Carter (**BM**). Ascot, 12 July 1932, A. J. Wilmott (**BM**). Under trees in meadow very near Ascot station, 8 July 1933, J. E. Lousley (**RNG**).

v.c. 34, West Gloucester. Forest of Dean near Bream, 7 April 1878, W. A. Shoolbred (**NMW**). Meadow, Stone, 1959, P. G. Munro-Smith (Sandwith & Sandwith 1959; no material traced). Wet meadows about Anwards Farm and Pighole, Tidenham, 30 April 1908, W. A. Shoolbred & H. J. Riddelsdell (**BM**, **NMW**).

v.c. 35, Monmouth. Barnett Woods, 7 May 1890, W. A. Shoolbred (**NMW**). Pontnewydd, marshy field, 3 June 1946, A. E. Wade (**K**, **NMW**, **OXF**; Wade 1948).

v.c. 36, Hereford. Bronsil, marshy stream side, one plant, 1955, C. E. A. Andrews (possibly in **BIRM**, untraced).

v.c. 37, Worcester. Bromsgrove, near, 1901, H. S. Thompson (**BM**). Hindlip Church, F. R. Jeffrey (Rea 1920; accepted on basis of following record). Near Hindlip Church, 1 May 1921, C. Rea (**BM**). Near Ockeridge Wood, F. R. Jeffrey (Rea 1920; no material traced). Lane near Lineholt, Stourport-on-Severn, 28 May 1949, C. M. Goodman (**LTN**).

v.c. 38, Warwick. Balsall Street, swampy meadow, SP223763, 22 April 1989, J. W. Partridge (**NMW**). Still present in 2002.

v.c. 41, Glamorgan. St Fagans, Cardiff, petals small, white with purple tips, 13 April 1972, J. W. Davis (**NMW**).

v.c. 57, Derby. Wet meadow bordering stream, white-flowered with both parents, Darley Dale, D. Dupree, May 2004, 2005 (**NMW**).

[v.c. 59, South Lancaster. There is a single BSBI Maps Scheme record for the 10-km square SD62 in the v.c. 59 card index without any further details (V. Gordon, D. P. Earl, pers. comm. 2001); the record is not accepted.]

v.c. 61, South-east York. Gibraltar Farm, Swine, Hull, meadow with both parents, 23 May 1904, J. F. Robinson (**BM**; petals noted as pure white; pollen c. 40% fertile). This appears to be the material noted as *C. amara* × *pratensis* by Robinson (1906); oddly both W. Whitwell and A. Bennett had seen the material and suggested *C. flexuosa* × *pratensis* but Robinson appears to have ignored them, perhaps on the basis of the pure white flowers. It appears to have persisted from at least 1898 to 1910.

[v.c. 99, Dunbarton. There is a single record cited for v.c. 99 in Jones (1975) but its origin is unknown (A. Rutherford, C. A. Stace, pers. comms. 2001) and it is not accepted.]

It is noteworthy that the generally southern distribution of the hybrid (Fig. 1) coincides with the area of relative high frequency of tetraploid *C. pratensis* (with aneuploid chromosome number of 2n = 30) in southern Britain as reported by Hussein (1955). This might be expected from the results of Lövkvist (1956), who found that *C. flexuosa* × tetraploid *C. pratensis* was relatively easy to synthesise, but only with *C. flexuosa* as the female parent; crosses with higher chromosome races were unsuccessful.

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WHAT IS *ROSA ALBA* L.?

The name *R. alba* L. is traditionally applied to the white rose of York, the badge of the Yorkist faction in the 15th century Wars of the Roses. Early accounts considered it a separate species but now the general consensus of opinion is that it is a garden plant of ancient hybrid origin.

There have been a number of opinions propounded by various authors (cf. references) as to the parentage of this hybrid rose, most often involving the species *R. arvensis, R. gallica*, *R canina* and others. In such an ancient hybrid it is likely that introgression and back-crossing have occurred. It is generally accepted that *R.* ×*alba* has a chromosome number of 2n = 42. This could result from a cross between a tetraploid (2n = 28) as male and an unbalanced polyploid (2n = 35) as female. It could also be an amphidiploid (2n = 42) derived from a triploid (2n = 21) hybrid such as *R. arvensis* × *R. gallica*.

There are three original elements for this Linnaean name: a Herb. Burser specimen in **UPS** seen by Linnaeus, a **LINN** specimen and an illustration by Besler (1613). The latter is grossly inaccurate in detail – for example the pedicel is about 6 cm long, has a pair of stipules at the base and a leaf with no stipules arising half way along it. Linnaeus's protologue allows for both single and *flore pleno* forms, the specimen in **LINN** being *flore pleno*.

We have examined the specimen in **LINN** (No. 652.44 LINN.), and Cafferty & Jarvis (2002) used this specimen with our description as the lectotype. They referred to Stearn (1978), who noted that Linnaeus' name refers to an ancient garden rose, and that the material in his herbarium (652.44 LINN) is " an authentic specimen" and agrees with the modern usage of the name.

R. ×*alba* occurs in Britain mainly as a naturalized garden escape and Stace *et al.* (2003) list it as recorded from ten vice-counties. We have examined specimens from four of these plus one additional locality – v.c. 9 (Bere Heath), v.c. 37 (Bentley), v.c. 58 (Prestbury and Gawsworth), v.c. 61 (Driffield) and v.c. 71 (Ramsey). We have also examined specimens at The Gardens of the Rose, St. Albans, Hertfordshire, where we took the opportunity to examine *R. gallica*. Fresh material in fruit was examined from all these places. These specimens, the specimen in **LINN**, a description of the Burser specimen kindly supplied from **UPS**, and the description in Graham & Primavesi (1993) are basically consistent in important characters such as leaf pubescence, glandulosity, armature, hip shape etc., allowing for the inevitable variation in cultivars of an ancient garden rose, and the difficulty of discerning all the characters in the two herbarium specimens.

In our experience, after having examined thousands of specimens in the field and herbaria, the characters of rose hybrids are always intermediate between the two parents. We consider at present that the true parentage of this hybrid is unknown, but we are certain that it is not a hybrid between *R. arvensis* and *R. gallica* as has been suggested by Graham & Primavesi (1993), as examination of these two taxa does not seem compatible with this parentage, the principal differences being:–

a) *R.* ×*alba* has a distinctly grooved stem, absent in both the other two species.
b) *R. gallica* has stems with many glands, pricklets and acicles. We would have expected that some of these to have appeared in *R.* ×*alba* but they are absent in all the specimens examined.
c) *R. gallica* has both glandular leaves and stipules; again these are absent in *R.* ×*alba*.
d) *R. arvensis* has small and simple sepals, in *R. gallica* they are short, broadly triangular, pinnate and glandular, whereas in *R.* ×*alba* they are distinctly longer than either species (up to 3·5 cm), pinnate with long leafy tips and eglandular.
e) *R. arvensis* has a very narrow stylar orifice, about 1/6 the diameter of the disc, in *R. gallica* the orifice is slightly wider, between 1/4 and 1/3 the diameter. It would be expected that, in at least some of the specimens of *R.* ×*alba*, the width of the orifice would be intermediate in size, but we have found none with the orifice less than 1/2 the diameter of the disc.

In our opinion considerable research would be necessary to establish what is the original parentage of this hybrid, and this would involve close cytological and morphological examination of at least a number of continental species.

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We thank Prof. C. A. Stace for obtaining copies of the relevant literature and for advice and helpful comments on the original draft; Prof. B. Jonsell for providing a description of the Burser specimen; Dr J. Marsden for allowing access to the **LINN** specimen and Dr C. E. Jarvis for additional background information.

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ERICA MACKAIANA BAB. AND *ERICA* ×*STUARTII* (MACFARL.) MAST. (ERICACEAE): TWO HEATHERS NEW TO SOUTH KERRY (V.C. H1), IRELAND

The flora of County Kerry (which is divided into two vice-counties, v.c. H1 South Kerry, and v.c. H2 North Kerry) is comparatively well-known – some of the earliest records of Irish native plants were from that county and it was the subject of one of the finest twentieth-century Irish county Floras, by Dr Reginald Scully (1916). It is, therefore, not only surprising but also of considerable phytogeographic interest to report two new heathers from South Kerry: *Erica mackaiana* Bab. (Mackay's heath), and its hybrid with *E. tetralix* L. (Cross-leaved heath), the Irish endemic *E.* ×*stuartii* (Macfarl.) Mast. (Praeger's heath) (for discussion of the authority of *E.* ×*stuartii*, see Nelson 1995). *Erica mackaiana* is a member of the so-called Hiberno-Lusitanian element of the flora of Ireland (*cf.* Praeger 1934): Preston & Hill (1997) placed this species in the Oceanic Temperate element. Hitherto *E. mackaiana* has been recorded from two separate localities in West Galway (v.c. H16) (see e.g. Praeger 1909; Scannell & McClintock 1974; Webb & Scannell 1983; for distribution map see Nelson 1981), from bogland in West Mayo (v.c. H27) (van Doorslaer 1990), and from the environs of Upper Lough Nacung, West Donegal (v.c. H35) (for distribution map see Webb 1954). Its distribution in Ireland is markedly disjunct, a feature emphasised by the population reported here. Figure 1 is a revised distribution map for the species and its hybrid.

The most extensive population, ranging through an area approximately 8 km from north to south and 5 km from west to east, is that in West Galway (Nelson 1981). The population at Lough Nacung, West Donegal, is the next most extensive, ranging about 2·6 km west to east and north to south (Figure 1 is deceptive: by a quirk of the positions of the 10-km grid lines, the more extensive Connemara population exists within just two 10-km squares, whereas the much less extensive Donegal one occupies twice as many squares.) The West Mayo and Carna (West Galway) populations each occupy only a few hundred square metres, and so are the smallest.

In July 2003, Mr David Edge (Forest Edge Nurseries, Wimborne, Dorset) was on holiday in County Kerry when he noticed a patch of an unusual heather. He collected a few small specimens which eventually reached the present author, and I identified them as *E. mackaiana*. Mr Edge was unable at that time to provide exact details of the locality but when he returned to Ireland in November 2003 he retraced his previous route and sent me the necessary precise details as well as some further specimens which, incidentally, included *E.* ×*stuartii*, thereby also adding that taxon to the county's Flora.

I visited County Kerry between 22 and 24 July 2004 to examine the population that Mr Edge had discovered and to attempt to determine its exact limits. This note reports the results of my research, during which I traced these two heathers within an area extending approximately 2 5 km north to south and an equal distance east to west, and within two separate river catchments. Voucher specimens of the heaths have been deposited in the National Botanic Gardens, Glasnevin, Dublin (**DBN**).

The habitat of the two heathers on the Iveragh Peninsula lies around 5–6 km due east of Cahersiveen, at an altitude ranging between c. 110 m and c. 150 m asl. Mr Edge found *E. mackaiana* growing in the narrow roadside reservation/firebreak on the northern side of the third-class road that links Cahersiveen, via Raheens townland, and Ballaghisheen Pass. The site of discovery (grid reference V574779) lies between two mountain streams, tributaries of Kealafreaghane River (itself a tributary of the River Inny), that flow south from the hill named Caunoge (502 m asl; grid reference V583800). The site is sandwiched between two substantial forestry plantations. *Erica* ×*stuartii* also grows in this reservation, which was evidently deeply ploughed when the plantations were established in the early 1970s (Denis O'Sullivan, Coillte Teoranta, Cahersiveen, pers. comm., 25 August 2004).

On the south side of the road there is a wide (c. 100 m) firebreak through which runs a high-tension electricity transmission line. The blanket peat which covers the terrain in the firebreak under the electricity lines is much less disturbed – it has not been deeply ploughed. In this wide reservation, I was able quickly to find numerous plants that resembled *E. mackaiana* (see below).

I traced both *E. mackaiana* and *E.* ×*stuartii* c. 0·7 km to the east of the original site, to a forestry road (closed by a barrier, grid reference V 580776) that runs north into the plantation. A single shrub of *E.* ×*stuartii* was growing on the western edge of the forestry road, about 30 m from the barrier. A remarkably large plant of *E. mackaiana* was growing in the reservation a few metres to



FIGURE 1. 10-km square distribution of *Erica* ×*stuartii* and *E. mackaiana*, amended and updated from that published in *New atlas of the British and Irish flora* (Preston *et al.*, 2002). ● Squares with both *Erica mackaiana* and *E.* ×*stuartii*, ○ squares with *Erica* ×*stuartii* only.

the west of the barrier. This particular plant, a mass of intertwined stems and twigs, formed hummocks around 1·5 m in height: where it was supported against the trunks of two birch trees, the flowering shoots reached at least 1·7 m. I also found scattered plants of *E.* ×*stuartii* in the wide firebreak on the southern side of the road.

A bog-road, situated in the townland of Knockaneden and leading south-south-east (from grid reference V561780) allowed limited access to the peatlands of the Kealafreaghane valley. There are abandoned and active turbary banks in this area. Approximately 0·5 km along this road, on the western side, is a small "quarry", and scattered plants of *E.* ×*stuartii* were found on the blanket bog to the east and also to the west of this. The individual shrubs were very widely separated, and the hybrid appeared to peter out to the west. In an area where modern peat-cutting machinery has

been working only *E. tetralix* could be found – it was abundant, indeed dominant, on the debris of the turbary workings.

In the field, using a ×20 hand-lens, I attempted to determine whether the plants that *looked* like Mackay's heath exactly matched that species. The diagnostic character that I used was a glabrous ovary; any plants that have hairs on the ovary are either *E* ×*stuartii* (sparse, usually very short hairs) or *E. tetralix* (dense, long, shaggy hairs) (see Nelson 2001). It soon became clear that *E.* ×*stuartii* was much more common than *E. mackaiana*. In an attempt to assess the relative abundance of the hybrid *versus* Mackay's heath, I traversed the blanket peat of the wide firebreak beneath the transmission lines, to the east of the two mountain streams. Pausing every three paces, I gathered a flowering shoot from whatever heather belonging to the *E. tetralix/mackaiana/* ×*stuartii* complex was at my feet; the total number of specimens was 86. Subsequently the ovaries were examined using a binocular microscope. Of those 86 specimens, 59 (69%) had sparsely hirsute ovaries indicating that they were of hybrid origin (i.e. *E.* ×*stuartii*), whereas only 2 (2·3%) had glabrous ovaries (i.e. *E. mackaiana*). The other specimens were identified as *E. tetralix*, due to their densely hirsute ovaries. There was remarkable variation in the density and disposition of the hairs on the ovaries of the *E.* ×*stuartii* specimens, suggesting that the hybrid has arisen many times in this area, and perhaps also that back-crossing has occurred.

The westernmost locality traced for *E. mackaiana* was a rocky bluff (grid reference V559786) due north of the "cross-roads" (named Knockaneden Cross on sheet 20 (Dingle Bay) 1975 ½-inch Ordnance Survey map). On the bluff is a dense patch of Mackay's heath (perhaps representing a single plant, and certainly a single clone) extending about 10 m along the road and ranging perhaps 5 m up the slope. At this site, *E. mackaiana* was growing with *E. cinerea* L. (Bell heather), *Euphorbia hyberna* L. (Irish spurge), and *Ulex* spp. (gorse). *Erica* ×*stuartii* occurs close by, to the south between the bluff and the "cross-roads", on wet blanket peat. I also found the hybrid at a site c. 1·2 km to the north of this in Teernahila townland: a single plant on a peat bank beside a fence (grid reference V561801). Thus *E. mackaiana* apparently occupies a very narrow strip (perhaps only 100 m wide) that extends c. 2 km east-west, whereas the area of occurrence of *E.* ×*stuartii* exceeds this with a north/south range of c. 2·5 km and an east/west range of c. 2 km. In this, the Kerry populations resemble the Mayo ones reported by van Doorslaer (1990); there *E. mackaiana* is restricted to two small areas (one extending only 100 m along the sides of a drainage ditch), whereas the hybrid ranges through an area 2·5 km long and 0·5 km wide (van Doorslaer 1990; and pers. comm.).

Whereas the site discovered by David Edge, as well as the others to the east and south which I have reported here, lie within the catchment of the River Inny (which includes the Kealafreaghane River), the plants located to the north of Knockaneden Cross lie within the quite separate catchment of the River Ferta which flows west into the Valentia River.

Having seen Mackay's heath and Praeger's heath in South Kerry, and despite the close proximity of forestry plantations, I am convinced that *E. mackaiana* is a native species in the county, and that *E* ×*stuartii* is also indigenous, having arisen *in situ* through cross-pollination of *E. tetralix* by *E. mackaiana*, or *vice versa*. The phytogeographic implications of this will require further analysis – it is highly desirable that pollen and macrofossil data are obtained from the blanket and raised bogs in this area to establish whether *E. mackaiana* has grown in the region throughout the post-glacial era. It is worth repeating that in South Kerry Mackay's heath and the Irish spurge coexist, and also noting that both species are now known from the northern and southern extremities of Ireland. *Euphorbia hyberna* grows in the Owenerk River valley at Dunree, East Donegal (v.c. H34), approximately 50 km to the east-north-east of the most northerly habitat of *Erica mackaiana* at Lough Nacung, West Donegal.

E. ×*stuartii* invariably accompanies *E. mackaiana* in Ireland. A report (Lamb 1964) of *E.* ×*stuartii* occurring without *E. mackaiana* nearby is enigmatic and needs to be treated with the greatest caution. Neither van Doorslaer (1990) nor the present author has found any signs of *E.* ×*stuartii* (formerly *E.* ×*praegeri* Ostenf.) at Lamb's carefully described locality at Portacloy in northwest West Mayo (I visited Portacloy during the late 1970s and again on 26 July 2004). However, an unusual variant of *E. tetralix* with almost glabrous foliage is predominant there (see also Synnott 1986). (Unfortunately, as noted by Coker & Nelson (2004), Lamb's (1964) paper had been misconstrued and was the basis of the erroneous "dot" in northwest Mayo (at F84) on the distribution map of *E. mackaiana* published in *New atlas of the British and Irish flora* (Preston *et al.* 2003).)

The Inny and Ferta valleys contain substantial areas of blanket and raised bogs which, while being harvested for peat, are not yet either covered by forestry plantations or intensively used for grazing cattle and sheep. My fieldwork was restricted to the peatlands adjacent to roads and tracks, although I did scan a substantial area using binoculars – *E.* ×*stuartii* plants stand out very clearly, and *E. tetralix* can easily be distinguished too. A more detailed survey of the valleys is clearly desirable, and such a survey could extend the range of both *E. mackaiana* and *E.* ×*stuartii* within the Iveragh Peninsula.

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RUBUS RADULICAULIS SUDRE (ROSACEAE) IN THE SOLENT REGION

In the late 1880s a distinctive, shortly glandular-aciculate bramble with deep pink concave petals and elliptical or obovate, often cuneate-based terminal leaflets was found to be widely distributed and locally abundant in shady habitats over much of Herefordshire, v.c. 36. Known for many years subsequently as *R. sertiflorus* P. J. Mueller on the strength of a determination by Babington, its eventual distribution under that name as no. 90 in the historic Set of British Rubi led one of the recipients of that, Sudre (1904), to identify that as a nomenclatural error: it matched instead another, seemingly undescribed bramble of which he had come across a specimen in Mueller's

herbarium and for which he had coined the name *R. radulicaulis*. Though Watson (1958) was to adopt a broader interpretation of the taxon, in his monograph placing under it material from nine further English counties and two regions of France, Edees & Newton (1988) concluded that that was misconceived and returned to Sudre's narrow definition, a treatment that has met with general assent. The species has accordingly reverted to its original status as a narrowly regional one, exclusive to the southern half of the Welsh Borders as far as Britain is concerned, with the adjoining vice-counties of Monmouth, v.c. 35, and Brecon, v.c. 42, alone added to the Herefordshire headquarters (Edees & Newton 1988; Newton & Randall 2004).

Never having had an opportunity of seeing *R. radulicaulis* in the living state, I did not connect it till 2004 with an unnamed bramble "H1056" (c.f. Allen 2003) that I had been encountering increasingly frequently in the Isle of Wight, v.c. 10, and South Hampshire, v.c. 11, during the previous decade and a half. The great distance of those from the Welsh Borders and their more maritime climate gave no ground for suspecting that this trans-Solent plant and *R. radulicaulis* were one and the same. The plentiful Herefordshire material of the latter in herbaria, moreover, is on the whole deceptively more robust. It was only after specimens similar to those increasingly began to be met with in the Solent region that the identity of the two eventually suggested itself, a conclusion with which A. Newton has subsequently concurred.

In the Isle of Wight the species is mainly found thinly scattered through what was clearly once a continuous belt of woodland across the north-east corner of the Island in the triangle of country between the towns of Newport, Ryde and Brading. Of the numerous separately-named fragments of that belt now surviving, nine have so far produced *R. radulicaulis*, usually on their margins but also in lightly-shaded areas within, on Palaeogene clays and Quaternary gravels alike. From the northernmost of those fragments, Quarr Wood, there is a specimen in **CGE** collected by T. Bell Salter as long ago as 1845 (later misdetermined by Rogers as the related member of series *Radula* now know as *R. rufescens* Lef. & P. J. Mueller). In **K** there is also one collected by J. G. Baker in 1869 in Shanklin Chine, by the coast some 7 km south-east of the southernmost point of that woodland belt. Mount Farm Copse, Ningwood (SZ391800), in the far west of the Island, has recently been the site of an even more isolated find.

The Hampshire populations tend to be larger but more remote from one another. With one exception all are in various fragments of the Forest of Bere that formerly covered most of the south-east of the county (topographically, the counterpart of the Isle of Wight woodland belt), three within a 10 km radius of Havant, the other close to Southampton Water, far to the west (Thatcher's Coppice, near Titchfield, SU528038). A solitary clump in the west half of the vice-county, on the edge of a section of planted conifers in Ampfield Wood (at SU411233), may be the product of a stray, accidental introduction with forestry saplings.

In all, *R. radulicaulis* is so far on record in the Solent region from seven hectads: SZ50, 58 and 59 in v.c. 10 and SU42, 50, 60 and 71 in v.c. 11. This doubles the hectad total for Britain known at the time the Atlas of British and Irish Brambles (Newton & Randall 2004) was compiled. The Solent region is thus revealed as not only a second area of occurrence fully as large as the one from which the species has hitherto been known, but as also gratifyingly filling a substantial gap in what may otherwise be a markedly disjunct European range.

Unfortunately, the extent of the Continental part of that range is at present uncertain. At the time he published the name of the taxon Sudre (1904) mentioned having seen specimens of it from "Alsace" – then in Germany – as well as three (named) French *départements* with "etc" added, implying several more. If the sole basis for his listing of Alsace, however, was the specimen he mentioned having found in Mueller's herbarium, that can only have been an informed guess – Alsace having been where Mueller lived and did at least most of his extensive collecting of *Rubus* – for re-inspection of the specimen in question at Lausanne (**LAU**), which has necessarily led to its being chosen as the lectotype, has revealed that it is unlocalised as well as undated (Edees & Newton 1988). It cannot therefore be excluded that it came from some quite other area, possibly received from another collector. By the time his eventual monograph began appearing (Sudre 1911) the original list of areas from which Sudre indicated having determined specimens of *R. radulicaulis* had altered considerably, a Bavarian locality having displaced *dép.* Saône-et-Loire and the "etc" having disappeared, with the result that Alsace-cum-Bavaria was now no better represented than two *départements* in south-west Brittany. The climatic difference between those two Continental regions is so great that one cannot help suspecting that Sudre had conflated two

different entities, a suspicion, however, that cannot be checked until and unless the specimens he so determined can be located, a task which has generally proved frustrating for present-day *Rubus* taxonomists. On balance, south-west Brittany seems more consonant with the British range of the species as now known (another species, *R. neomalacus* Sudre, has a distribution apparently shared virtually exclusively by the mouth of the River Loire and the western two-thirds of Surrey, v.c. 17), but the other region can by no means be discounted. On present knowledge all that can be safely asserted is that *R. radulicaulis* putatively occurs also in mainland Europe but the only specimen currently authenticated believed to be from there is of uncertain provenance.

Representative material from both v.c. 10 and v.c. 11 has been donated to **BM** and **HCMS**.

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A HITHERTO UNDESCRIBED BRAMBLE *RUBUS* SECT. *CORYLIFOLII* (ROSACAE) OF CHALKY BOULDER CLAY IN EAST ANGLIA

On 6 July 1973 ALB collected a pink-flowered member of the Section *Corylifolii* (then Section *Triviales*) at Ringstead Downs in north-west Norfolk, TF64, v.c. 28, which was abundant there but was unknown to E. S. Edees to whom it was submitted. The same plant was collected from the car park at R.S.P.B. Titchwell, TF74, in 1990 and from Ken Hill Estate at Snettisham, TF63, in 1996. These were all designated 'North West Norfolk Corylifolian'.

Whilst attending a B.S.B.I. *Rubus* meeting based on Colchester, v.c. 19, also in 1996, R. D. Randall presented ALB with a *Rubus* specimen that he had collected from nearby Daisy Green, TL9325, which agreed in the main with the Norfolk plant, though the stem was rather more pilose and glandular.

Both authors were visiting Borley Wood near Linton, Cambs., v.c. 29, on 16 July 2003 when a bramble was discovered which was immediately recognised as being the same as the plant from Ringstead *et al*. ACL then stated that the same plant occurred widely in Cambs. and that he had dubbed it the 'Wicken bramble'. It was then decided to visit various sites in Cambs. in 2004.

I noticed a sheet which stood out as part of the missing link between v.cc. 19, 29, and 28 whilst going through folders of indet. Suffolk *Rubi* during the winter of 2003/4 in **Herb. A. L. Bull**. This was collected in July 1977 from Bull's Wood where it was abundant 'because we had noted it to be frequent in the roadside hedges almost everywhere we had been that day'.

As a result of the discovery of the sheet from Cockfield, a specimen was sent to Dr. David Allen who is a frequent visitor to the *Rubus* section of the Herbarium at **BM** asking if he would be kind enough to look through indet. Corylifolian material when next he visited, to see if he could find any which matched our plant.

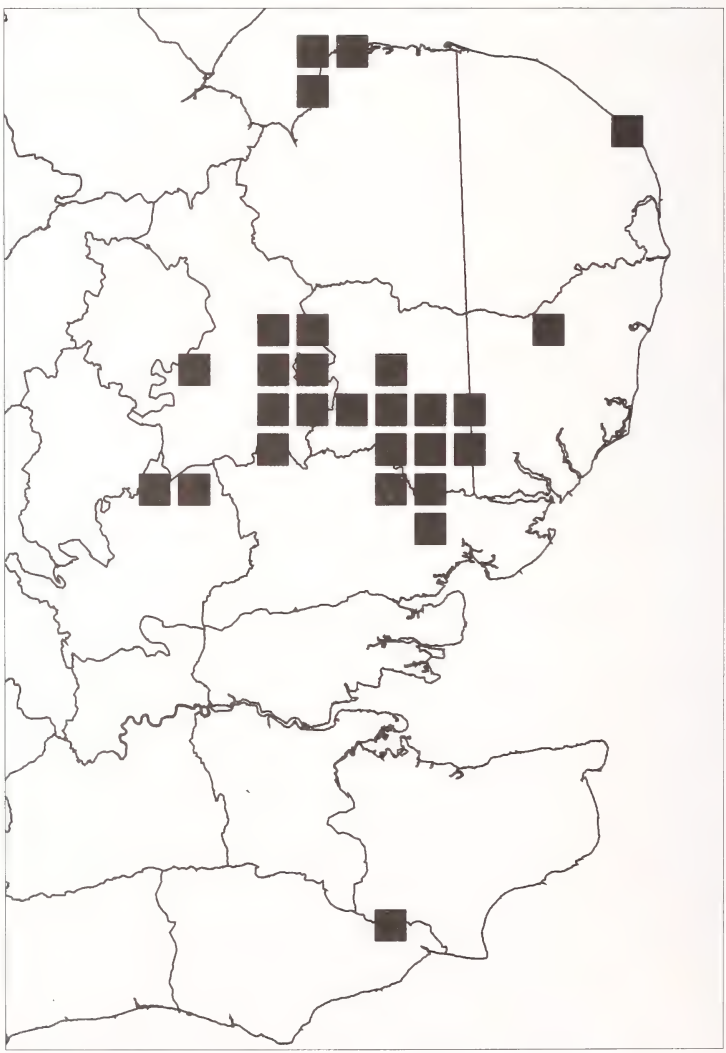
Several sheets were subsequently received on loan, mainly collected by the Rev. J. D. Gray from the vicinity of Nayland on the Suffolk/Essex border in the 1890s, but also, interestingly, a sheet from Little Boxhurst, Kent, TQ82, v.c. 15 collected by R. J. Pankhurst in 1973.

On 23 June 2004, the joint authors met at the Devil's Dyke, Newmarket, Suffolk, though in v.c. 29, and examined several clumps of the 'new' blackberry, and then went on to Horse Fen Drove near Wicken in Soham parish where, after due deliberation, type specimens were taken.

On 5 and 28 July 2004, ALB did two trips down through West Suffolk and into North Essex, stopping randomly once or twice in each hectad to, in the main, search the roadside hedgerows which in most areas on the clay contain little more than *Rubus ulmifolius*. By this method the plant was plotted in 11 hectads and, wherever it was present, it was found within 100 m of the parked car. Only 3 hectad stops drew blank and these were on more acidic soils. One of the sites where it was found was at Wissington Road, Nayland, where it had been collected by the Rev. J. D. Gray in 1898.

On 29 June 2004, whilst visiting E. Philp in Kent, a visit was paid to R. J. Pankhurst's grid reference at Boxhurst, and the site was found to have become overgrown and shaded. One weak stem corresponding to specimens of the new bramble was discovered, but insufficient to provide a voucher specimen. During visits to Herts., v.c. 20, during July 2004, whilst helping T. J. James with the Brambles for his forthcoming county Flora, the plant was found at several sites in TL23 and TL33, again on chalky boulder clay.

It was then decided that we ought to search through the indet. Corylifolian sheets in the Herbarium at **CGE,** so ACL arranged for us to pay a visit during December 2004. A certain



10-km records of *Rubus cantabrigiensis.*

number of sheets were discovered among the indet. folders, but even more were located when it was decided to look at all the Corylifolian material in the Herbarium. e.g., a sheet collected by J. D. Gray from Polstead, Suffolk, had been assigned to *Rubus balfourianus(=R. nemorosus),* which our plant very definitely was not.

The best sheet found amongst the earlier collections was one made by the Rev. W. M. Hind, from Long Melford in Suffolk, v.c. 28, TL84, on 16 July 1886. Curiously, the plant did not appear to have been collected by Babington.

Coming a little nearer in time, the plant obviously intrigued W. H. Mills who went back to Dry Drayton, v.c. 29 and collected it half a dozen times between 1947 and 1957, as well as from other sites in South Cambs. However, he named it incorrectly as *Rubus tuberculatus,* which is a densely glandular and prickly bramble with white flowers.

Sites have also been found for the plant in East Suffolk, v.c. 25 and East Norfolk, v.c. 27.

It has been mutually agreed that the plant will be named *Rubus cantabrigiensis*, the latinised name for Cambridge.

In addition, two sheets were sent to Professor H. E. Weber in Germany for a European opinion which was 'that the plant is not known in north-west Europe, but clearly belongs to the Corylifolii Ser. Subthyrsoidei and may have developed with *Rubus ulmifolius* as one of its ancestors.'

Rubus cantabrigiensis A.L. Bull & A.C. Leslie **sp. nov.**

Turio arcuatus, apice radicanti, acutangulus, glauciviridis, postea obscure purpurascens, pruinosus, glaber vel aliquando pilis simplicibus glandulisque brevistipitatis paucissimis, raro aculeolis sparsissimis praeditus; *aculei* 8–12 per 5 cm, validi, (5–)6–7(–8) mm, apice gracili patenti vel sursum curvato, e basi longa (4 mm) prolongato, sicut turio colorati, acumine luteo. *Folia* pedata; *foliola* terna vel quina, supra saepe aliquantum obscure cinereoviridia, pilis simplicibus sparsim strigosa, infra viridicinerea, coacta, pilis simplicibus stellatisque brevibus molliter pubescentia, in venis pilis simplicibus longioribus vestita; *foliolum terminale* 6–8 × 5–7 cm, aut elliptico-obovatum acuminatum lateribus rotundatis basique integra aut oblongo-obovatum lateribus infra medium rectis apice abrupte cuspidato 1 cm basique aliquantum emarginata, semper marginibus serratis dentes principales prominentes ferentibus, petiolulo lamina sua triplo breviore; foliolorum genera ambo in frutice eadem inveniantur; foliola basalia petiolulis 1 mm vel nullis praedita; *petiolus* foliolis basalibus longior, sicut turio coloratus, aculeis aliquot declinatis vel curvatis circa 3 mm munitus. *Ramus florifer* rectus vel interdum aliquantum flexuosus, usque ad apicem foliatus, foliis aliquot ternatis et plerumque folio uno simplice vestitus, paniculae terminalis foliolis saepe longe ellipticis vel aliquantum obovatis, fere duplo longioribus quam latioribus; *inflorescentia* plerumque corymbus densus ramulis inferioribus erectis vel ascendentibus instructus, aculeis longis gracilibus sursum versis, ad 5(–6–7) mm, e basi rubra luteolis, et in pedicellis aculeis gracillimis multis armatus; *rhachis* sicut turio colorata, per totam longitudinem coacta, in inflorescentia pilis longis simplicibus caespitosisque nonnullis vestita, sed his minus conspicuis quam glandulis stipitatis paucis vel satis numerosis, in pedicellis multum auctis. *Flores* 2·5 cm diametro; *sepala* cinerascentia spisse coacta longicuspidia, glandulis stipitatis paucis aciculisque sparsissimis praedita, primo patentia vel laxe reflexa, tandem fructum maturum laxe amplectentia; *petala* 10–12 × 6–8 mm, plerumque rosea, late elliptica vel infra medium latissima, saepe emarginata; *filamenta* alba, stylos rubros vel basi rubra aequantia vel excedentia; *antherae* glabrae; *carpella* juvenia glabra; *receptaculum* glabrum; *fructus* maturi nigri, perfecte formati, modice grandes bonique. Panicula secundaria e basi rhachidis principalis saepe crescens, primam superans et florescentiam e fine Maii in initium Augusti prorogans.

Stem arching, with rooting tip, sharply angled, glaucous-green becoming dull purplish, pruinose, glabrous or occasionally with very few simple hairs and short stalked glands, rarely with very sparse pricklets; *prickles* 8–12 per 5 cm, strong, (5–)6–7(–8) mm, with slender patent or upcurved tip from a long base (4 mm), coloured like the stem with a yellow point. *Leaves* pedate; *leaflets* 3–5, often rather dull greyish-green and sparsely strigose with simple hairs above, greenish-grey, felted and softly pubescent with short simple and stellate hairs below, with longer simple hairs on the veins; *terminal leaflet* 6–8 × 5–7 cm, either elliptic-obovate, acuminate, with rounded sides and entire base, or oblong-obovate with sides straight below the middle, abruptly cuspidate apex 1 cm and somewhat emarginate base, always with serrate margins, with the principal teeth prominent,

and petiolule 1/3 as long as the lamina; both types of leaflets may be found on the same bush; basal leaflets with petiolules 1 mm or 0; *petiole* longer than the basal leaflets, coloured like the stem, with several declining or curved prickles c. 3 mm. *Flowering branch* straight or sometimes somewhat flexuous, leafy to the tip with several ternate leaves and usually one simple leaf, with the leaflets of the terminal panicle often long-elliptic or somewhat obovate, almost twice as long as broad; *inflorescence* usually a dense corymb with erect to ascending lower branches, armed with long slender upturned prickles up to 5(–6–7) mm long, yellowish from a red base, and with many very slender prickles on the pedicels; *rachis* coloured like the stem, felted throughout its length, with some long simple and tufted hairs in the inflorescence, but with these less noticeable than the few to rather numerous stalked glands, which become more numerous on the pedicels. *Flowers* 2·5 cm in diameter; *sepals* greyish, densely felted, long-pointed, with a few stalked glands and very sparse acicles, spreading or loosely reflexed at first, at length loosely clasping the ripe fruit; *petals* 10–12 × 6–8 mm, usually pink, broadly elliptic or widest below the middle, often notched; *filaments* white, equalling or exceeding the red or red-based styles; *anthers* glabrous; young *carpels* glabrous; *receptacle* glabrous; ripe *fruits* black, perfectly formed, moderately large and good. A secondary panicle often grows from the base of the main rachis, overtopping the first and lengthening the flowering season from the end of May to the beginning of August.

Rubus cantabrigiensis can be recognised in the field by the grey green to dull purplish pruinose stem with long slender patent to upturned prickles, the grey green obovate leaflets on the stem and the often long obovate terminal leaflets in the panicle. The panicle is usually quite glandular but the stems are not. The large secondary panicle is a fairly constant feature in most populations.

HOLOTYPUS: Horse Fen Drove, Soham, Cambs, v.c. 29 TL583708 **BM**.

REPRESENTATIVE EXSICCATAE

V.C. 19 NORTH ESSEX

Woodland edge, Bulmer Tye, TL8436, 28 July 2004, **Herb. ALB**; Pentlow picnic place, TL8346, 5 July 2004, **Herb. ALB**.

V.C. 20 HERTFORDSHIRE

Weston Hills, TL2432, 9 July 2004, **Herb. ALB**; Barkway, TL3935, 7 July 2004, **Herb. ALB**.

V.C. 26 WEST SUFFOLK

Bull's Wood, Cockfield, TL9254, 15 July 1977, **Herb. ALB**; Wissington Road, Nayland, TL9634, 5 July 2004, **Herb. ALB**; Long Melford, TL84, 19 July 1886, W. M. Hind, **CGE**.

V.C. 28 WEST NORFOLK

Ringstead Downs, TF6941, 6 July 1973, **Herb. ALB**; Ken Hill Estate, Snettisham, TF63, 13 August 1996, **Herb. ALB**.

V.C. 29 CAMBRIDGESHIRE

Devil's Dyke, Newmarket, TL6261, 23 June 2004, **Herb. ALB**; Borley Wood, Linton, TL5748, 16 July 2003, **Herb. ALB**.

Our thanks are due to Mr Philip Oswald for providing the Latin diagnosis; to Mr Bob Ellis for doing the distribution map; to Dr. D. E. Allen for searching for and arranging the loan of specimens, from **BM**; to the Curator of the Herbarium at **CGE** for allowing us to spend most of a day searching for specimens which were then placed in a new folder appropriately labelled; to Mr A. Newton for examining and approving a whole parcel of *Rubus cantabrigiensis* and also to Prof. Weber for his valuable comments.

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HIEROCHLOE ODORATA (L.) BEAUV. (POACEAE) – A GRASS NEW TO ENGLAND

Hierochloe odorata, Holy Grass, has a Circumpolar Boreal-montane distribution (Preston & Hill 1997). In Europe it is frequent over much of Fennoscandia and extends to the Alps and the Black Sea (Hultén 1964). In Britain it has always been considered rare and its Scottish localities have only become known gradually over the last two centuries, though they are now known to extend from Orkney to the Scottish Borders. It also occurs by Lough Neagh in Northern Ireland (Preston *et al.* 2002). Holy Grass is sweet-scented when dried, like its relative *Anthoxanthum odoratum*, Sweet Vernal-grass, in whose genus it may soon be subsumed (T. A. Cope, pers. comm., 2004) and is sometimes believed to have been introduced to at least some of its British localities by the Vikings. Hooker (1821) refers not only to its being used to strew on church floors on saint's days in Germany (the origin of its name) but cites Linnaeus as telling us that 'it is a soporific, and sold in the towns in Sweden to be suspended over the beds, and induce sleep'. Its habitats in Britain are various but all are level, heavily-flushed habitats with some base-richness at low or modest altitude rather than montane.

On 3 May 2004 I found this grass while resurveying property owned by my family at Haughton beside the River North Tyne in Northumberland (v.c. 67), NY97, which I had recorded 30 years previously at a period when I was very ignorant about grasses. I revisited the site on 11 May with R. W. M. Corner, A. G. Lunn, F. J. Roberts and Mrs P. F. Braithwaite when a list of associated species was made. G. A. Swan was supplied with a voucher specimen. A further visit was made on 25 June.

The main North Tyne colony of *Hierochloe* lies at an altitude of about 65 m and is spread over about 50 m² in runnels between massive blocks of whinstone (quartz-dolerite) where it grows in a sandy calcareous alluvium. It is associated with a diverse plant community. Close associates are *Trollius europaeus*, Globeflower, and *Galium boreale*, Northern Bedstraw. Other associates are *Achillea millefolium, Achillea ptarmica, Alchemilla glabra, Alnus glutinosa, Anemone nemorosa, *Angelica sylvestris, Anthoxanthum odoratum, Blysmus compressus, *Caltha palustris, *Campanula latifolia, *Cardamine amara, Cardamine pratensis, Carex nigra, Carex remota, Centaurea nigra, Cirsium arvense, Conopodium majus, *Crepis paludosa, Dactylorhiza fuchsii, Deschampsia cespitosa, *Equisetum arvense, Filipendula ulmaria, Galium palustre, Galium verum, *Heracleum sphondylium, Hyacinthoides non-scripta, Hypericum ×desetangsii, Juncus conglomeratus, Leucanthemum vulgare, Luzula sylvatica, *Lysimachia vulgaris, *Phalaris arundinacea, *Ranunculus acris, Ranunculus ficaria, Rhinanthus minor, Rumex obtusifolius, Sagina procumbens, Salix purpurea, Salix ×multinervis, Sanguisorba officinalis, Trifolium repens,* and **Vicia cracca*. *Cirsium heterophyllum* grows nearby. A smaller colony of *Hierochloe*, a little upstream, forms a narrow strip along 3 m of the river's edge where it is closely associated with *Trollius europaeus* and *Persicaria bistorta*, Common Bistort. Other associates are those asterisked in the list above and *Aegopodium podagraria*. The *Hierochloe* might be thought to be particularly subject to domination by *Phalaris arundinacea*. In fact the *Phalaris* occupies a narrow strip actually in the water while the *Hierochloe* occupies a ledge just above normal water level. The habitat appears to be more base-rich than is typical of *Hierochloe* localities elsewhere, perhaps following the fairly general rule that species become less catholic in their habitat tolerances near the periphery of their distributions.

The North Tyne habitat, though choice, is by no means unique and the grass, which flowers in April and May, should surely be looked for again in suitable habitats by the Tyne, Tees and rivers in the Lake District where it could easily have been overlooked, not least because of its early flowering time and because it may not flower every year (J. K. Butler, pers. comm.). However, a search for *Hierochloe* at some of the other *Trollius* sites on the North Tyne was unsuccessful.

Although this may be the first record for England, a 19th C herbarium specimen of *Hierochloe* marked Wallington (a major landed estate in Northumberland, NZ08) exists in the Hancock Museum *ex herb.* Nathaniel Winch. Winch does not refer to *Hierochloe* in his *Flora of Northumberland and Durham* (1831), or its addenda (1837), and the specimen may well have been come from material circulated to his friend and fellow botanist Sir Walter C. Trevelyan, soon to be squire of Wallington on the death of his father in 1846, following its discovery by the Thurso river in Caithness by Robert Dick around 1834, as he is known to have distributed specimens. Trevelyan

gathered a large herbarium, largely of local plants, of which 1,200 sheets are preserved in the Hancock. Although Wallington is only about 15 km from the *Hierochloe* locality by the North Tyne it lies in a different river system, the Wansbeck, and does not appear likely to have had suitable habitat in its vicinity. Professor G. A. Swan in his *Flora of Northumberland* (1993) has taken the specimen to relate to material cultivated at Wallington; nevertheless, in the light of the new locality nearby, the possibility of a former locality at Wallington cannot entirely be ruled out.

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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* (VCCC), 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 redetermination 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.
¢ 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.
[ ] enclosing a previously published record: to indicate that that record should be deleted or changed.

The following list contains some of the records for 2004 and preceding years. The remaining records for this period will be published in the next edition of *Watsonia*.

‡2/1.2. SELAGINELLA KRAUSSIANA *__113(S)__, Channel Is. (Sark): Established over an area of c. 12 m^2 near planted trees in garden turf, La Seigneurie, WV463764, R.C. Stern, 2002, **herb. Société Sercquiaise**.

4/1.4×8. EQUISETUM ×DYCEI (E. FLUVIATILE × E. PALUSTRE) *__100__, Clyde Is. (Arran): King's Cave, NR8830, C.N. Page, 1988.

6/1.1. OSMUNDA REGALIS __113(S)__, Channel Is. (Sark): Foot of bank beside Harbour Hill footpath, WV475757, R.M. Veall, 2002, **herb. Société Sercquiaise**. 1st recent record.

9/1.1. PILULARIA GLOBULIFERA ▣**106**, E. Ross: Edge of river, Carbisdale, Kyle of Sutherland, NH572957, M.S. Porter, 2000. Fluctuating water levels, river still tidal here. ▣**106**, E. Ross: Washed up by boats on shore of trout loch, Lochan Eich, NH424583, B.R. and C.B. Ballinger, 2004, **herb. B. Ballinger**. Local Change visit.

17/3.2×3. DRYOPTERIS ×COMPLEXA (D. FILIX-MAS × D. AFFINIS) *__100__, Clyde Is. (Arran): East of house called Woodside, Ballymeanoch, NS027218, A.R. Church, 1999.

17/3.3a. DRYOPTERIS AFFINIS subsp. AFFINIS *__100__, Clyde Is. (Arran): Lochranza, NR9350, A. R. Church, 1993.

17/3.3b. DRYOPTERIS AFFINIS subsp. CAMBRENSIS *__100__, Clyde Is. (Arran): North Glen Sannox, NS0146, A.R. Church & A.W. Smith, 1996.

17/3.3c. DRYOPTERIS AFFINIS subsp. BORRERI *__100__, Clyde Is. (Arran): Corloch, NR9948, A. R. Church & A.W. Smith, 1991.

‡18/1.2. BLECHNUM CORDATUM *__46__, Cards.: Wooded dingle, Penglais, Aberystwyth, SN593820, A.O. Chater, 2004, **NMW**. Naturalised.

‡19/1.1. AZOLLA FILICULOIDES *__77,__ Lanarks.: Pond, south of Hamilton, NS732552, E. McGuire & C. Walker, 2002.

‡20/1.1. ABIES ALBA *__100__, Clyde Is. (Arran): Cladach/Home Farm by Brodick, NS0137, A.R. Church & A.W. Smith, 1994.

‡20/1.2. ABIES GRANDIS *__100__, Clyde Is. (Arran): Stronach Wood, NR999365, A.W. Smith, 1990.

‡20/1.3. ABIES PROCERA *__100__, Clyde Is. (Arran): Forest Enterprise car park, Tormore, NR898316, A.W. Smith, 1993.

‡20.1/CRY.jap. CRYPTOMERIA JAPONICA *__5__, S. Somerset: Over 10 trees, self-sown, some at least 3m in height, on bracken-covered slope, Timberscombe, SS956417, C.J. Giddens, 2002.

‡20.1/SEQ.sem. SEQUOIA SEMPERVIRENS *__100__, Clyde Is. (Arran): Cladach/Home Farm by Brodick, NS0137, A.R. Church & A.W. Smith, 1994.

‡20.1/SQD.gig. SEQUOIADENDRON GIGANTEUM *__100__, Clyde Is. (Arran): Roadside between Cordon and Gortonallister near Lamlash, NS028298, A.W. Smith, 1989.

‡20/2.1. PSEUDOTSUGA MENZIESII *__100__, Clyde Is. (Arran): Auchareoch Forestry, NR983223, A.W. Smith, 1995.

‡20/3.1. TSUGA HETEROPHYLLA *__100__, Clyde Is. (Arran): Merkland Wood between road/track junction and Merkland Burn, NS0238, A.R. Church, 1994.

‡20/4.1. PICEA SITCHENSIS *__100__, Clyde Is. (Arran): Tributary of Monamore Burn on its south side, NS0029, A.R. Church & A.W. Smith, 1994.

‡20/4.2. PICEA ABIES *__100__, Clyde Is. (Arran): Glen Dubh Forestry Enterprise, NR986335, A. R. Church, 1996.

‡20/4.gla. PICEA GLAUCA *__100__, Clyde Is. (Arran): Glen Dubh Forestry Enterprise, NR986335, A.R. Church, 1996.

‡20/4.omo. PICEA OMORIKA *__100__, Clyde Is. (Arran): Glen Dubh Forestry Enterprise, NR986335, A.R. Church & A.W. Smith, 1996. *__106__, E. Ross: Wet woodland, Garrick Wood by Tain, NH795793, B.R.& C.B. Ballinger, 2004, **herb. B. Ballinger**. Probably planted but seeding freely.

‡20/5.1. LARIX DECIDUA *__100__, Clyde Is. (Bute): Colmac woods, NS0467, A.C. Hannah, 2002.

‡20/5.1×2. LARIX ×MARSCHLINSII (L. DECIDUA × L. KAEMPFERI) *__100__, Clyde Is. (Arran): Machrie Forestry, NR916336, A.W. Smith, 1990.

‡20/5.2. LARIX KAEMPFERI *__100__, Clyde Is. (Arran): Glenashdale Forestry, NS022243, A.W. Smith, 1990.

20/7.1. PINUS SYLVESTRIS *‡__100__, Clyde Is. (Arran): Lower Glen Rosa, Ivy Cottage Sand Quarry, NS008371, A.R. Church, 1998.

‡20/7.2a. PINUS NIGRA subsp. NIGRA *__100__, Clyde Is. (Arran): Rosa Burn/Brodick golf course, NS010368, A.W. Smith, 1994.

‡20/7.2b. PINUS NIGRA subsp. LARICIO *__100__, Clyde Is. (Arran): Forestry near Meallach's Grave, NS017289, A.W. Smith, 1992.

‡20/7.3. PINUS CONTORTA *__100__, Clyde Is. (Arran): Forest Enterprise car park, Tormore, NR898316, A.W. Smith, 1993.

‡20/7.4. PINUS PINASTER *__100__, Clyde Is. (Arran): Brodick golf course by Rosa Burn bridge, NS012368, A.W. Smith, 1996.

‡20/7.5. PINUS RADIATA *__100__, Clyde Is. (Arran): Brodick golf course by Rosa Burn bridge, NS012368, A.W. Smith, 1996.

‡20/7.6. PINUS STROBUS *__100__, Clyde Is. (Arran): Merkland Wood forestry plantation, NS020391, A.W. Smith, 1994.

‡21/2.1. CHAMAECYPARIS LAWSONIANA *__100__, Clyde Is. (Arran): Glenashdale, NS032254, A. W. Smith, 1989.

‡21/2.noo. CHAMAECYPARIS NOOTKATENSIS *__100__, Clyde Is. (Arran): Altachorvie Wood by Lamlash, NS035324, A.R. Church & A.W. Smith, 1996.

‡21/3.1. THUJA PLICATA *__100__, Clyde Is. (Arran): Altachorvie Wood and Lochain Ime Margnaheglish, Lamlash, NS0332, A.R. Church & A.W. Smith, 1996.

23/1.1. TAXUS BACCATA *__100__, Clyde Is. (Bute): 2 old trees on upper crags at south end of Barmore Wood, NS067607, A.C. Hannah, 2002. ?Probably native.

¢28/3.arg. HELLEBORUS ARGUTIFOLIUS *__95__, Moray: 2 plants growing in a narrow strip of trees, Grantown-on-Spey, NJ031281, I.P. Green, 2004.

‡28/9.3. ANEMONE RANUNCULOIDES *__68__, N. Northumb.: Naturalised on bank between castle wall and road, Norham Castle, NT906475, M.A. Woodward & Q.J. Groom, 2002. Known for several years and evidently naturalised.

‡28/12.3. CLEMATIS TANGUTICA *__95__, Moray: 6 plants growing on sand dunes, Findhorn, NJ037648, J. Scott, 2004, I.P. Green & Somerset Rare Plant Group.

28/13.4. RANUNCULUS SARDOUS *__H6__, Co. Waterford: Single plant at roadside, Kilmeadow, S520099, P.R. Green, 2002, **DBN**.

28/13.11. RANUNCULUS SCELERATUS *__80__, Roxburghs.: Edge of pond, Tilery Moss, Muirhouselaw, NT623274, R.W.M. Corner, 1997. Known from v.c. 80 for 150 years but omitted in error from VCCC.

28/13.12. RANUNCULUS LINGUA *‡__100__, Clyde Is. (Arran): 2 colonies in Merkland Wood pond, NS020383, A.R. Church & A.W. Smith, 1998. Planted c1988.

28/13.19. RANUNCULUS OMIOPHYLLUS *__80__, Roxburghs.: Covering 2 m^2 in trackside ditch, Hartsgarth, Newcastleton, NY501927, J. Waddell, 2004, **herb. R.W.M.C.**

28/13.23. RANUNCULUS AQUATILIS *__100__, Clyde Is. (Bute): Loch Quien, NS0659, A.R. Church, 1988.

28/13.24. RANUNCULUS PELTATUS *__100__, Clyde Is. (Bute): Loch Quien, NS0659, BSBI Field Meeting, 1998.

28/15.1. MYOSURUS MINIMUS __39__, Staffs.: Disturbed edge of muddy lane, SE of Elford, SK202093, C. Higginbottom, C.N. Smith & M. Smith, 2004, **STOKE**. 1st record since 1910.

‡29/1.8. BERBERIS BUXIFOLIA *__106__, E. Ross: One shrub approx. 2m.high and suckering vigorously, on vegetated scree by Eileanich Lodge, NH548691, B.R. and C.B. Ballinger, 2004, **herb. B. Ballinger**.

‡30/1.2. PAPAVER ATLANTICUM *__67__, S. Northumb.: Natural, rather species-rich grassland, near Newbiggin, opposite nearby cottages, NZ952499, A.J. Richards, 2003, **herb. G.A.S.**, det. C. Grey-Wilson. 1st well-documented record. Probably escaped from cottage gardens.

†30/1.4. PAPAVER RHOEAS __91__, Kincardines.: Waste ground, Banchory Devenick, NO925995, J. Waddell, 2004. 1st record since 1930.

†30/5.1. CHELIDONIUM MAJUS *__91__, Kincardines.: Old kirkyard, Maruculter, NO844999, D. Welch, 2004.

‡30/7.cor × mic. MACLEAYA ×KEWENSIS (M. CORDATA × M. MICROCARPA) *__39__, Staffs.: Rubble embankment, Rugeley, SK049189, M. Bloxham, 2004, det. M.W. Poulton.

‡31/1.1. DICENTRA FORMOSA *__100__, Clyde Is. (Bute): Kerrycroy Bay, NS107614, BSBI Field Meeting, 1998.

31/5.2. FUMARIA OCCIDENTALIS __2__, E. Cornwall: Five plants under winter barley in arable field, Caerhayes Barton Farm, near St Michael Caerhayes, SW985414, H.M. Meredith & A. Broom, 2002. Other records for v.c.2 have been as casuals in roadside dumps. This is the first natural record.

‡36/3.1. SOLEIROLIA SOLEIROLII *__73__, Kirkcudbrights.: Crevices in sandstone walls of river bank, Dumfries, NX968760, D.M. Hawker, 2001. 1st and only record to date. *__100__, Clyde Is. (Bute): Rothesay; Craigmore, NS106652, BSBI Field Meeting, 1998.

‡39/2.1. NOTHOFAGUS OBLIQUA *__100__, Clyde Is. (Arran): Machrie forestry, NR917336, A.W. Smith, 2000.

‡39/2.2. NOTHOFAGUS ALPINA *__100__, Clyde Is. (Arran): Forest Enterprise plantation west of road, Cnoc na Dail, NS019330, A.R. Church & A.W. Smith, 1993.

†39/3.1. CASTANEA SATIVA __100__, Clyde Is. (Arran): Stronach Wood by Brodick, NS0036, A. R. Church & A.W. Smith, 1998. 1st record since 1970.

‡39/4.2. QUERCUS CERRIS *__100__, Clyde Is. (Bute): Several fine specimens in Carnhousan Wood, NS066580, A.C. Hannah, 2003.

‡39/4.3. QUERCUS ILEX *__100__, Clyde Is. (Bute): Shalunt lay-by, NS038724, A.C. Hannah, 2004. Planted by Council c1970.

‡39/4.7. QUERCUS RUBRA *__100__, Clyde Is. (Arran): East side of main road, Cnoc na Dail forestry, NS019331, A.R. Church & A.W. Smith, 1994.

‡40/2.2. ALNUS INCANA *__100__, Clyde Is. (Arran): Edge of forestry plantation along main road, NS020329, A.R. Church & A.W. Smith, 1995.

‡40/2.3. ALNUS CORDATA *__100__, Clyde Is. (Arran): Auchareoch forestry, NS001250, A. Smith & R. Whitla, 2003. *__H6__, Co. Waterford: Self-sown on wall of bridge, Kilmolash, S130949, A. C. Leslie, 2004.

‡40/2.rub. ALNUS RUBRA *__H6__, Co. Waterford: Single self-sown tree in grassy area next to Lough Kilmaloo, Garrananaspick, X126816, I.P. Green & P.R. Green, 2002.

¢41.1/MIR.jal. MIRABILIS JALAPA *__13__, W. Sussex: Roadside bank on dumped soil, Summer Down, TQ268109, A.G. Hoare, 2004, conf. A.G. Knapp & P.A. Harmes.

43/1.6. CHENOPODIUM RUBRUM __79__, Selkirks.: Waste ground, Old mill, Ettrick riverside, NT468290, L. Gaskell, 2004, **herb. R.W.M.C.** 1st record since 1908.

¢43/1.qui. CHENOPODIUM QUINOA *__46__, Cards.: Tracksides, Ynys-hir RSPB Reserve, SN669958, A.O. Chater, 2004, **NMW**.

43/3.2. ATRIPLEX PROSTRATA __100__, Clyde Is. (Arran): Drumadoon Point by Blackwaterfoot , NR8828, A.R. Church & A.W. Smith, 1987. 1st record since 1970.

43/3.2×3. ATRIPLEX PROSTRATA × A. GLABRIUSCULA *__68__, N. Northumb.: Shore by Pier Gate, Berwick, NU001526, M.E. Braithwaite, 2003, det. J.R. Akeroyd.

43/3.2×4. ATRIPLEX ×GUSTAFSSONIANA (A. PROSTRATA × A. LONGIPES) *__100__, Clyde Is. (Arran): Corriecravie West, NR9123, A.R. Church & A.W. Smith, 1994.

43/3.3×4. ATRIPLEX ×TASCHEREAUI (A. GLABRIUSCULA × A. LONGIPES) *__100__, Clyde Is. (Arran): Corriecravie West, NR9123, A.R. Church & A.W. Smith, 1994.

43/3.3×5. ATRIPLEX GLABRIUSCULA × PRAECOX *__100__, Clyde Is. (Bute): Ardroscadale North, NS039650, M.E. Braithwaite, 2003, det. J.R. Akeroyd.

43/3.5. ATRIPLEX PRAECOX *__100__, Clyde Is. (Bute): Rhubodach, NS0274, B.H. Thompson & B.S. Thompson, 1997.

43/3.6. ATRIPLEX LITTORALIS *‡__39__, Staffs.: Dozens of plants on roadside, Tunstall, SJ851512, J. E. Hawksford, 2004, **STOKE**.

43/6.1×2. SALICORNIA PUSILLA × S. RAMOSISSIMA *__13__, W. Sussex: Scattered thinly along edge of bare path through upper end of saltmarsh, Cobnor, SU799033, A. Spiers, A.G. Knapp & P. A. Harmes, 2004, det. A.G. Knapp & P.A. Harmes.

‡45/2.1. CLAYTONIA PERFOLIATA *__100__, Clyde Is. (Bute): Kirk Dam, NS0863, NCC Freshwater Loch Survey, 1996.

46/1.1c. ARENARIA SERPYLLIFOLIA subsp. LEPTOCLADOS *__80__, Roxburghs.: Waste ground, Maxwellheugh, Kelso, NT731332, R.W.M. Corner, 1998, **herb. R.W.M.C.**, det. G. Halliday. Probably introduced.

46/5.1a. STELLARIA NEMORUM subsp. NEMORUM *__79__, Selkirks.: By River Tweed upstream from Galafoot, NT5034, J. Murray & M. Little, 1996. Known from v.c. 79 for 130 years but omitted in error from VCCC.

46/5.4. STELLARIA NEGLECTA *__100__, Clyde Is. (Arran): Exact locality unknown, NR92, R. Mackechnie, 1956.

46/10.3×5. SAGINA ×MICRANTHA (S. SUBULATA × S. PROCUMBENS) *__1a__, W. Cornwall: With both parents in bare patches on stony soil around old mine building, East Cliff, east of Rinsey Head, SW594269, P.R. Green, 2002, **herb. P.R.G.**, det. N. Jardine. New to Cornwall.

46/10.7b. SAGINA APETALA subsp. ERECTA *__100__, Clyde Is. (Great Cumbrae): NS15, NCC Freshwater Loch Survey, 1996.

46/17.1. SPERGULARIA RUPICOLA *__100__, Clyde Is. (Little Cumbrae): NS15, Ecology and Conservation Studies Society, 1986.

46/20.9×10. SILENE ×HAMPEANA (S. LATIFOLIA × S. DIOICA) *__100__, Clyde Is. (Bute): St Ninian's Bay, NS039618, BSBI Field Meeting, 1998.

†46/20.11. SILENE GALLICA ¢__80__, Roxburghs.: Meadow sown with wild flower seed mix, Eildontree Stone, E of Melrose, NT565337, L. Gaskell, 2004, **herb. R.W.M.C.** 1st record since 1963.

†46/22.1. SAPONARIA OFFICINALIS *__100__, Clyde Is. (Bute): Kilchattan Bay, NS098554, A.R. Church, 1998.

‡46/22.2. SAPONARIA OCYMOIDES *__95__, Moray: About 30 plants growing on Elgin Rubbish Tip, NJ2162, I.P. Green, 2003. First found 2003, but not named till 2004. *__H6__, Co. Waterford: Single plant self-sown on field wall, Bawnmore, X075979, P.R. Green & A.C. Leslie, 2004, **DBN**.

‡46/25.6. DIANTHUS BARBATUS *__106__, E. Ross: Sandy waste ground, Portmahomack, NH913841, B.R. and C.B. Ballinger, 2004. Probably garden throw-out.

‡47/1.2. PERSICARIA CAMPANULATA *__77__, Lanarks.: Established colony on trackside east of Uddingston, NS7060, P. Macpherson, 2002, **herb. P.M**.

‡47/1.3. PERSICARIA WALLICHII *__89__, E. Perth: A large colony several metres long on clay soil grassland on E bank of River Tay, Dunkeld, opposite the fishing hut, Newtyle Beat, NO0440, D.R. McKean, 2004, **E**. *__100__, Clyde Is. (Bute): Kerrycroy Bay, NS107614, BSBI Field Meeting, 1998.

‡47/5.2. FALLOPIA SACHALINENSIS *__91__, Kincardines.: Abandoned quarry, Cobairdy, NJ582431, D. Welch, 2004, **ABD**. *__100__, Clyde Is. (Bute): Kerrycroy Bay, NS107614, BSBI Field Meeting, 1998.

‡47/7.rha×pal. RHEUM ×HYBRIDUM (R. RHAPONTICUM × R. PALMATUM) *__100__, Clyde Is. (Arran): Penrioch, NR877447, A. Smith & R. Whitla, 2003.

47/8.8×13. RUMEX ×PROPINQUUS (R. LONGIFOLIUS × R. CRISPUS) *__64__, Mid-W. Yorks.: Ribblesdale, SD7678, M. Wilcox, 2002.

47/8.13×14. RUMEX ×SCHULZEI (R. CRISPUS × R. CONGLOMERATUS) *__100__, Clyde Is. (Arran): Kildonan shore west, NS013211, A.W. Smith, 2002.

47/8.13b. RUMEX CRISPUS subsp. LITTOREUS *__100__, Clyde Is. (Arran): Luib nam Partain, NR9048, A.R. Church, 1998.

47/8.14×19. RUMEX ×ABORTIVUS (R. CONGLOMERATUS × R. OBTUSIFOLIUS) *__64__, Mid-W. Yorks.: Canal bank, Leeds, SE280340, Wild Flower Society, 2002, det. M. Wilcox. *__H6__, Co. Waterford: Single plant on waste ground with both parents, Knockboy, S640084, P.R. Green, 2004.

47/8.15×19. RUMEX ×DUFFTII (R. SANGUINEUS × R. OBTUSIFOLIUS) *__H6__, Co. Waterford: Single plant on bank of field with both parents, Deerpark Bridge, S184133, P.R. Green, 2004.

47/8.20. RUMEX PALUSTRIS *__65__, N.W. Yorks.: Gravel extraction silt pools, Mayfield Lagoons, Masham, SE218822, G.D.T. Wilmore, 2002.

47/8.21. RUMEX MARITIMUS __65__, N.W. Yorks.: Gravel extraction silt pools, Mayfield Lagoons, Masham, SE218822, G.D.T. Wilmore, 2002. 1st recent record. *__89__, E. Perth: Several plants on soft mud bank at edge of R. Isla, West of Green Bridge, Aberbothrie, Alyth, NO241446, N.F. Stewart et al, 2003.

50/1.1. ELATINE HEXANDRA __100__, Clyde Is. (Bute): Loch Quien, NS0659, NCC Freshwater Loch Survey, 1996. 1st record since 1970.

50/1.2. ELATINE HYDROPIPER *__89__, E. Perth: Depth of 0 5 m in Loch of the Lowes, Dunkeld, NO055439, N.F. Stewart et al, 2002.

51/1.6×7. HYPERICUM ×DESETANGSII (H. PERFORATUM × H. MACULATUM) *__106__, E. Ross: Amongst rocks of abutment of new bridge over R. Orrin, NH505533, I. Evans, 2002. *__95__, Moray: Lots of plants on the banks of the old railway line, Garmouth, NJ342641, P.R. Green, 2004.

51/1.15. HYPERICUM MONTANUM **1a**, W. Cornwall: Dry, thin, rabbit-grazed, calcareous grassland - part dune, part mine waste, Gear Sands, near Perranporth, SW772553, E.C.M. Haes, 2002, det. I.J. Bennallick & R.J. Murphy. Only extant site.

57/1.2. VIOLA HIRTA *__27__, E. Norfolk: Roadside verge, St Thomas' Lane, Ketteringham, TG154017, R.W. Ellis, 2002, det. A.L. Bull.

¢57/1.11×12×alt. VIOLA ×WITTROCKIANA (V. LUTEA × V. TRICOLOR × V. ALTAICA) *__100__, E. Ross: Mixed woodland, Marybank, NH480532, B.R. and C.B. Ballinger, 2004, Garden throw-out.

‡61/1.1. POPULUS ALBA *__100__, Clyde Is. (Little Cumbrae): Fintray Bay, NS158567, A.McG. Stirling, 1989.

‡61/1.3×del. POPULUS ×CANADENSIS (P. NIGRA × P. DELTOIDES) *__100__, Clyde Is. (Arran): Kildonan/Dippen/Largybeg shoreline, NS02, BSBI Field Meeting, 1987.

61/2.1. SALIX PENTANDRA *__100__, Clyde Is. (Bute): Stravanan Glen, NS080575, A.C. Hannah, 2003.

61/2.10b. SALIX CAPREA subsp. SPHACELATA *__65__, N.W. Yorks.: Limestone rock, Cronkley Scar, NY8528, D.J. Tennent, 2002, **herb. D.J.T.**, det. R.D. Meikle. *__67__, S. Northumb.: One bush c. 3m high in riverside scrub, River N. Tyne at Coldwell, NY909731, M.E. Braithwaite, 2004, **herb. G.A.S.**, det. R.D. Meikle.

61/2.11×12. SALIX ×MULTINERVIS (S. CINEREA × S. AURITA) *__100__, Clyde Is. (Bute): Lubas Bay and Barr Point, NS0854, M.E. Braithwaite, 2003.

†62/2.1. DESCURAINIA SOPHIA *__89__, E. Perth: Compressed soil of parking/turning area, Cambusmichael churchyard, NO115325, L. Farrell, 2004.

¢62/9.1. MALCOMIA MARITIMA *__H6__, Co. Waterford: Single plant on waste ground, Knocklucas, S211219, P.R. Green, 2004.

¢62/10.lon. MATTHIOLA LONGIPETALA *__64__, Mid-W. Yorks.: Rubbish heap, Tong Park, Baildon, SE160405, B.K. Byrne, B.A. Tregale & M. Wilcox, 2002.

‡62/11.4. BARBAREA VERNA *__100__, Clyde Is. (Arran): By track along shore near culvert works on shore west of Kildonan Post Office, NS017212, A.W. Smith, 1999. ?Introduced with culvert material. Since spread to nearby gardens.

62/12.1. RORIPPA NASTURTIUM-AQUATICUM *__100__, Clyde Is. (Arran): Kildonan/Dippen/ Largybeg shoreline, NS02, BSBI Field Meeting, 1987.

62/12.1×2. RORIPPA ×STERILIS (R. NASTURTIUM-AQUATICUM × R. MICROPHYLLA) *__100__, Clyde Is. (Bute): Scalpsie Bay, NS057583, BSBI Field Meeting, 1998.

62/12.4. RORIPPA PALUSTRIS *__100__, Clyde Is. (Bute): Scalpsie Bay and Loch Quien, NS05, A. R. Church, 1988.

62/12.5. RORIPPA SYLVESTRIS *__100__, Clyde Is. (Bute): Loch Ascog; Loch Fad, NS06, BSBI Field Meeting, 1998.

62/17.1. LUNARIA ANNUA *__100__, Clyde Is. (Arran): Sandbraes shore, Whiting Bay, NS051276, A.W. Smith, 1992.

62/23.3b. COCHLEARIA OFFICINALIS subsp. SCOTICA *__100__, Clyde Is. (Arran): Small bay immediately to south of Millstone Point, NR992498, A.R. Church, 1986.

62/23.5. COCHLEARIA DANICA **100**, Clyde Is. (Great Cumbrae): NS15, NCC Freshwater Loch Survey, 1996. 1st record since 1970.

¢62/30.1. LEPIDIUM SATIVUM *__100__, Clyde Is. (Arran): Sandbraes, pasture next to shore, NS053276, A.W. Smith, 2000.

‡62/30.8a. LEPIDIUM DRABA subsp. DRABA **100**, Clyde Is. (Little Cumbrae): NS15, Glasgow Natural History Society, 1984. 1st record since 1970.

†62/35.2. SINAPIS ALBA **2**, E. Cornwall: Arable field, mainly cereal, but with a game crop at one edge with Millet and *Chenopodium quinoa*, Caerhayes Barton Farm, near St Michael Caerhayes, SW964426, I.J. Bennallick & R.J. Murphy, 2002. 1st recent record & only extant site.

‡62/38.1. HIRSCHFELDIA INCANA *__H6__, Co. Waterford: Single large specimen, roadside, Rath, X148788, P.R. Green, 2002.

†63/1.1. RESEDA LUTEOLA **91**, Kincardines.: Roadside, Cammachmore, NO905943, D. Welch, 2004. 1st record since 1970. *__100__, Clyde Is. (Arran): Lamlash Village, NS0231, A.R. Church & A.W. Smith, 1994.

¢63/1.odo. RESEDA ODORATA *__64__, Mid-W. Yorks.: Rubbish heap, Tong Park, Baildon, SE160405, B.K. Byrne, B.A. Tregale & M. Wilcox, 2002.

‡65/8.1. GAULTHERIA SHALLON *__100__, Clyde Is. (Bute): Rothesay; Bogany Wood, NS104650, BSBI Field Meeting, 1998.

‡65/8.3. GAULTHERIA MUCRONATA *__100__, Clyde Is. (Bute): Rothesay; Bogany Wood, NS104650, BSBI Field Meeting, 1998.

‡65/9.1. ARBUTUS UNEDO *__H6__, Co. Waterford: Single tree, self-sown, in hedge, Knocknageragh, X141800, P.R. Green, 2002.

65/13.1. VACCINIUM OXYCOCCOS **106**, E. Ross: Sphagnum hollows with scattered birch. Main patch approx. 6m.x 6m, Monadh Mhor, NH587534, P. Wortham, 2004, **herb. B. Ballinger**. 1st record since 1970.

65/13.2. VACCINIUM MICROCARPUM ▣ **89**, E. Perth: On *Drosera rotundifolia* mound on peat moor, Blath Bhalg, Moulin Moor, NO005610, L. Farrell & R. Youngman, 2003. ▣ **106**, E. Ross: At 438 m altitude on wet moorland with *Empetrum nigrum* under *Calluna vulgaris*, by Deanich Lodge, NH383829, B.R. and C.B. Ballinger, 2004, **herb. B. Ballinger**.

66/1.1. PYROLA MINOR **73**, Kirkcudbrights.: 10,000+ plants in woodland on old dismantled rail bed on viaduct, Goldielea, NX 930736, J. Darbyshire, 2003. 1st recent record. Viaduct bed being re-sealed; translocation and replanting to be tried.

66/1.3. PYROLA ROTUNDIFOLIA **83**, Midlothian: Over 1000 plants in heathy birch wood, reclaimed coal bing, Gore Glen, Gore Bridge, NT337617, S. Maxwell, 2002, det. D.R. McKean. 1st record since 1863!

‡69/1.9. PRIMULA JAPONICA *¢**13**, W. Sussex: Well established in several places near stream in wet woods, Shottermill, SU884325, F. Abraham, 2004, det. A.G. Knapp & A.G. Hoare.

‡71/DEU.sca. DEUTZIA SCABRA *¢**64**, Mid-W. Yorks.: Neglected copse, Aberford, SE431396, P.P. Abbott, 2002, det. local nurseryman. Probably planted some time ago.

‡72/2.4. RIBES SANGUINEUM *¢**100**, Clyde Is. (Bute): Cnocnicol Wood, NS100608, A.C. Hannah, 2004.

‡72/2.5. RIBES ODORATUM *¢**67**, S. Northumb.: Seaton Sluice, NZ336768, R.E. Groom, 1994, **herb. G.A.S.** Re-found at the original site by A. & G. Young in 2004.

73/1.1. CRASSULA TILLAEA *‡**73**, Kirkcudbrights.: Patch 30 × 5 m. Roadside verge, Crossmichael, NX 720683, BSBI meeting, 2002. From a lay-by used by visiting birders from all over the UK. *‡**106**, E. Ross: Approx. 30 plants over 1 m^2 in gravel on station platform, Dingwall, NH553586, B.R. and C.B. Ballinger, 2004, **herb. B. Ballinger**, det. R. Stephenson. ▣‡**106**, E. Ross: 100+ plants in 2 m^2 in gravel at entrance to station, Invergordon, NH704686, B. R. and C.B. Ballinger, 2004, **herb. B. Ballinger**, det. R. Stephenson.

‡73/1.3. CRASSULA HELMSII *¢**65**, N.W. Yorks.: Moorland spring, Blackhill, Ellerton Moor, SE057966, D.J. Millward, 2002. *¢**79**, Selkirks.: Pond, Yair Forest, south of Yair House, NT452322, J. Muscott, J. Murray & M. Clarkson, 2002, **herb. R.W.M.C.**. *¢**100**, Clyde Is. (Arran): Merkland Pond, NS020382, A.R. Church & A.W. Smith, 1998.

73/5.5. SEDUM TELEPHIUM ‡**106**, E. Ross: Approx. 12 flowering shoots on roadside verge, Loandhu, NH815788, B.R. and C.B. Ballinger, 2004. Near houses. ?Garden escape.

73/5.11. SEDUM FORSTERIANUM *¢**100**, Clyde Is. (Arran): Lamlash Village, NS0231, A.R. Church & A.W. Smith, 1994.

‡73/CHI.op. CHIASTOPHYLLUM OPPOSITIFOLIUM *¢**46**, Cards.: Old wall, Plas Ynys-hir, SN681958, A.O. Chater, 2004, **NMW**. Naturalised.

‡74/5.2. SAXIFRAGA CYMBALARIA *¢**89**, E. Perth: Gravelly car park opposite Bridge of Cally Hotel, NO141513, A.G. Knapp, 2002. Not present as planted species on adjacent wall.

74/5.19. SAXIFRAGA TRIDACTYLITES *¢**77**, Lanarks.: Barish ground at site of previous Ravenscraig Steel Works, Motherwell, NS75, M. Bates, 2002.

‡74/7.1. TOLMIEA MENZIESII *¢**H6**, Co. Waterford: Edge of forest ride, Knocknaglogh, R971050, P.R. Green, 2002.

75/8.14. RUBUS ARRHENIIFORMIS *¢**46**, Cards.: Road verge, Gardeni, Llangwyryfon, SN612722, D.E. Allen & A.O. Chater, 2004, **BM**, conf. A. Newton.

75/8.37. RUBUS CALVATUS *¢**10**, Wight: Dame Anthony's Common, Binstead, SZ5791, D.E. Allen & C.R. Pope, 2004, conf. A. Newton, **BM**, **HCMS**.

75/8.45. RUBUS CRUDELIS *¢**11**, S. Hants.: Hedge-top, Calmore, near Totton, SU339153, D.E. Allen, 2004, conf. A. Newton, **BM**, **HCMS**.

‡75/8.55. RUBUS LACINIATUS *¢**91**, Kincardines.: Roadside, St Cyrus, NO795680, D. Welch, 2001, det. A. Newton, **herb. D. Welch**.

75/8.71. RUBUS PLYMENSIS *¢**45**, Pembs.: Shady bridleway, Trefloyne Wood, Penally, SS1099, **NMW**; plantation margin by Manorbier Castle, SS063978, **BM**, D.E. Allen, 2004, det. A. Newton.

75/8.75. RUBUS PURBECKENSIS *¢**45**, Pembs.: In quantity among gorse, Lydstep Headland, SS0897, **BM**, **NMW**; and in two places at Manorbier, SS058977 & 063981, **BM**, D.E. Allen, 2004. 1st Welsh records.

75/8.95. RUBUS CISSBURIENSIS *†**45**, Pembs.: Artificial bank opposite beach car park, Freshwater East, SS015978, D.E. Allen, 2004, **BM**. 1st Welsh record.

75/8.102. RUBUS ELEGANTISPINOSUS *__15__, E. Kent: Hedge, Kennington Road, Ashford, TR035422, D.E. Allen, 2004, **BM**.

75/8.122. RUBUS RUBRITINCTUS *__69__, Westmorland: Roadside, Brigsteer Road, Kendal, SD504919, A.M. Boucher, 2004, det. D.E Allen, **BM**.

75/8.125. RUBUS SUBINERMOIDES *__45__, Pembs.: Colony in thorny scrub, Caldey Island, SS139968, D.E. Allen, 2004, **BM**.

75/8.151. RUBUS EUANTHINUS *__45__, Pembs.: Hedge on moorland border above Tenby, SN?, S. H. Bickham, 1907, det. W.M.Rogers, **CGE,** conf. B.A. Miles: green lane near South Astridge Farm, near Gumfreston (the 1907 locality?), SN107024, D.E. Allen, 2004, det. A. Newton, **BM**, **NMW**.

75/8.155. RUBUS LETTII *__45__, Pembs.: Frequent, green lane near South Astridge Farm, Gumfreston, SN104025–6, D.E. Allen, 2004, conf. A. Newton, **BM**. 1st record outside Ireland and Man.

75/8.171. RUBUS MUCRONATIFORMIS *†__48__, Merioneth: Rough ground in garden, Dolgellau, SH7217?, W.C. Barton & H.J. Riddelsdell as *R. boraeanus*, 1923, **BM**, det. D.E. Allen, conf. A. Newton. Probably introduced with nursery plants.

75/8.184. RUBUS GLAREOSUS *__10__, Wight: Patch on cross-paths, Firestone Copse, SZ556913, D.E. Allen, 2004, **BM**, **HCMS**.

75/8.193. RUBUS MELANODERMIS *__10__, Wight: Under tall gorse, Ventnor golf links, SZ548777, D.E. Allen, 2003, det. A. Newton, **BM**.

75/8.199. RUBUS RADULOIDES *__45__, Pembs.: Hedgebanks, Petre Galar, SN176307, D.E. Allen, 2004, det. A. Newton, **BM**, **NMW**.

75/8.225. RUBUS BOTRYEROS *__11__, S. Hants.: Abundant in tall scrub encircling Little Testwood Lake, SU3415, D.E. Allen, 2003–4, det. A. Newton, **BM**, **HCMS**.

75/8.241. RUBUS LARGIFICUS *__45__, Pembs.: Abundant along former flood bank, Lower Common, Pembroke, SM982015, D.E. Allen, 2004, conf. A. Newton, **BM**.

75/8.254. RUBUS RUFESCENS *__83__, Midlothian: Only a bush or two by dyke under tall shrub by south side of Braepark Road, at edge of field, Cramond Brig, Edinburgh, NT181754, G.H. Ballantyne, 2002, **herb. G.H.B.**

[75/8.290. RUBUS THYRSIGERIFORMIS *__12__, N. Hants.: Hedgebank on one-time Froxfield Common, near Hawkley, SU700284, D.E. Allen, 2002, **BM**. This record is erroneous and should be deleted.]

75/8.290. RUBUS THYRSIGERIFORMIS *__12__, N. Hants.: One bush on A31 margin of Weathermore Copse, Four Marks, SU675355, D.E. Allen, 2000, **BM**.

75/8.308. RUBUS EBORACENSIS *__45__, Pembs.: Lane through marshy woodland, Scotsborough, near Tenby, SN117010, D.E. Allen, 2004, conf. A. Newton, **BM, NMW**.

75/8.hin. RUBUS HINDII *__11__, S. Hants.: Wood margins at corner of Hocombe Upper Plantation, SU423232, D.E. Allen, 2004, conf. A. Newton, **BM**, **HCMS**.

75/8.vin. RUBUS VINDOMENSIS *__10__, Wight: Hill Copse, near Yarmouth, SZ356880–2, D.E. Allen & C.R. Pope, 2004, **BM**, **HCMS**.

‡75/9.9. POTENTILLA NORVEGICA **95**, Moray: 200+ plants growing on the sidings of the old railway at Knockando, NJ191517, I.P. Green & Somerset Rare Plant Group, 2004. 1st record since 1970.

75/9.14×15. POTENTILLA ×MIXTA (P. ANGLICA × P. REPTANS) *__65__, N.W. Yorks.: Disturbed ground on bank below track, Catterick Garrison, Foxglove Covert LNR, SE162977, D.J. Millward & C. Newlands, 2004, conf. B. Harold.

‡75/18.1. ACAENA NOVAE-ZELANDIAE *__58__, Cheshire: Several scattered colonies on old railway (now trans-Europe footpath), Dunham Massey, SJ720884, G.M. Kay, 2002. *__79__, Selkirks.: Forestry track, North of Yair House, Yair, NT452331, J. Muscott, J. Murray & M. Clarkson, 2002, **herb. R.W.M.C.**

‡75/18.2. ACAENA ANSERINIFOLIA *__95__, Moray: Couple of plants growing around the edge of car park of Christie's Nurseries, Fochabers, NJ350584, I.P. Green, 2004.

‡75/21.1. ROSA MULTIFLORA *__H6__, Co. Waterford: Single bush in roadside hedge, Faha, S365030, I.P. Green, 2002.

75/21.11×12. ROSA ×ANDEGAVENSIS (R. STYLOSA × R. CANINA) *__H6__, Co. Waterford: Several bushes, with both parents, in roadside hedge, Dungarvan, X248947, P.R. Green, 2002, det. A.L. Primavesi.

75/21.12. ROSA CANINA **113(S)**, Channel Is. (Sark): In hedge among scrub and bracken on steep bank, by path from Harbour to Les Laches, WV475756, R.M. Veall, 2002, **herb. Société Sercquiaise**, det. A.L. Primavesi. 1st *R. canina* in Sark (?in v.c. 113) to be determined to Group Transitoriae.

75/21.12×14. ROSA ×DUMETORUM (R. CANINA × R. OBTUSIFOLIA) **13**, W. Sussex: One bush on shingle, Lancing Beach, TQ185037, E.B. Bishop, 2004, det. R. Maskew. 1st record since 1970.

75/21.13b×18. ROSA CAESIA SUBSP. VOSAGIACA × R. RUBIGINOSA *__64__, Mid-W. Yorks.: Shipley, SE151379, M. Wilcox, 2002, conf. A.L. Primavesi.

75/21.18. ROSA RUBIGINOSA *__H6__, Co. Waterford: Two bushes growing on wall of bridge, Kilmolash, S130949, P.R. Green & A.C. Leslie, 2004, conf. R. Maskew.

75/21.20. ROSA AGRESTIS *__H6__, Co. Waterford: Roadside hedge, Dungarvan, X248947, P.R. Green, 2002, det. A.L. Primavesi. First found here in 1983 by T. O'Mahony.

75/22.4×5. PRUNUS ×FRUTICANS (P. SPINOSA × P. DOMESTICA) *__H6__, Co. Waterford: Several trees naturally occurring on edge of woodland, Whitesfort, S143168, P.R. Green, 2004.

‡75/22.13. PRUNUS LUSITANICA *__91__, Kincardines.: A single mature tree in roadside woodland strip, Tilquhillie, NO726942, D. Welch, 2004.

‡75/32.11×18. COTONEASTER ×SUECICUS (C. DAMMERI × C. CONSPICUUS) *__H6__, Co. Waterford: Single self-sown bush on top of churchyard wall, Lismore, X047977, I.P. Green, 2002, det. J. Fryer.

‡75/32.22. COTONEASTER HJELMQVISTII *__39__, Staffs.: Floor of disused quarry, Fen's Pool Nature Reserve, SO941893, J.E. Hawksford, 2004.

‡75/32.35. COTONEASTER REHDERI *__65__, N.W. Yorks.: Lay-by, A684, NE of Sedbergh, SD683929, J. Clarke & C.E. Wild, 2004, conf. G. Halliday. Cumbrian Local Change square.

‡75/32.40. COTONEASTER STERNIANUS *__2__, E. Cornwall: Several bushes, evidently established, on waste ground, at western end of Par Beach, SX078533, P.R. Green & A.C. Leslie, 2002. New to Cornwall. *__H6__, Co. Waterford: Single bush, self-sown, forest ride, Toor South, X176858, I.P. Green, 2002, det. J. Fryer.

‡75/32.hen. COTONEASTER HENRYANUS *__H6__, Co. Waterford: 13 bushes self-sown on forest ride, Russelstown Bridge, S163196, I.P. Green, 2002, det. J. Fryer.

[‡75/32.ign. COTONEASTER IGNESCENS *__77__, Lanarks.: Well established on long abandoned railway cutting, Dalmarnock, Glasgow, NS6163, P. Macperson & E.K. Lindsay (not E.L.S. Lindsay), 2001, **herb. P.M.** det. J. Fryer. 1st British record.]

[‡75/32.mai. COTONEASTER MAIREI **77**, Lanarks.: Bird sown and established on long abandoned railway viaduct, Dalmarnock, Glasgow, NS6163, P. Macperson & E.K. Lindsay (not E. L.S. Lindsay), 2001, **herb. P.M.** det. J. Fryer. 2nd record.]

‡75/35.2. CRATAEGUS COCCINIOIDES *__5__, S. Somerset: Single bush, thought to be self-sown, at edge of path in woodland, Jenny Cridland's Copse, Watchet, ST053428, J. Webb, 2002, det. R.D. Meikle.

‡75/35.4. CRATAEGUS CRUS-GALLI *__58__, Cheshire: Hedgerow, Haslington, SJ734572, G.M. Kay, 2002.

75/35.7×8. CRATAEGUS ×MEDIA (C. MONOGYNA × C. LAEVIGATA) *‡__79__, Selkirks.: Hedge, Newburgh Farm, Ettrick, NT323199, M.E. & P.F. Braithwaite, 2004.

77/14.8. VICIA TETRASPERMA *‡__H6__, Co. Waterford: Several plants in disused quarry, Ballynaharda, X265120, P.R. Green, 2002.

‡77/15.7. LATHYRUS GRANDIFLORUS *__46__, Cards.: Roadside hedge, Bow Street, SN625851, A. O. Chater, 2004, **NMW**. Naturalised.

†77/17.1. MELILOTUS ALTISSIMUS *__79__, Selkirks.: Waste ground, old mill, Ettrick riverside, NT468290, L. Gaskell, 2004, **herb. R.W.M.C.**

‡77/19.17. TRIFOLIUM PANNONICUM *¢__1a__, W. Cornwall: Casual only in arable set aside field, Trelease Farm, Lanarth, near St. Keverne, SW761213, I.J. Bennallick, 2002. New to Cornwall.

77/25.2. GENISTA TINCTORIA *‡__77__, Lanarks.: Established colonies on motorway banks, both north and south carriageways, M74, north of Abington, between junctions 12 & 13, NS886273, J. R. Hawell, 2004, **herb. P.M.**

77/26.2. ULEX GALLII *‡**89**, E. Perth: Two bushes in flower on S facing bank in field opposite Finegand road-end, Glen Shee, NO138663, R.W.M. Corner, 2004, **PTH**, det. P.M. Benoit.

¢77/DOR.hir. DORYCNIUM HIRSUTUM *__6__, N. Somerset: Single bush self-sown at base of wall, Weston-super-Mare, ST314619, P.R. Green, 2004, det. M.L. Stephens.

79/2.3. MYRIOPHYLLUM SPICATUM *__79__, Selkirks.: Pond constructed by forestry authorities 10–20 years ago, by forestry track, Mid Rig, Craik Forest, NT310104, R.W.M. Corner, 2003, **herb. R.W.M.C.**

84/1.2×3. EPILOBIUM ×LIMOSUM (E. PARVIFLORUM × E. MONTANUM) *__H6__, Co. Waterford: Waste ground, Scart Bridge, S229048, P.R. Green & A.C. Leslie, 2004.

84/1.2×6. EPILOBIUM ×DACICUM (E. PARVIFLORUM × E. OBSCURUM) *__64__, Mid-W. Yorks.: Old sandstone quarry, Ireland Wood, Leeds, SE255385, M. Wilcox, 2002, conf. G.D. Kitchener. *__H6__, Co. Waterford: With both parents on side of forest ride, Coolishal, S2820, P.R. Green & M. L. Stephens, 2004.

84/1.2×8. EPILOBIUM ×FLORIDULUM (E. PARVIFLORUM × E. CILIATUM) *__H6__, Co. Waterford: Several plants, with both parents, in disused quarry, Ballynaharda, X264811, P.R. Green, 2002.

84/1.2×12. EPILOBIUM ×ARGILLACEUM (E. PARVIFLORUM × E. BRUNNESCENS) *__2__, E. Cornwall: With both parents on China-clay gravels on upper part of China-clay tip, Wheal Remfrey, SE of Indian Queens, SW925581, G. Kitchener, 2002. 1st known record - a Cornish endemic.

84/1.3×6. EPILOBIUM ×AGGREGATUM (E. MONTANUM × E. OBSCURUM) **39,** Staffs.: Pavement cracks, Bolehall, SK218041, C. Higginbottom, C.N. Smith & M. Smith, 2004. 1st record since 1941.

84/1.4×8. EPILOBIUM LANCEOLATUM × E. CILIATUM *__5__, S. Somerset: Weed in flower border with both parents, Dunster, SS9943, M. Wilcox, 2002.

84/1.5×6. EPILOBIUM ×SEMIOBSCURUM (E. TETRAGONUM × E. OBSCURUM) *__64__, Mid-W. Yorks.: Old sandstone quarry, Ireland Wood, Leeds, SE255385, M. Wilcox, 2002, conf. G.D. Kitchener.

84/4.1×3×4. OENOTHERA GLAZIOVIANA × BIENNIS × CAMBRICA *__46__, Cards.: Ynys-las Dunes, SN606933, A.O. Chater, 1999, **NMW**, det. J.C. Bowra.

‡84/4.3. OENOTHERA BIENNIS *__79__, Selkirks.: Roadside, A72 at west end of Galashiels, NT472375, L. Gaskell, 2003, **herb. R.W.M.C.**, det. R.W.M. Corner.

84/4.3×4. OENOTHERA BIENNIS × O. CAMBRICA *__39__, Staffs.: Roadside, Stourton, SO862848, W.A. Thompson, 2004. BSBI Meeting.

¢84/CLA.ung. CLARKIA UNGUICULATA *__95__, Moray: 1 plant growing on Elgin Rubbish Tip, NJ2363, I.P. Green & WFS, 2004.

90/1.1. BUXUS SEMPERVIRENS *‡__79__, Selkirks.: Woodland, by R. Tweed at Yair House , NT4529, M.E. & P.F. Braithwaite, J. Muscott & J. Murray, 1998. Planted. Omitted in error from VCCC.

‡91/2.15. EUPHORBIA CYPARISSIAS *__113(S)__, Channel Is. (Sark): At edge of unmetalled road, Le Grand Beauregard, WV458756, R.M. Veall, 2002, **herb. Société Sercquiaise**.

92/2.1. FRANGULA ALNUS ‡__106__, E. Ross: At least 3 trees in wet woodland, Loch Achilty, NH437569, B.R. and C.B. Ballinger, 2004, **herb. B. Ballinger**.

‡101/SKI.jap. SKIMMIA JAPONICA *__77__, Lanarks.: Established on edge of long abandoned garden with extension into neighbouring wood, Cadder, NS615722, P. Macpherson, 2003, **herb. P.M.**, det. E.J. Clement.

‡103/1.1×2. GERANIUM ×OXONIANUM (G. ENDRESSII × G. VERSICOLOR) *__65__, N.W. Yorks.: Lay-by, A684, NE of Sedbergh, SD683929, C.E. Wild, 2004, conf. G. Halliday. Cumbrian Local Change square. *__H6__, Co. Waterford: Very little in roadside hedge, Lisnakill, S529076, I.P. Green, 2002.

‡103/1.17. GERANIUM MACRORRHIZUM *__65__, N.W. Yorks.: Lay-by, A684, NE of Sedbergh, SD683929, J. Clarke & C.E. Wild, 2004, conf. G. Halliday. Cumbrian Local Change square. *__H6__, Co. Waterford: Several clumps on road bank, Ballyknock, S592051, D. McGrath, 2004, det. P.R. Green.

‡103/1.23. GERANIUM PHAEUM ¢__106__, E. Ross: Sandy shore, Tain, NH791827, B.R. and C.B. Ballinger, 2004, *album* form. ?Garden escape.

103/2.4. ERODIUM LEBELII *__5__, S. Somerset: Edge of dunes, Minehead Warren, SS9846, M. Wilcox, 2002.

¢106/FAT.jap. FATSIA JAPONICA *__6__, N. Somerset: Single healthy specimen growing by a ditch in a small fir wood between Barrow Wood and Barrow Copse, Witham Friary, ST729420, G. Read, 2004, det. A. Stevenson.

¢107/6.2. ANTHRISCUS CAUCALIS *__46__, Cards.: Flowerbed, Ysgol Penweddig, Aberystwyth, SN595810, A.O. Chater, 2004, **NMW**.

107/16.1. BERULA ERECTA *__106__, E. Ross: Abundant in approx.100m of fast flowing stream, Rhanich, NH714805, B.R. and C.B. Ballinger, 2004, **herb. B. Ballinger**, det. M.J. Southam. Unconfirmed record for Alness, 1899.

†107/21.1. FOENICULUM VULGARE __67__, S. Northumb.: One large flowering plant in central reservation of A69 just west of Corbridge, NY9565, A.J. Richards, 2004. 1st record since 1970.

¢107/32.1. AMMI MAJUS *__46__, Cards.: Garden 200m ESE of crossroads, Pontrhydfendigaid, SN731663, A.O. Chater, 2004, **NMW**. Bird seed alien.

¢107/32.vis. AMMI VISNAGA *__79__, Selkirks.: Tweed and Galaside, NT43, I.M. Hayward, 1913, **E**, det. M.B. Tyrrell. Information from D.R. McKean. *__80__, Roxburghs.: Tweedside below Galashiels, NT53, W.B. Boyd, 1904, **E**. Information from D.R. McKean.

107/41.1×2. HERACLEUM SPHONDYLIUM × H. MANTEGAZZIANUM *__64__, Mid-W. Yorks.: Several (sterile) plants on S bank of R. Aire, Leeds, SE280340, Wild Flower Society, 2002.

108/3.2. CENTAURIUM ERYTHRAEA __89__, E. Perth: Ledge on volcanic cliff, Kinnoull Hill, 100 m east of the monument, NO141227, A. Godfrey, 2003, det. M.C. Robinson. 1st recent record.

‡110/6.per. PHYSALIS PERUVIANA *__¢58__, Cheshire: Casual only on landfill site, Hooton, SJ347789, R. Goodchild, 2002.

¢110/PET.axi × int. PETUNIA ×HYBRIDA (P. AXILLARIS × P. INTEGRIFOLIA) *__13__, W. Sussex: Roadside bank, dumped soil, Summer Down, TQ265108, P.A. Harmes & A. Spiers, 2004, conf. A. G. Knapp.

111/3.2×4. CALYSTEGIA ×LUCANA (C. SEPIUM × C. SILVATICA) *__H6__, Co. Waterford: Along length of hedge leading to beach, Fornaght Strand, Knockavelish, S702037, I.P. Green & P.R. Green, 2002.

¢115/1.1. PHACELIA TANACETIFOLIA *__H6__, Co. Waterford: A few plants in a ditch, Knockboy, S642096, D. McGrath, 2004, det. P.R. Green.

116/2.1. ECHIUM VULGARE __H6__, Co. Waterford: Single plant on waste ground, Aughnamucka, S665072, P.R. Green, 2002. 2nd record & 1st since 1882.

‡116/2.2. ECHIUM PLANTAGINEUM *__¢58__, Cheshire: In cultivated field, in crop of *Chenopodium quinoa*, Nessholt, Wirral, SJ296755, R. Goodchild, 2002.

‡116/4.7. SYMPHYTUM CAUCASICUM *__13__, W. Sussex: Dumped soil at roadside, The Hoe, Ebernoe, SU983277, F. Abraham & R.I. Hemsley, 2004. Known here since 2002. *__46__, Cards.: Field behind Cefn Melindwr, Capel Bangor, SN658800, S.P. Chambers, 2004. Naturalised.

‡116/4.8. SYMPHYTUM BULBOSUM *__1a__, W. Cornwall: Established along roadside verge, Threemilesone, near Truro, SW775452, M.J. Stribley, 2002, det. F.H. Perring. New to Cornwall.

‡116/12.2. AMSINCKIA MICRANTHA *__79__, Selkirks.: Waste ground, old mill, Ettrick riverside, NT468290, L. Gaskell, 2004, **herb. R.W.M.C.**

‡116/13.1. PLAGIOBOTHRYS SCOULERI *__¢H6__, Co. Waterford: Single plant on re-seeded road verge, Kilmacthomas, S3905, I.P. Green, 2002.

¢116/CER.maj. CERINTHE MAJOR *__6__, N. Somerset: One plant growing on disturbed road bank on sharp bend, Stockwood, ST632692, I.P. Green, 2004, det. M.L. Stephens.

†118/2.1. BALLOTA NIGRA __46__, Cards.: Waste ground, Ysgol Penweddig, Aberystwyth, SN595810, A.O. Chater, 2004, **NMW**. 1st record since 1970.

†118/6.3. GALEOPSIS SPECIOSA __2__, E. Cornwall: Over 50 plants in arable field near Callington, SX349705, K. Preston-Marfham, 2002. The only extant site in Cornwall.

¢118/13.rac × nep. NEPETA ×FAASSENII (N. RACEMOSA × N. NEPETELLA) *__13__, W. Sussex: Several plants on top of earth bank by road, Beggars Bush, TQ161078, A.G. Knapp & B. Clough, 2004.

¢118/18.gra. CLINOPODIUM GRANDIFLORUM *__95__, Moray: 1 plant growing on bank of ditch on edge of car park of Christie's Nurseries, Fochabers, NJ350584, P.R. Green, 2004.

118/21.2. THYMUS PULEGIOIDES __64__, Mid-W. Yorks.: Limestone grass bank, Ripon Parks MOD training area, SE310746, Yorkshire Naturalists' Union, 2002. 1st record since Lees' *Flora of West Yorkshire*, 1888, in which it was recorded between Collingham and Wetherby. That area now 'improved'.

‡118/23.1×2×3. MENTHA ×SMITHIANA (M. ARVENSIS × M. AQUATICA × M. SPICATA) **2**, E. Cornwall: By small stream in marshy area above Porthcurnick Beach near Portscatho, SW878359, R.E. Lees, 2002, det. R.J. Murphy. *Mentha aquatica* & *M. spicata* present, *M.* ×*verticillata* recorded in the past. Now the only extant record for v.c. 2.

‡118/23.3×4. MENTHA ×VILLOSA (M. SPICATA × M. SUAVEOLENS) *__91__, Kincardines.: Grassland near cottage, Gourdon, NO823706, D. Welch, 2002.

¢118/24.1. ROSMARINUS OFFICINALIS *__46__, Cards.: St David's Road, Aberystwyth, SN591816, A.O. Chater, 2004.

‡124/13.6. LINARIA ARENARIA *__6__, N. Somerset: About 300 plants on Berrow Dunes, ST292537, J. Lidgate, 2004, det. A. Hepworth & I. P. Green.

‡124/16.25. VERONICA LONGIFOLIA *__95__, Moray: 1 plant growing on the edge of car park of Christie's Nurseries, Fochabers, NJ350584, I.P. Green & WFS, 2004.

‡124/3.1. PHYGELIUS CAPENSIS *__H6__, Co. Waterford: Patch on waste ground, Logleagh, S007033, P.R. Green, 2004.

124/23.1. PARENTUCELLIA VISCOSA *¢__73__, Kirkcudbrights.: Amenity grassland, Dumfries, NX 977749, A. White, 2002.

125/2.8. OROBANCHE HEDERAE *__27__, E. Norfolk: Shady hedgebank, Witton Lane, Little Plumstead, TG313109, S. Hobbs, 2002, det. K.A. Beckett.

130/6.6×7. GALIUM ×POMERANICUM (G. VERUM × G. MOLLUGO) *__64__, Mid-W. Yorks.: Roadside, Aberford, SE430399, P.P. Abbott, 2002.

131/4.1. LINNAEA BOREALIS ◘ __89__, E. Perth: In *Calluna* on open hillside, Ben Vrackie, NN963622, L. Tucker, 2003, det. M.C. Robinson. 2nd recent record.

‡131/6.1. LONICERA PILEATA *__H6__, Co. Waterford: Single bush self-sown on wall, Ballyduff More, X218934, P.R. Green, 2002.

‡131/6.4. LONICERA XYLOSTEUM *__H6__, Co. Waterford: Several bushes in small wooded area, Cooltegin, S682064, I.P. Green, 2002.

134/3.1. KNAUTIA ARVENSIS ¢__91__, Kincardines.: Grassland by car park, Ythsie, NJ882308, J. Malster, 2003. 1st record since 1906 but probably introduced in grass seed.

135/6.9×10. CIRSIUM ×CELAKOVSKIANUM (C. PALUSTRE × C. ARVENSE) *__80__, Roxburghs.: Grassland, Priesthaugh Cottages, Priesthaugh, Teviothead, NT467042, M.E. Braithwaite, 2002, **herb. R.W.M.C.** Supporting photograph of plants showing rhizomatous habit.

¢135/17.2. PICRIS HIERACIOIDES *__95__, Moray: 3 plants growing on made up bank of track, Kingston, NJ333651, I.P. Green, 2004.

135/27.2×6. PILOSELLA ×STOLONIFERA (P. OFFICINARUM × P. AURANTIACA) *__39__, Staffs.: Wall top, Upper Arley, SO764803, W.A. Thompson & M.O. Stead, 2004. BSBI Meeting.

†135/32.1. ANAPHALIS MARGARITACEA *‡__89__, E. Perth: Central reservation of A9, 1/2 mile S of N end of dual carriageway, NN655726, O. Mountford, 2003.

‡135/40.3. SOLIDAGO CANADENSIS *__91__, Kincardines.: Riverside woodland, Maryculter, NJ867012, J. Waddell, 2004.

‡135/50.lud. ARTEMISIA LUDOVICIANA *__95__, Moray: 1 patch growing on a heap of soil dumped near the ruins of Woodside Farm, Elgin, NJ235633, I.P. Green & A. Stevens, 2004, det. B. & C. Hawkins.

¢135/56.cor. CHRYSANTHEMUM CORONARIUM *__95__, Moray: 3 plants growing on Elgin Rubbish Tip, NJ2363, I.P. Green, 2004.

¢135/62.3. SENECIO INAEQUIDENS *__6__, N. Somerset: One plant only, with several stems on rockery in garden of Home Farm, 1km SSE of Charlton Musgrove, ST731307, B. Simmons, 2004, **herb. H. Crouch**, det. H. Crouch.

‡135/68.2. LIGULARIA PRZEWALSKII ◘ __67__, S. Northumb.: River alluvium, island in River N. Tyne, upstream of Riverhill, NY901734, M.E. Braithwaite, 2004, **herb. G.A.S.** Presumably garden escape.

135/81.1. BIDENS CERNUA __80__, Roxburghs.: Side of Barons Folly Loch, Ancrum, NT641266, L. Gaskell, 2004, **herb. R.W.M.C.** 2nd record and 1st since 1832.

¢135/ARH.cal. ARCTOTHECA CALENDULA *__6__, N. Somerset: Growing on Glastonbury wool tip, ST4838, A.C. Leslie, 1971, **herb. A.C. Leslie**. This record has only just come to light.

138/1.1. HYDROCHARIS MORSUS-RANAE *‡__73__, Kirkcudbrights.: White Loch, Colvend, NX 864546, J. Day (Scottish Lochs Survey), 1996. Naturalised but introduced.

[138/3.1. EGERIA DENSA **73**, Kirkcudbrights.: Old fish pond, New Abbey, NX 962663, O.M. Stewart, 1997, det. D.R. McKean. Re-determined as *Elodea callitrichoides*.]

‡138/4.3. ELODEA CALLITRICHOIDES *__73__, Kirkcudbrights.: Old fish pond, New Abbey, NX 962664, O.M. Stewart, 1997, det. D.R. McKean.

138/5.1. HYDRILLA VERTICILLATA *__73__, Kirkcudbrights.: Bargatton Loch, Laurieston, NX 6961, R.V.H. Lansdown, 1999, det. C. D. Preston & C.A. Stace. 1st British Isles record since 1941. (See *BSBI News* 84:62).

142/1.5×6. POTAMOGETON ×ANGUSTIFOLIUS (P. LUCENS × P. GRAMINEUS) *__H6__, Co. Waterford: River, Knocklofty Bridge, S144205, I.P. Green & P.R. Green, 1997. Very common on River Suir. Originally named as *P.* ×*nitens* and mapped in *New Atlas* as that but re-determined by N.T.H. Holmes.

144/1.1. NAJAS FLEXILIS **73**, Kirkcudbrights.: Drift-line leaves found, Loch Kindar, New Abbey, NX 972639, J. Day (Scottish Lochs Survey), 1996. 1st recent record.

‡147/6.1. DRACUNCULUS VULGARIS *¢__H6__, Co. Waterford: Two clumps (dumped at some time) in wood, Tramore, S583017, P.R. Green, 2002.

¢147/PIS.str. PISTIA STRATIOTES *__6__, N. Somerset: Number of plants found in ditch. Burnham Level, ST315487, P. Brewin, 2002, det. S. Parker.

‡148/2.4. LEMNA MINUTA *__60__, W. Lancs.: Main drainage ditch, Lytham Moss, Lytham St Annes, SD346305, E.F. Greenwood, 2002, **LIV**.

151/1.4. JUNCUS GERARDII **64**, Mid-W. Yorks.: Marsh, Roecliffe, SE388670, P.P. Abbott & R. Goodison, 2004, conf. E.F. Greenwood. Last recorded in v.c. 64 by W.A. Sledge in 1937.

151/1.8. JUNCUS AMBIGUUS ‡__21__, Middlesex, Marsh, Shortwood Pond, TQ046719, R.M. Burton, 2004, conf. T.A. Cope. Extinct as a native plant, but here perhaps connected with saline run-off from nearby A30 road.

151/1.10. JUNCUS CAPITATUS *__2__, E. Cornwall: Up to 120 plants at two sites, around rocky outcrop on coastal cliff slope, The Blouth, N.E. of Nare Head, SW928381, I.J. Bennallick & W. Eyre, 2002, **BM**. *Radiola linoides* present at these sites but nowhere else on the cliff.

151/1.26×27. JUNCUS ×KERN-REICHGELTII (J. EFFUSUS × J. CONGLOMERATUS) *__80__, Roxburghs.: Birchwood, above Kittyfield Farm, Gattonside, NT564358, L. Gaskell, 2002, **herb. R.W.M.C.**, det. C.A. Stace.

152/2.2a×2b. TRICHOPHORUM CESPITOSUM nothosubsp. FOERSTERI (T. CESPITOSUM subsp. CESPITOSUM × subsp. GERMANICUM) *__73__, Kirkcudbrights.: Boggy peat between 550 and 600 m altitude, Bawnhead & Dugland , NS 6200 & 601010, D.M. Hawker, 2001, **herb. G. A. Swan/M. Wilcox**, det. G.A. Swan. All records made on same day. *▣ __73__, Kirkcudbrights.: Boggy peat at 120 m altitude, St John's Town of Dalry, NX 612868, D.M. Hawker, 2002, **herb. G. A. Swan/M. Wilcox**, det. M. Wilcox. Several more records since. *__79__, Selkirks.: Mire, S. side of Clearburn Loch, Alemoor, NT338154, R.W.M. Corner, 2002, **herb. R.W.M.C.**, det. G.A. Swan.

152/15.1. KOBRESIA SIMPLICIUSCULA ▣ __89__, E. Perth: Base-rich flush, Coire a'Ghearraig, Dalmunzie, Glen Lochsie, NO076699, G.P. Rothero, 2003. Part of larger site in adjacent 10 km square.

152/4.1. BOLBOSCHOENUS MARITIMUS *‡__80__, Roxburghs.: Fringing swamp, N. side of Bowdenmoor Loch, Melrose, NT539307, N.F. Stewart, 2003, **herb. R.W.M.C.**, det. D.A. Pearman. Deliberate introduction.152/16.5×15. CAREX ×PSEUDOAXILLARIS (C. OTRUBAE × C. REMOTA) **65**, N.W. Yorks.: Waterside, Catterick Fishing Lakes, SE235995, P.P. Abbott, D. Grant & D.J. Millward, 2004. 1st record since 1939. *__69__, Westmorland: Floor of old quarry, just behind saltmarsh, with both parents, Arnside, SD451783, M.J.Y. Foley, 2001, **LANC**, conf. M.S. Porter.

152/16.10. CAREX ARENARIA *‡__64__, Mid-W. Yorks.: Marsh, Brennand Valley, SD654520, E. F. Greenwood, P. Jepson & G.M. Kay, 2004. See *BSBI News* 97:64.

152/16.28×29. CAREX ×INVOLUTA (C. ROSTRATA × C. VESICARIA) *__91__, Kincardines.: Pool among willows on island in R. Dee, Maryculter, NJ867011, J. Waddell, 2004, det. M.S. Porter.

152/16.39. CAREX LAEVIGATA *__27__, E. Norfolk: Acid Woodland, Felthorpe, TG172167, L. Hall, 2002, **BM**, det. A.C. Jermy.

152/16.63. CAREX RECTA ▣ __106__, E. Ross: By shore and edge of channels in saltmarsh, Bonar Bridge and Ardgay, NH607918, D. Rae, 1996. Still present 2004 at NH607918, NH607917 and NH602909. Seen by B.R. and C.B. Ballinger and M. Dean. ▣ __106__, E. Ross: At edge of muddy, tidal estuary. One patch of approx. 625 m^2 and one of approx. 400 m^2, Kincardine, NH605898, B. R. and C.B. Ballinger, 2004, **herb. B. Ballinger**, det. A.C. Jermy.

152/16.72. CAREX RUPESTRIS *__106__, E. Ross: Rock outcrop, Breabag Ridge, NH303190, G.P. Rothero, 1998. Still present (12 plants) in 2004.

‡152/16.buc. CAREX BUCHANANII *__H6__, Co. Waterford: Single clump on waste ground, Orchardstown, S547083, P.R. Green, 2004, **DBN**, det. A.O. Chater. 1st record for Ireland.

‡153/12.7g. FESTUCA RUBRA subsp. MEGASTACHYS *__64__, Mid-W. Yorks.: Waste ground, Shipley, SE151379, M. Wilcox, 2002.

153/12.13. FESTUCA LEMANII *__46__, Cards.: River shingle, Aber-ffrwd, SN670783, A.O. Chater, 1989, **NMW**, conf. C.A. Stace.

153/13.1×2. LOLIUM ×BOUCHEANUM (L. PERENNE × L. MULTIFLORUM) *__H6__, Co. Waterford: Clump on road verge, Dromina, S695063, I.P. Green, 2002.

153/14.1. VULPIA FASCICULATA __95__, Moray: Frequent on sand dunes at Findhorn, NJ037648, I.P. Green, 2004, **LTR**, det. C.A. Stace. 1st record since 1970.

153/16.2a. PUCCINELLIA DISTANS subsp. DISTANS *‡__89__, E. Perth: Side of A724, above Moulin, Pitlochry, NO968599, 978605, R.W.M. Corner, 2000, **herb. R.W.M.C.** 1st post-1970 and inland records. Neophyte here but earlier records (on shore) probably native.

153/18.1. POA INFIRMA *__6__, N. Somerset: Scattered plants (fewer than 20) on corner of sea lawns, Weston-super-Mare, ST316603, P.R. Green, 2004, det. T.A. Cope.

153/36.1. HIEROCHLOE ODORATA *__67__, S. Northumb.: Colony covering 50 m^2 in runnels between blocks of whin at edge of River N. Tyne at Haughton, NY917730, M.E. Braithwaite, 2004, **herb. G.A.S.**, conf. R.W.M. Corner. 1st native record for England. There is a 2nd colony along 3 m. of water's edge at NY917730.

153/39.1×2. AGROSTIS ×BJOERKMANII (A. CAPILLARIS × A. GIGANTEA) *__46__, Cards.: At 300 m altitude Llety-Ifan-Hen, Tal-y-bont, SN686853, A.D. Bradshaw, 1959. *New Phytologist* 58: 214 (1959).

153/39.2×4. AGROSTIS GIGANTEA × A. STOLONIFERA *__64__, Mid-W. Yorks.: On weir on canal, Dowley Gap, Bingley, SE120382, M. Wilcox, 2002, conf. T.A. Cope.

153/50.2. BROMUS COMMUTATUS ‡__39__, Staffs.: Weed amongst wheat, W of Four Ashes, SO792875, J.E. Hawksford, D. Wall & C. Conroy, 2004, **STOKE**. 1st record since 1930; also found on the same day in a field W of Pattingham, SO809987 by G.M. Kay, J.H. Clarke, A.P. Daly & C. Tero, both during a BSBI Meeting.

153/50.3. BROMUS RACEMOSUS *__H6__, Co. Waterford: Many plants in marshy field next to Annestown Stream, Annestown, X499991, I.P. Green, 2002, det. T.A. Cope.

†153/50.7. BROMUS SECALINUS __67__, S. Northumb.: Waste ground, near North Sea Ferry terminal, NZ3466, A. & G. Young, 2002, **herb. G.A.S.**, det. L.M. Spalton. 1st record for many years. Was known in 19th Century; appears to have started to come back again.

‡153/52.4. ANISANTHA TECTORUM *¢__1a__, W. Cornwall: Casual only in a field sown with *Lolium perenne*, Cadgwith, The Lizard, SW719143, A. & M.G.C. Atkinson, 2002, conf. R.J. Murphy.

‡153/53.1. CERATOCHLOA CARINATA *__77__, Lanarks.: By roadside fencing on both sides of Kirklee Road, Kelvinside, Glasgow, NS5667, P. Macpherson, 2002, **herb. P.M.**, det. L.M. Spalton. Still present in 2004.

‡153/62.1. CORTADERIA SELLOANA *__46__, Cards.: Spoil of Goginan lead mine, SN692819, A. O. Chater, 2004. Naturalised.

¢153/71.san. DIGITARIA SANGUINALIS *__46__, Cards.: Base of wall by Aberystwyth Station, SN585815, S.P. Chambers, 2004, **herb. SPC**, det. T.B. Ryves.

¢153/PAN.mil. PANICUM MILIACEUM *__67__, S. Northumb.: In a roadside gutter, Stocksfield, NZ053616, S. Hedley, 2003, **herb. G.A.S.**, det. T.B. Ryves.

154/1.1b. SPARGANIUM ERECTUM subsp. MICROCARPUM *__H6__, Co. Waterford: Bank of R. Suir, Coolnamuck, S369221, P.R. Green, 2004, **herb. P.R.G.** 1st subspecies record.

158/1.1. TOFIELDIA PUSILLA *__68__, N. Northumb.: Near Loughend, NT9855, J. Ray, 1671. In the past thought to be north of the Border but evidence published by M.E. Braithwaite suggests it to have been in v.c 68. Long extinct.

158/7.1. COLCHICUM AUTUMNALE *¢__91__, Kincardines.: Birch woodland, Banchory Devenick, NJ914006, I.P. Green, 2004. Established outcast.

‡158/12.2. LILIUM PYRENAICUM *__106__, E. Ross: Milton, NH770744, S. Donald, 2000, det. P. Wortham. *__H6__, Co. Waterford: Single clump by roadside hedge, Ballyvad, S441111, I.P. Green, 2002.

158/13.1. CONVALLARIA MAJALIS *__91__, Kincardines.: By trackside in birchwood, Ardoe, NJ894011, J. Waddell, 2004, **ABD**.

‡158/19.3. SCILLA SIBERICA *__106__, E. Ross: By railway, Tain, NH785821, B.R. and C.B. Ballinger, 2004. Probably garden throw-out.

‡158/22.1. CHIONODOXA FORBESII *__106__, E. Ross: Five flowering spikes by railway, Tain, NH785821, B.R. and C.B. Ballinger, 2004. Garden throw-out.

‡158/22.2. CHIONODOXA SARDENSIS *__106__, E. Ross: Five flowering spikes in mixed woodland, Dingwall, NH552596, B.R. and C.B. Ballinger, 2004. Garden throw-out.

‡158/22.luc. CHIONODOXA LUCILIAE *__95__, Moray: Lots of plants on south road bank, Mosstodloch, NJ338594, I.P. Green, 2004.

‡158/23.2. MUSCARI ARMENIACUM *__106__, E. Ross: Four flowering spikes in mixed woodland, Dingwall, NH552596, B.R. and C.B. Ballinger, 2004. Garden throw-out.

‡158/24.1. ALLIUM SCHOENOPRASUM *__106__, E. Ross: By shore path, Hilton, NH873765, B.R. and C.B. Ballinger, 2004, **herb. B. Ballinger**. Near houses and probably garden throw-out.

‡158/24.12. ALLIUM CARINATUM **1a**, W. Cornwall: Naturalised along roadside verge, Illogan, Redruth, SW660437, P.R. Green, 2002. 1st naturalised record & only extant site.

‡158/24.13. ALLIUM AMPELOPRASUM var. BABINGTONII *__H6__, Co. Waterford: Twelve specimens on road bank, Ballynaneashagh, S568103, I.P. Green, 2002.

¢158/24.por. ALLIUM PORRUM *__95__, Moray: One Plant growing on roadside where it had been dumped near Dulicht Bridge, Grantown-on-Spey, NJ0228, I.P. Green, 2004.

‡158/31.2. LEUCOJUM VERNUM *__73__, Kirkcudbrights.: Wet woodland, Laurieston, NX 679662, A. White, 2002. Probably naturalised from nearby cottage.

158/34.1b. ASPARAGUS OFFICINALIS subsp. OFFICINALIS *__¢113(S)__, Channel Is. (Sark): Self-sown in crack in concrete steps outside shop, The Avenue, WV468758, R.M. Veall, 2002, **herb. Société Sercquiaise**.

¢158/ERY.den. ERYTHRONIUM DENS-CANIS *__106__, E. Ross: Waste ground by carpark at golf course, Tain, NH786822, B.R. and C.B. Ballinger, 2004. Probably garden throw-out.

‡159/2.5. SISYRINCHIUM STRIATUM *__58__, Cheshire: Industrial tip, Runcorn, SJ5484, D. Platt, 2002.

159/7.1. ROMULEA COLUMNAE **2**, E. Cornwall: Over 1000 plants in thin grassy turf around cliff-top rocky outcrops and on rocky ledges, near Wellake, east of Polruan, SX132505, I.J. Bennallick, 2002. 1st recent record for Cornwall.

‡159/13.1. CROCOSMIA PANICULATA *__91__, Kincardines.: Riverside grassland, Strachan, NO680921, D. Welch, 2004.

‡159/13.3. CROCOSMIA POTTSII *__77__, Lanarks.: Established in damp, grassy waste ground, East Kilbride, NS6351, P. Macpherson, 2002, **herb. P.M.**, conf. A.McG. Stirling.

162/3.7. EPIPACTIS PHYLLANTHES **39**, Staffs.: A dozen plants in secondary woodland, Wollaston, SO894850, M.E. Smith, 2004, **STOKE**, conf. A.J. Richards. 1st definite record.

162/7.3. SPIRANTHES ROMANZOFFIANA **103**, Mid Ebudes (Tiree): Two flowering plants and 1 single leaf, in wet, species-rich marshland, The Reef RSPB reserve, NM014461, J. Bowler & L. Farrell, 2002. New island record.

162/13.1. PLATANTHERA CHLORANTHA **78**, Peebless.: Rough grass on uncultivated hillside, Dawyck Botanic Garden, Stobo, above Dawyck Chapel, NT1734, D. Knott, 2002, det. D.R. McKean. 1 plant first found in July 2001. Pollinia not parallel.

162/23.1×3. OPHRYS INSECTIFERA × O. APIFERA **6**, N. Somerset: 3 plants found in 2003, 4 in 2004, Blackford, ST664269, S. Andrew, 2003. The only known site at present. Previously recorded from a different site but no longer found there and thought extinct.

Obituaries

JOAN FLORENCE HALL
(1919–2004)

With the death of Joan Hall on 28 August 2004 after a short illness we have lost one of the rapidly diminishing number of stalwarts of the BSBI who took our society by what David Allen called "full steam ahead" into a "golden period", i.e. the 1950s, when the BSBI as we know it today started to take shape. The defining activity in that period was of course the field work for the 1962 *Atlas of the British Flora*, in which Joan, along with her husband Peter, was deeply involved.

Joan Hall was born on 22 February 1919 in Folkestone, Kent. Joan's father died early in her life, and her mother was an accomplished studio photographer who often travelled away from home, so Joan was largely brought up by her grandmother, of whom she became extremely fond. Joan excelled at school, and gained a scholarship to the grammar school and then, in the late 1930s, a place at East London College (later Queen Elizabeth College, University of London) to read Chemistry. Unfortunately at about that time her grandmother became seriously ill and Joan characteristically passed up the opportunity of University life to nurse her. In any case war broke out, and after her grandmother's death Joan took up infant school teaching, at first in London and later while evacuated to the West Country. She then sought a more demanding job that was closer to her interests in chemistry and moved to Manchester to work on quality control for the Scientific Civil Service in a paint laboratory. After the war this moved to Risley, Cheshire, where she met her future husband Peter, whose job had also taken him there in 1946.

Their favourite spare-time occupation in their first years together was walking, especially tramping the moors in Derbyshire and Yorkshire. I remember Joan telling me, when I moved to Manchester in 1962, that after a day on the moors their trousers were covered in black soot from the factories in the valleys, before the Clean Air Act came into force. In the late 1940s the Risley laboratory closed down and they were moved to Woolwich, Joan to continue working on paints and adhesives and Peter on fuels and lubricants. They were married in the Kensington Registry Office in 1950.

During their walks they became interested in the plants that they saw and frustrated at not knowing their names. An increasing fascination with plants led them to join the BSBI and the London Natural History Society in 1952, in both of which they became prominent and influential members, and they were founder members of the Kent Field Club in 1955. After their return to London they spent a holiday walking the Pennine Way, via Youth Hostels.

During the 1950s Joan and Peter rapidly became expert field botanists, and gradually, as their expertise became more widely known, they took on greater roles in organising field work for the societies, and many less expert botanists, such as myself, benefited enormously from their kind and patient tuition. Peter became the BSBI Field Secretary in 1956, and Joan and he participated in all the field meetings concerned with Atlas recording until the *Atlas* was published. Perhaps their most notable discovery was of *Spiranthes romanzoffiana* in South Devon in 1957, still the only English or Welsh locality and the most southerly site in Europe. Although they were very much an equal partnership, Joan was happy to remain in the background and simply take pleasure in Peter's achievements. She served on the BSBI Development and Rules Committee from 1959 to 1965, and was Minuting Secretary to Council from 1963 to 1967. Joan also prepared by hand many of the nearly 1000 maps in Peter's *Sussex Plant Atlas* (1980).

In 1969, aged 50, Joan retired from her profession and could then devote more time to her love for plants, both wild and cultivated. She was an expert gardener, both skilled and knowledgeable, with a special interest in alpines, lilies and penstemons, and was a keen participating member of the Alpine Garden Society and of the National Trust. Her expertise was much needed since for many years her garden was on the chalky boulder clay of North Kent. Another of Joan's talents lay in tailoring and needlework, skills learned from her grandmother, and she made almost all the clothes worn by her and Peter to a fully professional standard.



Joan Hall at an *Atlas* field meeting around 1960

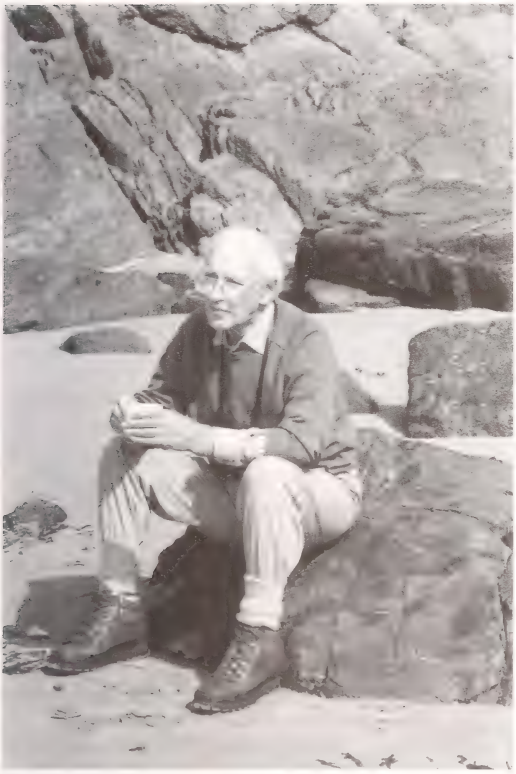
Soon after 1977, when Peter retired, they escaped the over-crowded south-east to live in a rural house just outside Monmouth, where Joan took over a larger garden overlooking the River Monnow. During their time there they attended many B.S.B.I. and local field meetings and so made new friends. In 1994, when the garden proved too large to maintain, they moved again to a flat in Poole, where Joan created and enjoyed a tiny balcony garden.

Many will wish to extend their sincere sympathies to her husband Peter, to which I add my thanks for most of the above biographical details.

CLIVE STACE

ALLAN McGREGOR STIRLING
(1924–2004)

Allan Stirling joined the Botanical Society of the British Isles (B.S.B.I.) in 1954 and was actively involved with the Society until his death. In particular, he was appointed plant recorder for Dunbartonshire (v.c. 99) in 1961, transferring to Ayrshire (v.c. 75) in 1987. In the 1960s–1970s he was a member of the Committee for the Study of the Scottish Flora (C.S.S.F.), a joint undertaking involving the B.S.B.I. and the Botanical Society of Edinburgh (B.S.E.), whose aim was to promote projects in Scotland – e.g. the C.S.S.F. instigated recording which culminated in the 1985 publication of *A Map Flora of Mainland Inverness-shire*. Elected a founder member of the B.S.B.I. Committee for Scotland in 1977, he became its first Vice-chairman and second Chairman. He served on the committee again from 1986–91. He was joint editor of the *B.S.B.I. Scottish Newsletter* for Issues 1–26 (1979–2004). In 1993 he gave the formal presentation at the Scottish Annual Meeting, the subject being the "Flora of the Vice-county Ayrshire". It was subsequently reported that the talk had given the history of plant recording, along with a description of the geology and topography that dictate the habitats of the area, with particular attention to the flora of Ailsa Craig. The special botanical features and local plant rarities had been splendidly illustrated.



Allan Stirling at Knock Bay, near Portpatrick in 1994.

Being an excellent photographer he was a frequent contributor to the post-supper presentation of colour transparencies and tabled many interesting exhibits. When leading field meetings, he shared his expertise willingly according to the level of knowledge of those attending. In general, he was very unstinting in sharing his time with others.

His interest in wild plants was kindled when, as a student at the West of Scotland Agricultural College, he was sent for practical experience to work on a hill farm on the west side of Loch Lomond. As part of his course, he was expected to identify 100 different plants growing on the farm, Initially, he took the National Diplomas in Agriculture and Dairying and after War and National Service in the R.A.O.C., obtained the General Agriculture Diploma in 1949. After qualifying he worked in the Bacteriology Department of the West of Scotland Agricultural College, engaged in Farm Advisory work and part-time lecturing. He then became a cheese and butter grader, working for a time in Chester, before returning north to become Assistant Manager of a Milk Powder Factory of the Scottish Milk Marketing Board. In 1962 he was appointed Technical Officer of Creamery Production at the head office in Glasgow.

At the time of the recording project for *Atlas of the British Flora* (1962) he teamed up with Alfred Slack, by camping out overnight they were able to explore some of the more mountainous areas of Scotland. He developed an interest in hawkweeds, going on excursions with Archie Kenneth and they made significant contribution to the study of the genus in Scotland; initially just collecting, but subsequently becoming knowledgeable. Specimens presented to the Cambridge Botanic Garden about 1960 formed a valuable addition to their collection. A summary of their findings appeared in *Watsonia* (Stirling & Kenneth 1970). Working with Anne Sleep on the 'false serpentine spleenwort' *Asplenium adiantum-nigrum* subsp. *corrunense* (Page 1977) (=subsp. *silesianum* Milde); he visited serpentine outcrops all over Scotland, taking many tiny glass tubes and preservative for pieces of frond. Having learned of the re-finding of *Polystichum* ×*illyricum* (*P. aculeatum* × *P. lonchitis*) in Ireland in 1972, he surmised that a likely site would be on the limestone scree at Inchnadamph in Sutherland. Accordingly, he paid a visit in 1973 and (with permission from the Nature Conservancy) fronds taken from three plants which he considered to be likely candidates, were confirmed by Dr Sleep to be the hybrid. Later in the year they both visited the site and discovered 39 plants. The discovery constituted the second British record. With the help of Dick Roberts he became an expert at identifying the *Polypodium* spp. and their hybrids. He had made a study of base-rich areas and with A. R. found eleven sites for *Polypodium cambricum* in Scotland, and one for the only known site for *P.* ×*font-queri*, its hybrid with *P. vulgare*, at Maidenbower Craigs near Dumfries (Rutherford & Stirling 1973). They also made exploration trips to discover which *Lamiastrum* subspecies were established in central Scotland – the ramping *L. galeobdolon* subsp. *argentatum* or spangled forms of subsp. *montanum*. The resulting information was published in *BSBI News* (Rutherford & Stirling 1987) and the differentiating features in the Plant Crib 1998 (Stirling & Rutherford 1987). In addition, he had a good working knowledge of a number of other critical genera: e.g. brambles, dandelions, roses, willows and sedges.

His knowledge of plants was not limited to Scotland. He botanised in other parts of Great Britain and as co-recorder is credited with the first record for Wales of *Eriophorum gracile* (Slender Cottongrass). Further, he went with the C.S.S.F. on their annual field meetings to Scandinavia or

Europe and attended foreign meetings led by B.S.B.I. members, in particular to south Spain. By taking ivy cuttings from a wide range of sites, he laid the groundwork for the *Hedera* research by Hugh McAllister at Ness Gardens, Liverpool University, which led to the *Hedera* account in *Flora Iberica* (Valcarcel *et al.* 2003).

His experience and dedication were appreciated also by other societies. He served as an office bearer in the Glasgow Natural History Society continuously from 1963–2004. In particular, at various times he held the offices of President, Treasurer, Convenor of botany and Editor of Short Notes for the *Glasgow Naturalist*. In recognition of his contribution, he was elected an Honorary Member in 1995. He had an interest also in bryophytes (joining the Bryological Society in 1963) and became acknowledged by fellow bryologists as having a 'good eye' for even the most inconspicuous of species.

To our knowledge, he had between 45 and 55 publications (10 as co-author with P.M.). Most were related to the west of Scotland – mainly new native or alien records, distribution of a species or site recording.

The B.S.B.I. are extremely grateful to the Stirling family for donating not only the botanical records and VCR material but also much of his botanical book library and vast collection of Scottish geological maps. The B.S.B.I. Scottish Officer, Jim McIntosh is now the 'proud owner' of an almost complete set of botanical atlases and Scottish floras, which will be immensely useful to his work. The geological maps are being dispersed, along with the copious extra v.c. 75 records and notes, to vice-county recorders around Scotland. Alison Rutherford has, at present all the VCR material safely stored. The remainder of the books, along with his photographic slides and microscope have been presented to the Glasgow Art Gallery and Museum. Allan Stirling accumulated an enormous private vascular plant and bryophyte herbarium. The specimens were carefully pressed and kept between newspaper pages, with detailed annotations along the margins. Although this collection is predominantly from west and central Scotland, it also includes much material from other parts of the British Isles and abroad. *Pteropsida*, *Rubi* and *Hieracia*, three of his particular interests, are very well represented and there is also an appreciable collection of named *Taraxaca*. He has bequeathed this invaluable collection the Royal Botanic Garden Edinburgh Herbarium, whose curating staff are most grateful, if rather daunted by the processing task ahead. It required two crammed-full carloads to transport the packages! To the end he resisted new technology – persisting with his typewriter and card indices.

He was frequently asked to leave a botanical curriculum vitae to aid anyone who might be involved in writing an obituary. However, it was appreciated that its production would be unlikely on account of his natural diffidence. It is hoped that no item has been left out which was of special importance to him. In 1972 J. E. (Ted) Lousley had told one of us that Allan Stirling was shaping up to be one of the best Scottish field botanists. This prediction was justified – Allan Stirling was definitely one of the best.

We are grateful for information supplied by John Mitchell, David McCosh and Jim McIntosh.

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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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